PB-224 300

DUALISM IN MEXICAN AGRICULTURAL DEVELOPMENT: IRRIGATION DEVELOPMENT AND THE PUEBLA PROJECT

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Prepared for:

Agency for International Development

21 June 1972

BIBLIOGRAPHIC DATA SHEET	1. Report No. MX-630.972-B592	2.	3. Recipient's Accession No. PB-224 300
4. Title and Subtitle "Dualism in Mexican Agricultural Development: Irrigation Development and the Puebla Project"			5. Report Date Jun 72
			6.
7. Author(s) Huntley H. Briggs			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Colorado State Univ.			10. Project/Task/Work Unit No. 931-11-120-489
			11. Contract/Grant No. AID/csd-2460
12. Sponsoring Organization Name and Address Department of State Agency for International Development Washington, D.C. 20523			13. Type of Report & Period Covered
			14.

15. Supplementary Notes

16. Abstracts

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17. Key Words and Document Analysis. 17a. Descriptors

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group 630

18. Availability Statement	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 27
	20. Security Class (This Page) UNCLASSIFIED	22. Price $3.50-145

)UALISM IN MEXICAN AGRICULTURAL DEVELOPMENT: :RIGATION DEVELOPMENT AND THE PUEBLA PROJECT

Water Management Technical Report No. 21

by

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Prepared under support of

United States Agency for International Development
Contract No. AID/csd-2460
Optimum Utilization of Water Resources:
With Special Emphasis on Water Delivery
and Removal Systems and Relevant
Institutional Development

Department of Economics
College of Humanities and Social Sciences
Colorado State University
Fort Collins, Colorado 80521

June 21, 1972

ID72-73HHB2

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DUALISM IN MEXICAN AGRICULTURAL DEVELOPMENT: IRRIGATION DEVELOPMENT AND THE PUEBLA PROJECT

One of the bitter lessons of the Development Decade of the 1960's is that accelerating the rate of growth in output is not a panacea for widespread poverty. The persistence of poverty is evidenced by massive unemployment, both open and disguised, and by the dramatic skew in income distribution. Once the goal of development is perceived as the alleviation of poverty on a broad scale, the strategy for its accomplishment must be aimed at raising total output, and expanding employment, and increasing average income. Because of the relative scarcity of capital resources, the problem of capital productivity needs to be considered as well in designing the strategy. The purpose of this paper is to explore a policy prescription, aimed at the agricultural sector, which will promote the three development objectives within the criterion of allocative efficiency. The discussion will be limited to the experience of Mexico which holds many valuable lessons in this regard.

ALTERNATIVE TECHNOLOGIES FOR AGRICULTURAL DEVELOPMENT

The importance of expanding agricultural output for general economic development is now a well established part of the liturgy on economic development. A partial explanation for the slow growth in agricultural output in many developing countries lies in the use of traditional technologies among a large number of farming units. Traditional technologies have placed ceilings on productivity and limited aggregate production possibilities. Quite often new technologies call for the use of non-conventional capital inputs.[1] Given the relative scarcities of capital,

development planners are faced with the task of promoting the adoption of new technologies which use capital resources while simultaneously raising both per capita income and employment.

Some development experts claim that it is impossible to accomplish all three development objectives because of an apparent irreconcilable conflict between output and employment. This conflict is based on the assumption of limited factor substitutibility and on the contention that labor-intensive techniques are inefficient in the use of capital.[2] Precise conclusions regarding the relative productivity of capital under techniques of differing labor intensity must take into consideration the scale of operation which is directly influenced by the degree of divisibility of the capital inputs.

