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dissertation entitled

Impact of Large Irrigation Projects on Participant Ejidatario-Farmers Over Time: The Panuco River Irrigation Project Between 1987 and 1995

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Resource Development

Major professor

Date August 21, 1997

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# IMPACT OF LARGE IRRIGATION PROJECTS ON PARTICIPANT *EJIDATARIO*-FARMERS OVER TIME: THE PANUCO RIVER IRRIGATION PROJECT BETWEEN 1987 AND 1995

By

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Resource Development

1997

**ABSTRACT**

**IMPACT OF LARGE IRRIGATION PROJECTS ON PARTICIPANT *EJIDATARIO*-FARMERS OVER TIME: THE PANUCO RIVER IRRIGATION PROJECT BETWEEN 1987 AND 1995**

**By**

**Esteban Valtierra-Pacheco**

This research looks at Mexican large irrigation projects can deliver the intended benefits to poor participant farmers (i.e., *ejidatario*-farmers). This study focuses on the Panuco River irrigation Project (PRIP). The research design for is a panel design. The research included a survey conducted in 1995 in which 150 *ejidatario*-farmers. The results of this survey were compared with a survey conducted among 238 *ejidatario*-farmers in 1987. These surveys had a common sample of 57 *ejidatario*-farmers who were interviewed in both years.

The null hypothesis for this study is "The PRIP did not meet its initial objectives: a) to develop an intensive irrigation system, b) to contribute to national food security, c) to reduce the uneven income distribution between the rural and urban populations, and d) to reduce the unemployment among landless peasants." The variables used to test the null hypothesis include perceived efficiency of the irrigation system, amounts of food crops

produced by *ejidatarios* in 1987 and 1995, *ejidatarios'* income (i.e., annual, on-farm and off-farm incomes), and land rent.

The results of this study indicate that the PRIP failed to achieve its initial objectives. The PRIP did not develop an efficient irrigation delivery system. The production of food crops cultivated by *ejidatarios* experienced a dramatic reduction between 1987 and 1995, except for sugar cane. The *ejidatarios* total annual income did not increase significantly. The average *ejidatario's* income was below the poverty line both in 1987 and 1995. *Ejidatarios* on-farm income had a significant reduction between 1987 and 1995. The *ejidatarios'* farm lost its importance as primary source of income and employment because *ejidatarios* worked more off-farm in 1995 than in 1987 and many of these *ejidatarios* rented their land to outsiders in 1995.

This study indicates that large scale irrigation projects, like the PRIP, did not always help *ejidatarios* to overcome poverty. Large scale irrigation projects are not always the best ways to address poverty among the nation's poor or increase the national food security.

My degree is an achievement that belongs to my family. Their love kept me going.

To my wife Ignacia

To my daughter Nancy

To my son Erick

**ACKNOWLEDGEMENTS**

I thank Dr. Scott G. Witter who served as my dissertation director and the chairman of the guidance committee for his support that I received from him during the four years I was in MSU. I would like to thank him for being always ready to advise me and for all the continuous favors he gave me.

A special appreciation goes to Dr. Scott Whiteford who was more than a advisor. I always counted with his friendship and words of encouragement.

Thanks to Dr. George Axinn and Dr. Mary Andrews for their contributions to this dissertation and their patience to review this dissertation.

I am indebted to the institutions that make my studies and this dissertation possible, particularly my home institution in Mexico, the Colegio de Postgraduados.

My studies were possible, thanks to the support from the W.K. Kellogg Foundation that awarded me a scholarship to support my family during these four years and funding to my dissertation research. I would like to thank all the W.K. Kellogg Foundation's staff for their support and kindness, especially to Rebecca Hernandez, Robert DeVries, Maria Martin, and Heliodoro Diaz.

Additional funding for the field research of this dissertation was provided by the "Ejido Reform Research Project (ERRP)" of the Center for U.S.-Mexican Studies at the University of California, San Diego. This center awarded me a Grant for Graduate Student Field Research on the Transformation of Rural Mexico.

I appreciate the revision of the grammar made by Emily Holley, who had the patience to get through unintelligible sentences.

Thanks to all my friends who helped me to make easy these four years at Michigan State University.

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**ABBREVIATIONS**

| | |
|---|---|
| ANAGSA | National Insurance Company for Agriculture and Livestock<br>*Aseguradora Nacional Agrícola y Ganadera S.A.* |
| AGROASEMEX | Mexican Agricultural Insurance Company<br>*Aseguradora Agrícola Mexicana* |
| BANRURAL | National Bank of Rural Credit<br>*Banco Nacional de Crédito Rural* |
| CBDA | Chad Basin Development Authority |
| CP | Graduate College on Agricultural Sciences<br>*Colegio de Postgraduados en Ciencias Agrícolas* |
| CNA | Nacional Water Commission<br>*Comisión Nacional del Agua* |
| CONASUPO | Nacional Company of Popular Supplies<br>*Compañia Nacional de Subsistencias Populares* |
| FAO | Food and Agriculture Organization |
| INEGI | National Institute for Statistics, Geography and Informatic<br>*Instituto Nacional de Estadística, Geografía e Informática* |
| NAFTA | North American Free Trade Agreement |
| ODA | Overseas Development Agency |
| PIDER | Programa Integral de Desarrollo Rural Integral<br>*Integrated Rural Development Program* |
| PRIP | Panuco River Irrigation Project<br>*Proyecto de Irrigation de la Cuenca Baja del Río Pánuco* |
| SARH | Secretariat of Agriculture and Water Resources<br>*Secretaría de Agricultura y Recursos Hidraúlicos* |
| UNDP | United Nations Development Programme |

