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THE PUEBLA PROJECT: PROGRESS AND PROBLEMS

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Under the guidance of CIMMYT (Spanish initials for the International Maize and Wheat Improvement Center), the Puebla Project in Mexico was initiated in 1967 with the express purpose of raising maize yields on small farming operations. During the early years, the results of the Project were so impressive that many observers believed that the riddle of how to extend new technologies to subsistence farmers had been solved. However, more recent results have not fulfilled previous expectations. The attitude has changed from one of bold enthusiasm to one of cautious optimism. It is becoming increasingly apparent that the problem is an extremely complex one, requiring an interdisciplinary analysis to explain the Project's successes and failures.

This paper describes innovative features of the Puebla Project's research, and extension problem of smallscale, subsistence farming. Second, the obstacles to continued progress are examined. It is hoped that this paper will prove informative for planners and development practitioners of all types who view the alleviation of poverty on a widespread basis as the most basic objective of the development process.

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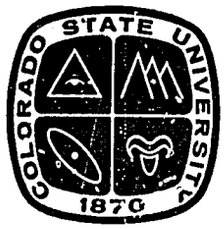

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THE PUEBLA PROJECT: PROGRESS AND PROBLEMS

In recent years, development planners and politicians are paying increasing attention to the problems of subsistence farmers who populate the majority of the world's arable land. While much discussion has been given to the subject, few actual attempts have been made to offer a practical solution. One such experiment has been underway in Mexico for the past seven years. Under the guidance of CIMMYT (Spanish initials for the International Maize and Wheat Improvement Center), the Puebla Project was initiated in 1967 with the express purpose of raising maize yields on small farming operations. During the early years, the results of the Project were so impressive that many observers believed that the riddle of how to extend new technologies to subsistence farmers had been solved. However, more recent results have not fulfilled previous expectations. The attitude has changed from one of bold enthusiasm to one of cautious optimism. It is becoming increasingly apparent that the problem is an extremely complex one, requiring an interdisciplinary analysis to explain the Project's successes and failures.

The basic purpose of this paper is twofold. First, a description of the innovative features of the Puebla Project in its approach to the research and extension problem of small-scale, subsistence farming will be offered. Second, the obstacles to continued progress will be examined on the basis of the experiences over the past two years as related to the author by persons directly involved in the Puebla Project.* It is hoped that this paper will prove informative for planners and development practitioners of all types who view the alleviation of poverty on a widespread basis as the most basic objective of the development process.

Before beginning a discussion of the Puebla Project per se, it is worthwhile to review briefly two related topics: first, the significance of subsistence farming in the process of development; and second, the reasons for the relative lack of attention in the past accorded to this sector by development planners. These topics will provide a background for a discussion of the innovative features of the Puebla experiment and the obstacles to its progress.

THE SIGNIFICANCE OF SUBSISTENCE FARMING FOR DEVELOPMENT

Some cynics may view the growing interest in subsistence farming as a fad on the part of economists from the developed nations of the world. However, there is within many nations of the developing world a genuine sense of urgency for raising the levels of well-being of the rural peasantry. Quite obviously the politician senses the mounting pressures being placed on the establishment by the unsatisfied expectations of an increasingly vocal political group. The developmental planner also is facing the fact that the prescription of economic growth is not the panacea for underdevelopment. The planner is beginning to realize that he must deal directly with the poverty problem as it exists and that it will not necessarily go-away with increased aggregate growth rates. The reality is that over one half of the world's population is engaged in subsistence farming on about 40 percent of the land under cultivation.[1] If one were to look only at the developing countries, it is probable that the figures for each category are much higher. The sheer magnitude of the problem and its persistence have caused planners to reassess their developmental strategies.

Raising the levels of well being for the world's subsistence population may be viewed as a legitimate development objective from many

perspectives. One of the obvious ways in which this goal may be approached is to raise the productive capacity of existing, subsistence farming operations. From the simple standpoint of humanitarianism, higher levels of production may prevent starvation and suffering caused by undernourishment and malnutrition, particularly among children. Not only are immediate consumption levels enhanced, but also more adequate diets can be viewed as an investment in human resources. These investments will enhance mental and physical productive capacity and thus, lead to higher consumption levels in the future which is the ultimate objective of the economic process.

From a very general standpoint, the modernization process involves the integration of all social elements into the effective national society and economy. Currently, most subsistence families live in virtual economic and social isolation from the modern society. By raising the productive capacity of the farming operation, operators may be able to commercialize a part of the crop permitting them to participate in the market economy. This process disintegrates the dualistic nature of most developing countries.