Let us begin by analyzing the interrelationships between output, employment and capital use which alternative technological changes in agriculture imply. This discussion is facilitated by the use of an identity.[3] The level of per capita production in agriculture (Q/L) is the product of the average yield (Q/A) times the average availability of land per worker (A/L):

$$(1) \qquad Q/L = Q/A \cdot A/L$$

To raise per capita output (Q/L) is one of the objectives of development as indicated earlier. This may be accomplished within agriculture either by raising yields and/or by increasing the land-man ratio. Accomplishing these may be quite difficult within the framework of the traditional technology and existing tenure arrangements. There is the need for introducing non-conventional inputs to raise the values of the elements on the right side of the identity. These non-conventional inputs may be called landesque and laboresque capital, referring to the factors for which they substitute.[4]

The term "landesque" capital may be used to describe the landsaving qualities of inputs designed to raise yields (e.g., hybrid seeds, fertilizers, etc.). Due to the fact that these inputs are highly divisible, returns on this type of investment are neutral to farm size. In addition, this type of capital generally requires additional labor inputs compared to traditional production methods in order to optimize returns (e.g., careful planting, fertilizing, weeding, etc.). Agricultural capital of the "laboresque" variety (e.g., tractors, mechanical equipment, etc.) is designed primarily to substitute for labor inputs, and only indirectly, if at all to enhance yields. Measuring capital and labor inputs in terms of standardized units, one may conclude that a unit of investment in landesque capital generates higher levels of employment at the farm level than a unit of investment in laboresque capital. Because of the lumpiness of laboresque capital, a minimum amount of acreage must be cultivated to make such an investment economically feasible. Of course, once the laboresque capital is introduced onto the farm, the returns on the initial investment can be increased by expanding the acreage under production beyond the minimum, threshold amount.

In sum, landesque capital operates on the right side of the identity to raise yields (Q/A), absorbs labor and can be applied irrespective of farm size. Conversely, laboresque capital operates to raise the land-man ratio (A/L), displaces labor, and requires a minimum land size to be economically, and perhaps physically, feasible.[5]

In the light of the tripartite development objective within the constraints of maximizing returns to capital, the strategy of agricultural development becomes determined by the relative availability of land and labor resources and by the related structure of agriculture. In regions

where labor is increasing faster than land, per capita output can be raised without adversely affecting employment by raising yields with landesque capital. Typically, such areas are characterized by numerous relatively small holdings where production is oriented primarily to satisfying family consumption needs. On the other hand, in underpopulated regions where labor is relatively scarce compared to land resources, per capita output can be raised by introducing laboresque capital to permit the cultivation of large tracts of land. In some regions, mechanization may increase employment by opening new lands to agricultural persuits through land clearing, deep plowing, etc. There also may be special cases where the absolute decline in the number of rural workers, caused by migration to urban areas, necessitates the introduction of mechanical equipment so as to prevent declines in total agricultural production.

In most less-developed countries, however, the absolute number of persons living in rural areas is continuing to increase despite the fact that there are examples, such as Mexico, where the percentage of workers engaged in agriculture is falling. The decline in the proportion of persons engaged in agriculture need not be a cause for optimism among developmental experts. The decline in the share of agriculture in total employment is often accounted for not by rises in industrial employment but rather by increases in tertiary and "unspecified" activities, a residual category characterized by a high degree of underemployment.[6] For some years to

come, development planners will have to be concerned with creating effective employment possibilities within the rural areas both to raise the living standards of an increasing rural population and to discourage urban drift.

CONTRIVED DUALISM: A POLICY PRESCRIPTION

To accomplish the tripartite goal of development within the agricultural sector, policies directed toward "contrived dualism" have been suggested.[7] Briefly, this approach calls for the planned development of two subsectors. The output subsector would be oriented to stimulating production growth to feed an expanding urban population and to generate foreign exchange reserves. This implies the existence of large-scale farms utilizing large quantities of off-farm inputs. This subsector should be encouraged in regions where land is relatively abundant so as not to displace workers and create unemployment. The employment subsector would be primarily responsible for absorbing labor and providing for the consumption needs for the family members until employment growth in the industrial-urban sector catches up with population growth. Besides performing a social welfare function, per capita incomes and total output can be raised through policies directed toward encouraging the introduction of landesque technologies on the multitude of small farms that populate this sector.