# CHAPTER I

# INTRODUCTION

## A. Problem Statement

### Problem Background

For many years, construction of irrigation projects was considered the most suitable way to increase agricultural productivity and reduce poverty in many Third World countries. More than twenty years ago, Orive-Alba (1970: 235) indicated that "the most important improvements on agriculture in the twentieth century have taken place in irrigated lands and new irrigation projects were good alternatives to alleviate rural poverty and to redress agrarian problems."

As time has passed, optimism about how irrigation could redress problems of poverty, hunger and food security has declined. More than a decade ago, a Food and Agriculture Organization (FAO) document (Sagardoy, 1982) expressed some concerns about rapid increases in the world's population which had made the efficient use of irrigation water critically important, particularly in poorer countries where the greatest potential for increasing food production and

rural incomes was often found in irrigated areas. However, the poor performance of many irrigation schemes became a matter of serious concern. Despite their very high cost, many irrigation projects fell far short of their initial expectations.

Recently, the World Bank (1994: 2) noted that the previous optimism has become a great concern. Major investments were made in irrigation infrastructure stocks, but in too many developing countries these assets did not generate the quantity or the quality of services demanded. The costs of this waste --in forgone economic growth and lost opportunities for poverty reduction and environmental improvements-- were high and unacceptable.

The main failures in irrigation infrastructure projects have been inadequate design, deficient drainage, operational inefficiencies, inadequate maintenance, excessive dependence on fiscal resources, unfair practices of water distribution, lack of responsiveness to users' needs, limited benefits to the poor, lack of equity objectives, lack of stakeholders' participation and insufficient environmental responsibility (World Bank, 1994: 4-5). The World Bank attributes these failures to the direct participation of governments in the economy. Government intervention distorts the conditions of a free market, resulting in unwarranted allocation of resources and distribution of benefits among the economic sectors of a society. However, these conclusions are product of the change in the World Bank's policy. In the

past, the World Bank encouraged the direct participation of government in the economy for many years. In addition, many of the irrigation project failures were a direct result of the way in which the World Bank provided the loans. Sometimes those loans were a direct intervention of the World Bank in national affairs of Third World countries.

Those limited benefits to the poor have been continually reported, but governments have done little to understand the problem, explore the causes, or readdress the problem identifying the poor as project priority.

**Research Question**

Who is getting the benefits of irrigation, the poor or the rich? Perhaps nobody is benefitting when irrigation projects fail. Since there is a lack of research information regarding these questions, this research looks at the following: Can Mexican large irrigation projects, like the Panuco River Irrigation Project, deliver intended benefits to poor farmers (*ejidatarios*[1]), especially as the new government initiatives underway reduce government

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[1] *Ejidatarios* or ejidatario-farmers are small farmers organized in a community based group, called *ejido*. Originally, ejidatarios could own ejido land collectively, but they could cultivate their land collectively or individually. Ejidatarios could use ejido land but not sell it. In 1991, a constitutional amendment allowed ejidatarios to transfer their land tenure from collectively owned land to individual privately owned land and, therefore, to sell their land.

agricultural support services?

**Previous Studies**

There are no studies in Mexico that have assessed the impact of large irrigation systems on poor *ejidatario*-farmers across time, especially when government support for irrigation has become more scarce. It is important to know if poor farmers have increased or reduced their income over time; if the poor farmers' economic returns have been sustainable from the use of irrigation water; how poor farmers have balanced their income between on-farm and off-farm economic activities; and how the poor farmers have survived, while the Mexican economy has undergone one of its greatest structural transformations ever.

In Mexico, most of the recent social and economic studies on irrigation have centered their attention on how the transference of infrastructure management has improved the operative and economic efficiency of irrigation districts. However, they have put aside important aspects such as who is having access to water or who can pay the new water fees. The Mexican government justified the transference of irrigation infrastructure management from the government to user associations because the operational cost of irrigation projects were not covered by water fees (Gorriz et al., 1995). In 1988, the water fees only covered 15% of the operative water costs and the Mexican government

maintained a large percentage of subsidies. At the beginning of the 1990s, the situation was unbearable because the fiscal deficit crisis resulted in an increasing deterioration of the irrigation infrastructure resulting from the lack of maintenance. As a response to this problem, the World Bank and the Mexican government suggested that the only way to assure water irrigation supply was to transfer irrigation districts to users (Palacios, 1994: 113-115)[2].