From the perspective of the development economist, the subsistence sector represents a potential source of larger production. The low productivity of physical and human resources encountered in this sector represent sacrifices of agricultural output. Inadequate supplies of agricultural production contribute to inflationary pressures and to balance of payments difficulties. With higher levels of productivity, the subsistence sector could contribute not only to total agricultural supplies but also to capital and labor availabilities for other sectors.

The subsistence sector can benefit the development process not only as a supplier but also as a demander. Currently, the bulk of commercial production in many devoloping countries is made available by a small

proportion of the total number of farmers. As a result the income distribution within the agricultural sector tends to be highly skewed, which in turn is reflected in national income distribution. This fact places severe limitations on the effective demand for manufactured products from the industrial sector. This is one explanation for the retardation of growth and excess capacity for some industrial firms. A more equitable distribution of income would raise the levels of effective demand chiefly for consumer non-durables which typically are characterized by labor-absorptive technologies so that aggregate employment levels are enhanced.

Raising income earning possibilities on small farms contributes to the developmental process by discouraging migration to urban centers. This massive influx of people into the cities is creating serious developmental problems. Typically the immigrants are not able to find effective employment in industrial activities and so join the ranks of the urban unemployed and participate in "unspecified activities."[2] The phenomenon has been labeled urban drift to distinguish it from the movement that characterizes the changes in sectoral distribution of employment in the development process of the now developed countries. Rising numbers of urban unemployed tax social overhead capital capacity, calling for additional expenditures of public funds which have high opportunity costs. Also, the crowding of disaffected persons into urban ghettos creates a tinder box of political and social instability.

Finally, rural dwellers throughout the world are becoming increasingly sensitive to the vast differentials between living levels within their countries. With limited or no access to the fruits of economic progress, the rural peasantry is venting its frustrations through spontaneous demonstrations and outright seizures of property. By enhancing

the possibilities for the enjoyment of a higher level of well being for the subsistence farmer and his family, social and political tensions in the countryside may be attenuated.

THE NEGLECTED MAJORITY

The relative neglect of the subsistence sector until the recent past has many explanations. It has often been contended that efforts would be better spent on guaranteeing the successful performance of the manufacturing and commercial agricultural sectors. It is assumed that high levels of activity in these sectors would tend to reallocate resources out of subsistence farming and thus, automatically alleviate widespread poverty. Others have argued that modern, productive technologies demand a large fixed capital component which is beyond the financial grasp of subsistence farmers. In addition, new technologies to serve the interests of small farmers would be quite expensive to develop and very costly to extend to a large number of decision-making units. As a result, the existing organizational and institutional arrangement supporting agriculture have been oriented to serve the interests of the large, commercial farmers. The pressing need to raise quickly total output level has caused development planners to focus their attention on a small number of commercially oriented farmers, controlling large quantities of land and capital resources.[3]

A NEW APPROACH: THE PUEBLA PROJECT

In recent years, development planners have begun to recognize the pressing need for raising income levels among the subsistence segments of the rural population; however, many are at a loss as to how to execute an effective program. In 1967, the International Maiz and Wheat Improvement Center (CIMMYT) launched a program in the State of Puebla, Mexico

specifically designed to raise maize yields on small holdings. The program is an experiment not only in devising new production technologies suitable to the needs of maize farmers in this region, but also in devising an appropriate extension strategy for conveying the new technology to a large number of small operators. Having been in operation for five years, there are a number of lessons to be learned from the Puebla Project that have application to other countries desiring to initiate similar programs aimed at subsistence cultivators.

There are a number of unique features in the Puebla Project.[4] First, great efforts were made to integrate the research and extension functions. Rather than conducting agronomic experiments in the isolation of an experiment station, the farmers' plots were used in performing the research for developing new production recommendations. In this way, experimental results were obtained under precisely the same environmental conditions confronting the cultivator, shortening the feedback loop to the researcher. On the basis of field experiments in 1967, three basic changes in production techniques were recommended. First, the recommendations called for increased fertilizer applications of a different mix than that used locally. To carry out the new fertilizing recommendations an increase of about 25 percent in the amount of credit was needed. Second, the fertilizer should be applied at the time of planting with the balance at the time of the second cultivation. The traditional techniques called for applications only at the first cultivation after the seedlings were well established. Third, the plant population was increased from about 20,000 to 50,000 plants per hectare.