This paper is an attempt to analyze the agricultural development of Mexico and related policies in terms of the notions of contrived dualism. Over the past twenty years, the major focus of agricultural policy has been on stimulating output chiefly by alleviating the resource constraints of land and water, and by directing public services (research, extension, credit, etc.) at the large farms. Until recently public policies regarding the employment subsector have been limited to land redistribution, public

education and rural electrification. Little effort has been made toward changing traditional production techniques so as to raise productivity levels. The growing poverty among the majority of the rural population has forced the attention of policymakers to be redirected toward small-scale subsistence farmers of the employment subsector. Since 1967, the International Wheat and Maize Improvement Center (CIMMYT) with the support of the Mexican government has been engaged in the Puebla Project. The purpose of this project is to design and convey technologies for raising maize yields on small-scale subsistence farms. The Puebla Project is also concerned with institutional innovation to support the extension effort. The balance of the paper is devoted to examining the output and employment subsectors in Mexican agriculture.

THE OUTPUT SUBSECTOR

In the past, Mexican agricultural policy has been oriented primarily toward increasing output through the development of irrigated agriculture in the underpopulated, arid and semi-arid Northern States.[8] Since the late 1920's, about two million hectares of federal land have been brought under irrigation while the amount in private hands has remained at about 1.5 million hectares.[9] Over this period, irrigation works have constituted between 10 and 15 per cent of all public investments, ranking second to communications and transportation.[10]

As a result of the public sector's emphasis on irrigated agriculture, the aggregate growth in Mexican agricultural output has been quite respectable, averaging about 4.6 per cent, or 3.1 per cent per capita, over the period 1946-65.[11] Within the irrigated districts, output has been growing at an annual rate of 12 per cent.[12] During 1960-66, the irrigation districts accounted for 30.7 per cent of the total value of Mexico's crop

production on only 14.4 per cent of the country's harvested land,[13] and 13 per cent of all farming units.[14] The significance of irrigated farming can be explained partly by the high value of output per land unit. The average value of output per hectare for 1960-66 was 2.7 times greater than for the rest of the country, or US$289 and US$112 per hectare, respectively.[15]

The distribution of holdings within the irrigation districts reveals that a major portion of the agricultural output is attributable to a small number of relatively large, private farms. In 1966 private farms in excess of 10 hectares accounted for 45.8 per cent of the land, yet constituted only 9.1 per cent of the operating units. These units were over twelve times larger than the average ejido unit. On the other hand, the ejido farms made up 71.0 per cent of the operating units, but covered only 46.2 per cent of the area.[16]

The large private farms are either portions of former extensive haciendas or are newly created estates, called "colonos." In constituting the Agrarian Code, the key document in the land reform program, Mexican officials apparently recognized both the potential for size economies and the possible adverse effects on total output which excessive parcelization of the old estates might have entailed. The National Irrigation Commission permitted the original owner to retain 100 hectares of irrigated land of his choice with reasonable compensation for the remainder. Lands in excess of the allowed maximum were combined with public lands either for redistribution to ejiditarios or for the establishment of new private owners colonos. Since 1963, amendments to the Agrarian Code have restricted the redistribution of land to the creation of ejidos only. Generally, the size of ejido plots is limited to about four hectares of irrigated land; however, private holdings can reach a maximum of 100 hectares for most crops and even

300 hectares for certain industrial and tree crops (e.g., sugar cane. cacao, bananas, etc.).[17]

From the preceding description, it is safe to say that the large private, irrigated farms have been the leading units in the output subsector. It is they that have been largely responsible for the success of Mexican agricultural development in the past three decades.