To effectively integrate the extension function with the research component a number of "high-yield plots" were initiated on the farms

themselves. These were small areas on which the farmer employed the recommendations under the close supervision of project personnel. Field days were conducted by the participants for the benefit of representatives from the agricultural infrastructure and the other farmers in the region.

A second innovative feature of the Puebla Project is the use of an interdisciplinary team to carry out the functions of research, extension, evaluation and coordination of activities with other public and private institutions. In Table 1 below, the composition of the team is listed by years. The change in the mix of the membership of the team reflects

Table 1

Composition of Team Membership, Puebla Project

	1967	1968	1969	1970	1971
Agronomic researcher	3	3	4	5	3
Extension adviser	0	1	4	5	5
Evaluator	1	1	1	1	2
Coordinator	1	1	1	1	1
TOTAL	5	6	10	12	11

Source: Display charts made available by Puebla Project personnel.

the increasing emphasis on extending the new techniques once they had been developed by the research agronomists. While each of these is a trained specialist he also must be capable of working with persons from other disciplines. Generally, the team members are young men, many holding the equivalent of a Masters degree, most likely from the National Agricultural

University at Chapingo. Each seemed to be quite enthusiastic and willing to spend much time in the field with the cultivators.

The third area of innovation is in the organization of the extension function. Initially, participants were selected with the advice and assistance of the local leadership. During the first year of extension, 1968, the technical team worked very closely with the farmers to assure proper execution of the recommendations. However, in order to disseminate information to a much larger number of farmers, it became necessary to develop techniques which economized on the team's efforts. In 1969, each of four farm advisers was assigned a region. It was his responsibility to form producer groups of farmers within his region and to work closely with the group's democratically elected leaders in disseminating the new production technologies. In addition, a number of communications media were adopted. Folios were printed and distributed with the recommended practices for each of the four zones. A sound truck was used to attract the attention of the community's inhabitants and to announce future meetings with project personnel. A radio program was initiated to keep farmers informed as to what to do, at what time. Finally, a sound movie was prepared to explain the recommended practices. Undoubtedly, these innovative approaches to the extension of new technologies to a large number of small operators contributed to the success of the project during its first years of operation.

The history of the Puebla Project is summarized in Table 2. On the basis of the first two years of extension experience, 1968-69, there was a high degree of optimism expressed by observers of the Puebla Project. Yields were high and participation rates were soaring. With the adoption of the recommended practices, yields could be increased from about 1.5 tons

Table 2

Puebla Project Area:

Yields, Participation and Credit, 1968-71

	1968	1969	1970	1971
Yields (kgs./ha.):				
1. Participants[a)]	3894	2765	2670	2618
2. General for area (including participants)	2091	1790	1917	1883
3. Difference (1 minus 2)	1803	975	753	735
Participation:				
4. Area in high-yield plots (hectares)	95	5642	12500	14438[b)]
5. Cultivators	103	2561	4833	5240[c)]
6. Producer groups	3	128	218	183
Credit (hundred thousand pesos	0.75	49.0	96.0	76.0[d)]

Explanations: a) Participants are defined as those who obtained bank credit for fertilizer purchases. This ignores cultivators who utilized the recommended practices but financed purchases of inputs out of past savings or used non-bank sources for credit. b) For 1971 participants accounted for 19% of total area sown in maize and 36% of the total maize production. c) It is estimated that the number of cultivators for 1972 is about 5200. d) Part of the explanation for the large decrease in the value of credit is due to a 20% reduction in the price of fertilizer from the government operation, Guanomex.

Sources: 1) The above data was taken from charts used by Puebla Project personnel for explaining the project's performance to visitors, except as listed below. 2) Yield data for 1971 from: "Programa de Evaluación Resultados del Ciclo 1971" (mimeo. Puebla Project), p. 10. 3) Note b) above: Ing. Mauro A. Gomez Aguilar, "Síntesis de los Aspectos Principales en el Plan Puebla Durante 1971." (mimeo. Puebla Project), pp. 6-7.

per hectare to 3.9 tons over the traditional technology. To implement the new technology, farmers experienced a 90 percent increase in costs, chiefly in the form of higher fertilizer outlays (166%) and expenditures for animal and labor power (17%). The government agency, CONASUPO, (Compañía Distribuidora de Subsistencias) guaranteed a price of 900 pesos per ton

of shelled corn at 12% moisture, which allowed farmers a net profit of 1574.50 pesos (US $130) per hectare. This represented a profit nearly five times larger than that possible under the traditional cultivation practises. Based upon the average farm size in the project region of 2.5 hectares, this implies an additional family income of nearly US $250.00 per maiz crop.[5] This additional income represents an increase of 117% in the income derived from crop sales, and 50% increase to total family income from all sources.[6]

The economic advantage of adopting the recommended practices probably was a factor in explaining the sharply rising rates of participation in the early years of the project. After reaching a level of 4833 farmers in 1970, participation rates have not grown rapidly. Despite the fact that the number of participating cultivators has increased over fifty times during four years, the number of cultivators in 1971 represented only about one-tenth of the total in the region.[7] One project worker confided that it is estimated that the 1972 levels of participation may actually have fallen over the previous year. The slowing of the rates of growth in participation has given rise to some serious concerns on the part of the Project personnel and persons at CIMMYT. One of the major areas of attention on the part of the newly created Economics Section at CIMMYT is to learn what motivates farmers: 1) to participate in the new practices on a continuing basis, 2) to participate for a time and then cease, and 3) not to participate at all.

The early reports from CIMMYT aroused the author's interest in the Puebla Project as it seemed to hold much promise for many developing countries that are wrestling with the problems of raising productivity levels of small-scale farming operations. Efforts to obtain information

on the Project since mid-1969 proved to be fruitless.[8] I became particularly anxious to learn of the impact of the project on regional economic development. The sharp and quick increases in incomes for thousands of rural dwellers would most certainly have a dramatic impact on a number of social and economic variables in the region.

I went to Mexico fully expecting to hear glowing reports of the project's accelerating progress. I very quickly learned that the goal of reaching a large portion of Mexico's campesinos is proving to be quite elusive. A number of obstacles and problems must be surmounted before the lives of many peasant farmers will be affected. The balance of the paper will be devoted to an examination of some of the problems of the past which may prove to be obstacles to future progress. These comments are based upon my own observations, and conversations with Project personnel and other interested parties in Mexico.

OBSTACLES TO PROGRESS

There are a number of problems or obstacles to extending new production technologies to a larger number of farmers both in this region and in other regions of Mexico. Although it is recognized that these problems are quite complex and interrelated, I have formulated three broad categories of problems for the purposes of discussion: 1) technical-production 2) organizational and institutional, and 3) those related to farmer decision-making. These problems and facts interact to explain why the early successes of the project have been limited. It is hoped that an analysis of these problems will help in the formulation of solutions to promote future progress.

Technical-production Problems

A glance at the yield figures (Table 2, line 1) reveals that yields on the participants' high-yield plots have fallen by 33% between 1968 and 1971. There are a number of variables influencing these yields not in the least of which is weather. Precipitation levels in 1968 were above normal and well distributed throughout the growing season from April to October; however, late rains in 1969 and 1970, as well as generally dry conditions throughout 1971 had a decided adverse effect on yields.

The new technologies, which employ heavy doses of fertilizer and a doubling of plantings per unit of area, are particularly sensitive to deficiencies in rainfall. When precipitation is below normal, the intense competition of the increased plant population for available moisture actually causes absolute yields to fall. The annual variation in yield (Table 2, lines 1 and 2) was much more evident in the case of the high-yield plots than in the case of the general average for the region. Between 1968 and 1969 yields on the participants' plots fell by 1129 kilograms compared to 301 for the general average. Between 1969 and 1970, yields under the new practices fell by 95 kilos while the average for the region actually increased by 127 kilos. One possible explanation for the latter inverse pattern of yield experiences between the two categories lies in the differences in cultivation practices. The traditional method calls for moderate doses of fertilizer at the first cultivation; whereas the new technology calls for large applications at the time of planting and again at the second cultivation. The moisture stress factor may be much greater with the increased plant population and higher fertilizer dosage when rainfall is deficient during the germination period as was the case in 1970. On the other hand, smaller plant populations without fertilizer during the

period of germination may lessen moisture stress during seasons when the rains are abnormally late. Applications of fertilizer later in the cycle when precipitation is more probable will assure a higher level of moisture-fertilizer interaction. This hypothesis is supported by the dramatic decline in the differentials between the general average and the participants' yields during the years of inadequate or maldistributed rainfall (Table 2, line 3).