The output subsector has been oriented toward generating foreign exchange and satisfying a growing urban demand. In 1960, over three-fourths of the total irrigated cropland was allocated to three crops: corn (26.9%), cotton (25.8%) and wheat (24.7%).[18] Cotton is the leading export earner, constituting about one-fifth of the total value of exports between 1960 and 1965.[19] Over the period, the irrigation districts supplied about 85 per cent of the total cotton crop.[20] Sugar products accounted for about seven per cent of total exports and nearly one-third of the land was located in the irrigation districts.[21] Of increasing importance for international trade are winter fruits and vegetables produced for the U.S. market. Exports of these commodities to the U.S. have quadrupled since 1960, and doubled since 1967. By 1970 they had reached a total of US$191 million or between five and ten per cent of total exports.[22] A large share of these crops (tomatoes, strawberries, peppers, cucumbers, and melons) are raised on irrigated lands with the assistance of U.S. capital. Nearly two-thirds of the production of these crops in 1966/67 was concentrated in the State of Sinaloa, where the federal government has invested heavily in irrigation facilities, highways and railroads.[23]

Corn and wheat have made significant contributions to the domestic food supplies, and to international reserves via import substitution and exportation. Between 1950 and 1968, wheat output tripled and corn quadrupled.[24] Much of the dramatic increases can be attributed to the introduction of

improved seeds and related inputs within the irrigated districts. In 1965 the irrigated districts accounted for 95 per cent and 13 per cent of the country's wheat and corn production, respectively, on 81 and 7 per cent of the total land area devoted to these crops.[25] The share of total corn production may tend to understate the importance of irrigated farming for commercial sales, since a large portion of total output is concentrated on small plots chiefly for family consumption.

With the increased availability of irrigation water, there has been introduced simultaneously a production technology emphasizing purchased inputs. One study indicates that the value of purchased inputs per farm in irrigated districts is over twice that for non-irrigated farms.[26] Both landesque and laboresque capital inputs are used. One explanation for the increased use of off-farm inputs in irrigated areas is that they are relatively low cost compared to non-irrigated regions. This is accounted for by easier access to transportation facilities and easier adaptation of inputs to the relatively homogenous environmental conditions in the irrigated zones.

Another explanation for the heavy use of purchased inputs is that public policies have increased the effectiveness of these inputs at no cost to the farmer.[27] Agricultural research and extension efforts have been geared to the needs of the larger farmers in irrigated districts. Both private and public credit have similarly been concentrated because recovery rates on loans are good. Public investments in highways have been heaviest in the same regions that have received the bulk of federal expenditures for irrigated land, the North and North Pacific regions. Thus, the expansion of output in irrigated areas can be explained by public policies aimed at the development and dissemination of progressive farming techniques which utilize both landesque capital (water, fertilizers and seeds) and laboresque capital equipment.

EMPLOYMENT SUBSECTOR

The public policies, aimed at increasing total agricultural production by concentrating efforts on the large private farms in the irrigated zones, have met with a large measure of success. However, from the standpoint of the broader developmental objectives, these policies have met with only limited success. Rural poverty is still the major development problem in Mexico. Three-fourths of the persons in the two lowest income brackets are in agriculture.[28] There is also evidence that the standard of living of the lowest income group has actually declined since 1950.[29]

The core of rural poverty is located in the densely populated areas of the Central and South Pacific regions. There, the bulk of Mexico's rural population subsists on extremely small, rain-fed parcels. Governmental policy regarding this subsector has been concerned primarily with land redistribution. This program has involved a small expenditure of public funds relative to that for irrigated agriculture in the Northern States. Despite rather extensive land reform, the number of landless rural laborers increased from 2.3 million to 3.3 million between 1950 and 1960. The rising levels of rural unemployment are reflected in both a decline in per capita man-days worked, and a decline in real incomes among landless laborers.[30] For those having access to land for their own cultivation, the relative small size and traditional production technologies have placed ceilings on production possibilities. Together with increases in population, output limitations explain low and perhaps falling rural per capita incomes for many rural dwellers.