The experience of the Puebla Project in this regard is not dissimilar from that associated with the development and introduction of new agronomic practices in other parts of the world. It is not unusual to find that new technologies, particularly those requiring increased amounts of off-farm inputs (new seeds and fertilizers) are quite often vulnerable to moisture stress. New technologies developed and field tested under adequate moisture conditions often perform worse than the local technologies when subjected to rainfall deficiences. Greater efforts in the future are needed to devise more flexible recommendations which can take into account variations in rainfall patterns. In addition, communication techniques need to be devised to assure that farmers are fully informed of modifications in recommendations based on variations in weather patterns.

Organizational and Institutional Problems

The new production technology was developed in a relatively short period of time; however, it appears that there has not been sufficient modification of the institutional and organizational structure to support the extension of the new technology to a large number of farmers. This category of problems can be further subdivided into those associated with particular groups of persons and institutions: (1) the agricultural infrastructure, (2) the research and extension team, and (3) the producers. The problems associated with each of these groups will be discussed below

The agricultural infrastructure refers to the institutions which provide the services necessary to support the introduction of the new technologies. In addition to the extension function discussed below, the key services are the extending of credit and the supplying of fertilizers. In the first year of the project, 1968, the public credit institutions chose not to participate in the project. In that year, all of the credit was supplied by a private fertilizer distributor, Impulsora de Puebla. The provision of credit and fertilizer by the same institution simplifies much of the administrative detail associated with contracting for production credit. In addition, the technical team's coordinator worked closely with the farmers and the fertilizer distributor to assure adequate fertilizer supplies of the proper mix, at the proper time.

Once the merits of the new technology had been demonstrated, public banks decided to participate in the program. These included: Banco Ejidal, Banco Agropecuario, and Banco Agrícola. While a larger volume of credit was made possible, the procedure for obtaining credit was somewhat complicated. Many farmers complained that credit was not available from the banks. A further investigation of this complaint reveals that it is based upon two explanations: one sociological and the other financial. First, there is a tremendous communication gap between the campesino and the bank personnel. The campesino often does not fully comprehend the impersonal contracting procedure for obtaining bank credit. He very often finds the detailed paperwork involved confusing and he ends up deciding "no vale la pena" (it's not worth the trouble). This attitude is quite understandable when one grasps the limited contacts that the typical campesino has with various aspects of urban life, particularly those involving impersonal obligations. He may even opt for obtaining

credit through a rural moneylender at exorbitant interest rates rather than exposing himself to the frustrations of dealing with an impersonal institution. At the same time, it is no doubt frustrating and quite expensive for bank personnel to work with a large number of individuals who are quite ignorant of the institution's procedures for obtaining and repaying credit. The whole lending procedure becomes a learning process as much much as a financial transaction, and the banker can hardly be expected to serve as a qualified teacher. Equally significant is the fact that many bank personnel, who have managed to attain a position of relatively high social and economic status, may find it demeaning to deal with campesinos. Finally, as the number of participants increased, the extension coordinator was no longer able to work as closely with the financial institutions to facilitate credit transactions.

A second explanation for the allegation that credit is not available rests upon an economic foundation. In 1970 and 1971, a number of the participants incurred heavy losses due to the poor harvests resulting from the lack of adequate rainfall. As a result, they defaulted on their loans made for the purchase of fertilizers. This may have damaged their creditworthiness and made it difficult and perhaps impossible to obtain credit in subsequent seasons.

There also have been problems with assuring adequate fertilizer supplies to guarantee the proper timing of application. Shortages were particularly acute in 1971 when the government lowered the price of fertilizer creating a sudden surge in quantities demanded.[9] In 1972, many farmers did not receive fertilizer in time for the sowing because the local distributor had failed to allow a sufficient lead time in ordering the ingredients from his supplier in Mexico City. Part of the neglect was due also to inadequate

foresight on the part of the group leaders who should have made sure that the orders were placed well in advance of the planting season. Some observers suggested that the previous year's harvest experience was so poor that it was assumed that many farmers would not participate in the Project the next year. Thus, the expected demand for fertilizer would be much below that of previous years, discouraging the local distributor from ordering as much as in the past.

Of equal seriousness were the allegations that the fertilizer bags did not contain the appropriate strengths and amounts as stipulated on the labels. It was remarked that the 50 kilo bags actually contained only between 47 and 48 kilos of fertilizer. This means that the farmer was applying four to six per cent less fertilizer per hectare than was recommended. This obviously would diminish yields and distort the results of the evaluation surveys.

Many of the organization and institutional problems confronting the Project called for strong support from the political leadership for their resolution. Quite favorable reports were given regarding the efforts of key officials at the State level, particularly the state representative of the Secretariat for Agriculture and Livestock. However, there was also a general feeling that there was insufficient support at the national level for programs aimed at the small farmer. The explanation for this neglect most often offered was that the lion's share of the limited amounts of public funds were being channeled to support the industrialization process and commercial agriculture in the irrigation districts.

The second group involved in the organizational problems is the technical team. The team is composed chiefly of relatively young men who have recently completed a bachelor's or master's degree. There can be little

doubt about their enthusiasm nor about their level of technical competence. Two facts that are particularly impressive are: their willingness to work in the field and their candidness in discussing shortcomings of the Project.

On the basis of very superficial evidence, there are three critical observations that I will venture concerning the technical team. First, while the number of cultivators involved in the project has increased fifty times, the number of team members has only doubled (see Table 1). Despite the fact that extension efforts were to be facilitated by the formation of producer groups, it only seems logical that some of the effectiveness of the team's efforts would be diluted when working with forty-five farmers than with only twenty. It was anticipated that the demonstration effect would assist in disseminating the new production technology; however, for the campesino the recommendations of a neighbor may not carry nearly as much weight as those of the technical experts. It seems, therefore, that either a more effective level of group organization and degree of confidence among the farmers must be generated, or more team members enrolled to permit closer supervision of the farmers.

The Mexican national extension service may prove to be a source of manpower to assist the CIMMYT team; however, there appear to be some problems of cooperation between the two organizations. It was explained to me that in the initial years of the program the assistance of the national extension service was not solicited to support the project effort. This neglect bred a sense of jealousy and competitiveness on the part of the national extension service so that in subsequent years, CIMMYT was unable to obtain the cooperation that was needed to extend the effort over a wider number of farmers.

One of the innovative features of the project was the use of various mass media to disseminate information about the new technology. Printed pamphlets were made available containing the recommended practices for each zone. Despite the fact that the benchmark survey reported that 77 percent of the farmers considered themselves literate, the average number of years of school is only 2.36.[10] The pamphlets which I observed seemed to be rather technical, raising some doubts as to their effectiveness in the hands of semi-literate campesinos. The problem of mass communication of new techniques still remains a problems throughout most of the world, and Mexico appears to be no exception.

Finally, as mentioned above, there seems to be no question as to the technical competence of the team members; however, there did appear to be an absence of experience. For example, the problem of how to modify the optimal practices to account for unpredicted environment conditions, such as a drought, may take a number of years of experience in the field. Such events are not so easily dealt with solely by textbooks and formal education. Admittedly, finding those rare individuals who have such experience and are keenly motivated to work in the field is no doubt a difficult task. One such individual joined the team in an advisory capacity in the spring 1972. This person is a sociologist with excellent educational credentials and also with numerous years of experience working in the field as an extension specialist. He will no doubt prove to be a beneficial addition to the team.

The cultivators form the third group associated with organizational problems. A number of producer groups were formed with the help of the team, chiefly to disseminate information concerning the new technologies. Each group elected a leader with whom the team members would work closely. In addition it was hoped that the group leaders would be able to take the

primary responsibility for making sure that credit and fertilizer supplies were available to the members. Unfortunately, these groups have not proved to be effective in the latter regard. One explanation is that the groups are not legal entities and thus, can not contract with the input suppliers. Consequently, their bargaining effectiveness is quite limited. Another factor influencing the viability of the groups is the leadership capabilities of the group representatives. It seems that the group leaders rely too heavily on the team members for making decisions and resolving problems. This also perhaps reflects a general lack of community solidarity throughout the region.

These are but a few of the many organizational and institutional problems confronting the project. Despite the dramatic economic advantage offered by the new technology, farmers will not reap the full rewards unless these problems are resolved. The experience of the Puebla Project reiterates an important lesson -- innovative efforts in the area of organization and institutional modification to support the new production techniques are as essential for the long-run success of such programs as the creation of the new techniques themselves.

Farmer Decision Making

The final problem area to be discussed is concerned with the individual's decisions regarding the new technology. One set of decisions deals with the area of participation: what motivates the farmer to participate or not, and if the decision is made to participate, what motivates the farmer later to cease participation. A second set of decisions is concerned with how the participant applies the recommendations. This will influence yields and in turn, affect future participation levels. Let us examine each of the decision-making areas.