Despite only marginal contributions to output growth, the employment subsector has performed many key functions in the general economic development of Mexico. First, a large measure of general political stability can be attributed to stability in the rural areas, encouraged by the land

distribution policy. Second, this policy has lessened to some degree the flow of persons from the rural to urban areas by absorbing family labor and providing the means of subsistence for those on the farm. Finally, individual producers in this subsector have utilized scarce inputs more productively than the larger landholders. One study indicates that the output per unit of all purchased inputs is greatest on the small, private holdings less than five hectares, followed by the ejidos (many of which are less than five hectares), and lastly the large privately owned farms.[31] In addition, productivity residual growth in agriculture has been greatest in those regions receiving relatively low levels of public investment. In these areas (Central and South Pacific), labor- and land-intensive techniques are common compared to the North and Northwestern regions which have been favored by public investment and where capital-intensive techniques prevail.[32]

On the basis of recent evidence cited above, one may raise some doubts as to the efficacy of past policy in the allocation of public funds for agricultural development. While there can be little doubt that investments to open new lands for large scale, irrigated agriculture have contributed to growth in both total output and absolute productivity, these resources perhaps could have made even greater progress toward achieving the larger goals of economic development had they been used to raise productivity levels on existing farming units in the densely populated areas of the country.

In recent years, Mexican officials have become increasingly aware of the contributions which the employment subsector can make to the three development objectives (output, employment and per capita income) with relatively small outlays of public funds. Even more significant, they are increasingly sensitive to the continued poverty among the rural masses, and its socio-political, as well as economic connotations. Rural dwellers are no longer

ignorant of the differentials in income that exist between the rural and industrial-urban areas, and between agricultural regions within the country. Both social stability and industrial progress are contingent upon efforts to raise average incomes of small, subsistence farmers since they constitute a significant proportion of the total population. In the face of the increasing pressures of population on available land resources in the poverty areas, per capita incomes can be raised chiefly by raising average yields. This calls for new technologies based on the use of non-conventional, landesque inputs. Experience in this regard is being obtained from the Puebla Project.

In 1967, an experiment was launched in the State of Puebla to develop and convey a new maize-growing technology to a large number of small farmers. The Puebla Project is being directed by the International Wheat and Maize Improvement Center (CIMMYT) with the cooperation of both public and private agricultural agencies.[33] The environmental and organizational characteristics of the Project zone typify those found in many regions of Mexico as well as other parts of the world. In the zone, there are about 47,535 farms, averaging about 2.5 hectares. Despite the fact that soil depths and rainfall are adequate, average yields are low so that the major share of output is only for family consumption. Generally speaking, farmers use a traditional technology, developed over many years by trial-and-error. Despite the fact that many farmers have knowledge of fertilizers, hybrid seeds and pesticides, they seldom use them and then in inappropriate quantities and combinations to raise yields substantially.

The project staff in 1967 consisted of a production agronomist, a maize breeder and a coordinator. During that year, experiments were conducted on farmers' fields to formulate recommendations. In essence the project area became the experiment station. This arrangement allowed reliable results to

be obtained quickly. The experiments called for increased fertilizer applications of a new mix, the doubling of plantings per field, and the availability of fertilizer and credit at the planting time, rather than after the first cultivation, as done previously.

In 1968, the research and extension functions were integrated. To assist in the extension function a farm advisor and an evaluator were added to the staff. A number of plots were selected for conducting studies of agronomic practices and improvement trials, and a number of high-yield plots were initiated. The latter were small areas on which the farmer employed the project recommendations under close supervision. Participating farmers were selected with the assistance of the local and municipal leaders. Credit availability was crucial to the success of the project; however, the banking institutions were reluctant to participate without more convincing evidence of potential results. Fortunately, a private seed-fertilizer distributor agreed to extend credit to the participants.

The results were remarkable. The farmers experienced at least a doubling and in some cases a quadrupling of yields over the traditional techniques. The experimental and high-yield plots served as demonstration fields. Field days were held for both farmers and representatives of the agricultural infrastructure. In this way, the farmers learned the recommended practices by observing the experiences of their neighbors, and the institutional representatives gained confidence in the reliability of the new techniques, thus encouraging their support particularly in the field of credit. The participating farmers took the leadership in organizing and conducting the field days to gain experience for support of future extension efforts.

The successes in 1968 convinced project personnel to expand further their efforts during the next year. It was decided to increase the number

of plots from 151 to 5,000 encompassing an area of about 10,000 hectares. To accomplish the task, twenty non-technical people and five agronomists were added to the staff. Each of the four farm advisors was assigned a particular region. To facilitate the dissemination of information, the farm advisors worked with groups through a democratically elected leader, rather than with individual farmers. On the basis of the 1968 results, a number of institutions agreed to make the credit available. The project coordinator was responsible for making sure that the fertilizer and credit were available at the right time; however, each group leader had the primary responsibility for procuring credit and fertilizer.

The available evidence suggests that the Puebla Project has met with notable success. The number of participants has increased from 103 in 1968 to 4,833 in 1970 and from 76 to 12,496 hectares. The general attitude of the local inhabitants has changed from one of skepticism to enthusiasm.[34]

The economic impact of the Project has been quite dramatic. Compared to traditional production methods, the costs of production have increased about 90 per cent; however, the dramatic increases in yields (from 1.3 metric tons per hectare to about 4.0 tons) have allowed net profits per hectare to increase nearly five times (from US$27.35 to US$125.96 per hectare). Also the use of animal and labor power under the new technology increased by 58 per cent compared to the traditional one, indicating a potential for increased levels of employment. The prices for the output were guaranteed under the national agricultural marketing program, a fact which no doubt encouraged adoption of the new practices. It is believed that the new techniques can be effectively extended to over six million hectares currently under subsistence production in other zones in Mexico.[35] The implications for general economic development are quite significant.

A benefit-cost study of the Project itself has been made. It reveals that the benefit-cost coefficients for 1968 and 1969 were 0.05 and 1.66 respectively. Projected to 1975, the ratio rises sharpely to 7.8.[36] These figures suggest a rather substantial return on this type of social investment.

There are many lessons to be learned from the Puebla Project regarding the research and extension activities aimed at raising productivity levels on small holdings in the less-developed countries. The Project's experience emphasizes the importance of integrating the research and extension functions. Experiments should be conducted on the farmers' plots under precisely the same environmental conditions confronting the farmer. It is important to gain the participation of the agricultural infrastructure in support of the extension function. This support is vital in the area of making credit available, and assuring that inputs are available at the proper time, in the right quantities, and priced to make their use attractive to farmers. Guaranteed prices and crop insurance are also important for overcoming risks associated with the innovation.

Organization also plays a key role. Research and extension should be a team effort. Each member is a specialist, but he must be capable of working with individuals from other disciplines, and he must be willing to spend much of his time in the fields with the farmers. The direct involvement of farmers in the research and extension functions convinces them of the beneficial results of the recommended practices and gives them confidence in their own organizational capabilities.

SUMMARY

In the past, the major emphasis of Mexican agricultural policy has been on increasing total production through the development of irrigated farming. Heavy investments of public funds have been made in irrigation works and

transportation facilities in the relatively underpopulated Northern States. At the same time, public policy has focused on large, private holdings within the government irrigation districts. Thus, much of the agricultural growth over the past three decades can be attributed to government policies aimed at a small segment of the country's land and farmers. However, despite high aggregate growth rates, average agricultural incomes remain quite low.[37] Regional and sectoral income differentials continue to grow, indicating that only a minority of the population have participated in Mexico's "success story." Progress has only marginally touched the lives of the myriad of subsistence farmers and agricultural workers who with their families constitute about two out of every five persons in the Mexican population.[38]

Increasingly, development specialists, both in and outside of Mexico, are becoming aware that widespread poverty may not be eliminated in the process of general economic growth. To attack the problem of poverty at its roots, special efforts must be made to raise per capita incomes among the vast numbers of small-scale farmers. The Puebla Project provides convincing evidence that this goal can be achieved through an effective research and extension effort, designed to develop and disseminate technologies that emphasize nominal investments in landesque capital with large doses of mental and physical effort. Surprisingly, the task can be accomplished with relatively modest outlays of public funds.