Perhaps the single most important factor influencing the decision to participate or not is the degree of risk implied by the new technology. Fundamentally, the campesino is a risk averter. Even under the possiblity of doubling the income derived from farming, many farmers view the new technology as a very risky venture. Despite the fact that crop insurance is required for all participants, a poor crop year could jeopardize the family's economic security and wipe out any personal savings, given the heavy investments in fertilizers, insecticides and herbicides recommended under the new technologies. As mentioned earlier, inadequate moisture actually diminishes absolute yields where chemical fertilizers are used and plant population doubled. Due to the poor rainfall of 1970 and 1971, many participants incurred heavy debts which no doubt discouraged participation rates.

The practices recommended by the extension team were economically optimal for that particular zone, based upon agronomic experimentation and certain assumptions about prices and costs.[11] As a result, separate techniques were suggested for each of the five zones. From the standpoint of the extension effort, disseminating a single set of recommendations to each zone is relatively efficient and easy to accomplish. However, making a number of alternative practices available to the cultivator, allows him to select the one which will optimize his returns given the capital constraint confronting him. The amount of capital which he is willing to invest indirectly reflects the cultivators estimate of the riskiness of the venture.

The project personnel realized the significance of the capital constraint and risk factor, as well as the importance of differences in soil conditions and planting dates in the decision making of cultivators.

Consequently, in 1971 a number of alternative technologies were generated for each of the zones. For 1972 there were 27 different recommendations available to the farmers throughout the region.

There are many cases where farmers participated in the Project but then decided to withdraw. By far the most frequent explanation for dropping out of the program was the accumulation of bad debts from previous years. The major reason given for default on previous borrowings was low levels of production. While weather no doubt played a key role in this regard, some farmers expressed a lack of confidence in the recommendations themselves. Another important consideration is that there is no way to check whether the farmers are following precisely the recommendations. The team evaluator has to rely on statements offered by the farmer which may not be entirely accurate. More empirical analysis is needed to determine precisely what factors influence the farmer's decision to cease participation. This will be important for devising new strategies and expanding the participation rates in this and other regions.

Once the decision to obtain credit for participation is made, how the farmer executes the recommendations is vital to the success of the harvest. One of the recommended changes was to apply fertilizer at the planting and the second cultivation rather than at the first cultivation only, which is the traditional practice. Many farmers were reluctant to apply the fertilizer at the sowing. They argued that they would prefer to wait until the first cultivation. Their reasoning was that by the first cultivation the farmer can be sure if the rains have been adequate to assure a reasonable crop. If the rains have been too late, the money invested in fertilizer for the sowing would be lost. This reasoning seems rational under the highly variable rainfall pattern in the region.

Another problem closely associated with the preceding one is the difficulty of making certain that the farmers are in fact following the recommended practices and that they are accurately reporting what they in fact did. There is no visible evidence in the field to attest to the fact that the farmer has applied the appropriate mix and quantity of fertilizer at the correct time. For example, many farmers preferred to use the conventional 10-8-4 mix rather than the recommended 130-40-0 combination. Part of the reason for this was that the cost of the old mix was much cheaper and secondly, 10-8-4 was a mixture that had been used for a number of years in the region so that the results were predictable. Another problem is in making sure that the reported quantity applied was the actual quantity. Often farmers would buy the recommended quantities but not apply the entire amount. Some cultivators see the fertilizer purchase as a form of savings to be sold at a later time when cash is needed. Others would sell part of the total to a neighbor or family member who was not able to obtain credit. As a result of these practices it is difficult to evaluate accurately the results of the sampling survey on yields. Much of the yield differential between participants' plots and between participant and non-participant plots can be attributed to differences in the degree to which farmers followed the recommended practices. The decline in yields seen in Table 2, line 1, on the participants' plots perhaps reflects the fact that as the number of participants grew so rapidly, it became increasingly difficult for the team members to monitor the farmers' cultivation practices.

Finally, some farmers complained that the increased fertilizer dosage and the necessity of applying it in precise amounts was quite laborious. The stooping to apply the correct amount by hand often resulted in a

backache. Frequently labor was hired for helping in the application of the fertilizer at the sowing. Some farmers contended that the extra work of applying the new technology was not worth the additional return, although clearly the marginal revenue well exceeded the marginal cost of its application. This view was given mostly by persons who held full or part time jobs in the city. For them the farm plot was a supplementary form of income. The additional work required to implement the new technology was viewed as competition for leisure time that could be spent in relaxation with the family.