NOTES

[1]The introduction of non-conventional, capital inputs may be referred to as an "embodied" technological change. The new capital unit is qualitatively distinct from the conventional capital inputs in that it embodies new scientific knowledge aimed at raising productivity levels. Rarely does one encounter a technological change that is totally "disembodied" from any additional or qualitatively different capital component. A simple reorganization of existing inputs of a given quantity and quality may raise productivity levels. However, what appears to be a "disembodied" technical change does involve a capital investment from the society's viewpoint in the form of expenditures either for research and experimentation or for the importation of technology from abroad. Additionally, expenditures made to support an extension effort are in essence capital investments in human resources, which alter the quality of the original labor input. Thus, despite the fact that quantitatively input use may have changed little, if at all, at the farm level, disembodied technological change does require capital investments from the viewpoint of the total economy.

[2]For a discussion of the issues surrounding the apparent conflict between output and employment objectives see: Stewart, Frances; and Streeten, Paul. "Conflicts Between Output and Employment Objectives in Developing Countries." Oxford Economic Papers (New Series), XXIII (July 1971), 145-68.

[3]This approach is well developed in the following: Yudelman, M.; Banerji, R.; and Butler, G. "The Use of an Identity to Examine the Association Between Technological Changes and Aggregate Labour Utilization in Agriculture." The Journal of Development Studies, VII (October 1970), 37-49.

[4]The terms landesque and laboresque capital used here were borrowed from the following article: Sen, A. K. "The Choice of Agricultural

Techniques in Underdeveloped Countries." Economic Development and Cultural Change, VII (April 1959), 279-85.

[5]For our purposes, we may consider the effects of the two types of capital to be independent; however, there are cases in reality of interaction. For example, "...labour utilization may increase because of the adoption of land-saving innovations and despite the adoption of labour-saving innovations." Yudelman et al., "Use of Identity and Technological Change," p. 29. Reference here is to mechanization of specific tasks in the production cycle that alleviate periodic labor shortages, aggrevated by the introduction of landesque capital. The net effect may be employment expansion through double-cropping possibilities.

[6]This category is used by the United Nations encompassing mainly disguised unemployed persons. The annual growth of persons in this category has been about 8.5 per cent between 1950 and 1965. See: William C. Thiesenhusen, "Latin America's Employment Problem," Science CLXXII (March 5, 1971), p. 870.

[7]The notion of encouraging a "deliberate creation of two subsectors in agriculture" was first suggested in the following: Owen, Wyn F. "The Double Developmental Squeeze on Agriculture." American Economic Review, LVI (March 1966), 43-70. Since that time the theme has been iterated and elaborated in many articles including: Owen, Wyn F. "Structural Planning in Densely Populated Countries: An Introduction with Applications to Indonesia." The Malayan Economic Review XIV (April 1969), 97-114. Thiesenhusen, William C. "Population Growth and Agricultural Employment in Latin America, with some U.S. Comparisons." American Journal of Agricultural Economics, LI (November 1969), 735-52, Dorner, Peter; and Felstehausen, Herman. "Agrarian Reform and Employment: the Colombian Case." International Labour Review, CII (September 1970), 221-240.

[8]Over three-fourths of the publically irrigated land is found in the twelve Northern States, the North Pacific region alone accounting for about 50 per cent. See: Eduardo L. Venezian and William K. Gamble, The Agricultural Development of Mexico: Its Structure and Growth Since 1950 (New York: Frederick A. Praeger, 1969), p. 100.

[9]Ibid., p. 98.

[10]U.S. Department of Agriculture, Economic Research Service, Sources of Change in Mexican Agricultural Production, 1940-65, by Reed Hertford, Foreign Agricultural Economic Report No. 73 (Washington, D.C.: Government Printing Office, 1971), p. 6.

[11]Ibid., pp. 17-8.

[12]Ibid., p. 35.

[13]Calculated by the author on the basis of data in Table 18 of: Adolfo Orive Abla, La Irrigación en México, (México, D. F.: Editorial Grijalbo, S. A., 1970).

[14]Hertford, Sources of Change, p. 34.

[15]Alba, Irrigación, Table 18.

[16]Ibid., Table 15, p. 211.

[17]In El Carrizo, Sinaloa regulations promulgated in 1969 placed limits on the size of private holdings to 30 hectares of irrigated land and stipulated a minimum ejido size of 10 hectares. This may reflect a growing concern over increasing sizes of private farms. Ibid., pp. 208-9.

[18]Venezian and Gamble, Agricultural Development, p. 101.

[19]United Nations, Food and Agricultural Organization, Trade Yearbook (Rome: FAO), several issues.

[20]Total output data from: United Nations Food and Agricultural Organization, Production Yearbook (Rome: FAO), several issues. Data for

irrigation districts from: Secretaría de Recursos Hidraulicos, Dirección General de Distritos de Riego, Estadística Agricola, (México, D. F.: SRH), several issues.

[21]See notes 18 and 19.

[22]U.S. Department of Agriculture, Economic Research Service, Supplying U.S. Markets with Fresh Winter Produce: Capabilities of the U.S. and Mexican Production Areas, by C. J. Fliginger, E. E. Gavett, J. C. Podany, and L. A. Powell, Sr., supplement to Agriculture Economic Report No. 154 (Washington, D.C.: Government Printing Office, 1971), p. 1.

[23]U.S. Department of Agriculture, Economic Research Service, Supplying U.S. Markets with Fresh Winter Produce: Capabilities of the U.S. and Mexican Production Areas, by C. J. Fliginger, E. E. Gavett, L. A. Powell, Sr., and R. P. Jenkins, Agriculture Economic Report No. 154 (Washington, D.C. Government Printing Office, March 1969), pp. 4-6.

[24]Dana G. Dalrymple, "New Varieties in Mexico: Wheat, Corn" (paper presented at AID Spring Review of New Cereal Varieties, Washington, D.C., May 1969), p. 1.

[25]Ibid., p. 7.

[26]Hertford, Sources of Change, p. 19.

[27]Ibid., p. 35.

[28]Eduardo Venezian, "Income Distribution and Agricultural Development in Mexico" (paper presented at the Ford Foundation Agricultural Program Seminar, Bogota, November 6-9, 1968), p. 11.

[29]Cited in: Roger D. Hansen, Mexican Economic Development: The Roots of Rapid Growth, (Washington, D.C.: National Planning Association, 1971), p. 73.

[30]Ibid., p. 78.

[31]Salomon Eckstein, El Macro Macroeconómico del Problema Agrario Mexicano, (México: Centro de Investigaciones Agrarias, 1968) as cited in: Hansen, Mexican Economic Development, p. 60. Another study indicates that there is no significant difference in crop yields between ejidos and private farms over five hectares. Since yield growth on the ejidos is attributable to increased labor inputs, and that on larger farms to increased purchased inputs, one author concludes that "small-scale labor-intensive production of the reform sectors (ejidos) is less costly than large-scale production, in terms of the goods that are scarce in the Mexican economy (capital)." Bracketed words are mine. See: Folke Dovring, "Land Reform and Productivity in Mexico." Land Economics XLVI (August 1970), p. 273.

[32]Clark W. Reynolds, The Mexican Economy: Twentieth-Century Structure and Growth (New Haven: Yale University Press, 1970), p. 173.

[33]The following description of the Puebla Project has been condensed from: International Maize and Wheat Improvement Center. The Puebla Project: Progress Report of a Program to Rapidly Increase Corn Yields on Small Holdings. Mexico, D. F.: International Wheat and Maize Improvement Center.

[34]Leobardo Jiménez 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, ed. by Delbert Myren (Mexico, D. F.: International Maize and Wheat Improvement Center), pp. 15-16.

[35]Ibid., p. 16.

[36]Jairo Cano and Delbert T. Myren, "Benefit-Cost Analysis of the Puebla Project," in Strategies, pp. 60-61.

[37]Farm output per agricultural worker in 1963-65 was US$350 "lowest among the Latin American countries for which comparable data are available." Hertford, Sources of Change, p. 2.

[38]E. J. Wellhausen, "The Urgency of Accelerating Production on Small Farms," in Strategies, p. 8.