On the surface, these contrary decisions appear to be irrational given the tremendous returns that could be reaped if the recommendations were followed closely. When analyzed more deeply, however, they seem to be perfectly rational in light of the physical and financial constraints confronting the farmer. It can be generally concluded that the risk factor plays a very important role in the campesino's decisions to participate or not, and how closely to follow the recommended practices. Clearly the inadequate rainfall in 1970 and 1972 has worked to increase the riskiness of adopting the new practices. Fairly widespread accumulation of bad debts because of a poor harvest acts as a major deterrent to continued participation and growth in the number of participants.

CONCLUSIONS

In recent years, development experts have been turning their attention to the problem of persistent and widespread poverty. Experience has shown that high rates of production growth are not sufficient to guarantee higher levels of well being for the majority. Sadly, the fruits of economic progress tend to be concentrated in the hands of the well-to-do minority.

Persistent poverty has its roots primarily in the subsistence agricultural sector. Small size and traditional techniques have placed limitations on production possibilities and thus, potential family incomes. Nevertheless, the small farming sector can make a positive contribution to the developmental process if the production constraints are broken. In the short run, the solution of increasing the size of the operation is unfeasible for most countries. Introducing new production technologies seems to hold the most promise for raising income levels and encouraging integration of the rural peasantry with the modern society.

In 1967, the Puebla Project was launched with the objective of increasing maize yields among small, subsistence farmers in the State of Mexico. The early successes, which gave rise to widespread optimism throughout the developing world, were not sustained in subsequent years. Many of the problems faced by the Project are shared by developing countries throughout the world which have attempted similar experiments. Generally, the technical production problems are relatively simple compared to those of a socio-economic nature. The future of this and other projects largely will be determined by the ability to resolve the associated institutional, organizational and social problems.

Perhaps the most significant factor influencing the participation of farmers is risk. The heavy capital investments and the high variability of yields under unpredictable weather conditions cause farmer reluctance to participate in the new technology. Equally significant is the guaranteeing the availability of credit and the physical inputs at the proper time and in the correct amounts. Certainly, a higher degree of organization among the producers themselves may assist in obtaining the financial and physical inputs. The cooperation of various public and private institutions and how these are

organized vis-a-vis the Project can contribute toward minimizing the risk attached to these problems.

The most positive results of the Project to date have been derived from its experiences with new organizational techniques in the area of extension, and research. The integration of the research and extension functions at the farm level is particularly significant. Farmers can learn immediately about new techniques as they participate in the research itself. This experience should heighten his awareness of alternative production techniques, incourage his confidence in them, and make him more likely to adopt new practices. Additonally, it makes the researcher more sensitive to the actual conditions confronting the farmer in contrast to the highly artificial ones found on the experiment station.

The problems confronting the Puebla Project should not result in frustration and despair but rather should serve as a stimulus for further research and innovation, particulary in the social sciences. The poverty problem must be faced on its own terms as it is found in the subsistence agricultural sector.It is hoped that successful efforts to raise production levels on these operations will be a first step toward eliminating the dual problems of unemployment and maldistribution of income, which are the primary sources of persistent poverty throughout the world.

NOTES

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[1]E. J. Wellhausen, "The Urgency of Accelerating Production on Small Farms," in Strategies for Increasing Agricultural Production on Small Holdings, ed. by Delbert Myren (Mexico, D.F.: International Maize and Wheat Improvement Center), p. 6.

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

[3]The experience of Mexico is instructive in this regard. See: Huntley H. Biggs, "The Dualistic Approach to Mexican Agricultural Develop-mnet: Irrigation Development and the Puebla Project" (paper presented at the Rocky Mountain Social Science Association Meetings, Salt Lake City, Utah, April 28, 1972).

[4]For a complete description of the Puebla Project during its initial years of operation see: International Maize and Wheat Improvement Center. The Puebla Project, 1967-69: Progress Report of a Program to Rapidly Increase Corn Yields on Small Holdings. Mexico, D.F.: International Maize and Wheat Improvement Center.

[5]Ibid., p. 92.

[6]Ibid., p. 18.

[7]Ibid., p. 14.

[8]References to the experiences of the Puebla Project for the early part of 1970 may be found in: Myren, Delbert T., ed. Strategies for Increasing Agricultural Production on Small Holdings: Proceedings of an International Conference, Puebla, Mexico, August, 1970. Mexico, D.F.: International Maize and Wheat Improvement Center.

[9]Aguilar, Mauro A., "Síntesis de los Aspectos Principales en el Plan Puebla durante 1971," (mimeographed for use by Puebla Project), p. 3.

[10]International Maize and Wheat Improvement Center, The Puebla Project, p. 17.

[11]Ibid., p. 45.