Irrigation management transference is not an exclusive Mexican government policy, it is a global policy being encouraged by the World Bank and implemented by many countries around the world (World Bank, 1994; Johnson, 1994; Jones, 1995). The transference can be a good way to encourage efficiency and achieve users' expectations, the problem is that the current policy to transfer irrigation systems to users is a product of international pressures to reduce government expenditures. For this reasons, the transference of irrigation management has been mainly analyzed in terms of how much money governments have saved by eliminating subsidies and increases in water fees (Johnson, 1994). However, the current and potential impact on human capital has received little attention from donors

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[2] By March of 1994, the Mexican government had partially or totally transferred infrastructure management in 51 irrigation districts, which encompassed 2,314,870 hectares --75% of the total irrigated land in irrigation districts.

and host governments.

The transference of the irrigation infrastructure and reduction of government support have been successful in improving the efficiency of the irrigation management and service delivery system. The question is who gains and who loses? The studies noted above do not consider equity or distributional objectives as a measure of success in these irrigation projects, even though, it has been demonstrated in other countries that when equity is achieved, other indicators of project success are achieved (e.g., water delivery) (Shivakoti, 1991).

Water fees and water rights are important parts of the recent government irrigation policies. Different types of water fees can have a great impact on the performance of irrigation schemes. Marginal productivity has been suggested as a fair criterion to charge farmers for irrigation water (Bernal, 1994). However, in Mexico, water fees have never been established in agreement with irrigation users. When irrigation users are not in agreement with water fees and are therefore unwilling to pay, the funds available for maintenance and operation may be drastically reduced (Valdivia, 1994; Levine & Garces-Restrepo, 1994).

Technical problems are still a great concern for users, the Mexican government and donor agencies (Sotomayor, 1994; Palacios-Sánchez, 1994; Chacón, 1994). The lack of control of ordinary operations can be a very important threat to

irrigation productivity. Salinization, waterlogging, and erosion perturb large portions of the irrigation districts in Mexico (Cortez, 1994).

Few studies focus on income distribution and irrigation users' well-being (Valdivia, 1994). However, these studies have limited their scope to the current situation without establishing how farmers' situations improve or deteriorate over time. In addition, these studies do not focus on the rural poor. Chambers (1991) suggests some possible explanations for this situation, such as the fact that these studies have been conducted by "positive practitioners", who only see the potentially positive benefits of the irrigation infrastructure on agricultural productivity, but do not see the overwhelming problems of the rural poor users; or the poor are too weak and are, thus, unknown and unseen; or knowing the overwhelming problems of rural poverty, researchers feel powerless to offer a solution or to participate in seeking one.

To overcome the limitations of these studies, this research assesses the impact of government-run irrigation projects on poor farmers in Mexico. Thus, anyone interested in improving the income and well-being of poor irrigation users in Mexico may gain important insights from this study. Representatives of irrigation user organizations need to understand how the recent government policies on irrigation may affect the economy of their affiliated farmers. At the academic level, it is necessary for scholars to bring the

poor into the intellectual discourse because the opinions of the poor have rarely been taken into account. They have disappeared from the intellectual discourse or have appeared in pseudo-theories such as the "Social Liberalism"[3] that was coined by the former Mexican President Salinas for electoral purposes.

This study assesses the impact of a large government-supported irrigation system on *ejidatario*-farmers' households, comparing their situation over two time periods, 1987 and 1995. A survey of 238 *ejidatarios* was performed in the Panuco River Irrigation Project in 1987 (Díaz, et al., 1988; World Bank, 1989; Díaz & Valtierra, 1992). To make the comparison possible, a similar study was administered to 150 *ejidatarios* in PRIP in 1995. This study encompasses a time period of eight years in which the Mexican government drastically reduced its support for irrigation.

The study site selected was the Panuco River Irrigation Project (PRIP) which is located about two hundred miles south from the Mexican-U.S. border, at 108° WG, 22° N. PRIP is composed of three irrigation units which encompass 144,000 ha. This irrigation project gave land to 8,500 *ejidatarios*. The PRIP was created in 1974, when the World Bank approved a loan to be disbursed between 1974 and 1982.

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[3] This theory proposes that free market driven economies promotes social justice for most of the people. If it does happen, a direct subsidy (i.e., money in hand) should be given to the poor.

## B. Research Objectives

The research objectives for this study are:

1. To estimate the extent to which the benefits from large scale government supported irrigation projects have been sustainable, using the Panuco River Irrigation Project as an example.
2. To estimate whether the Panuco River Irrigation Project was able to meet its original objectives: a) to develop an intensive irrigation system, b) to contribute to national food security, c) to reduce the uneven income distribution between the rural and urban populations, and d) to reduce unemployment among landless peasants (World Bank, 1989: i).

## C. Hypotheses

$H_o1$: The Panuco River Irrigation Project did not meet its initial objectives: a) to develop an intensive irrigation system, b) to contribute to national food security, c) to reduce the uneven income distribution between the rural and urban populations, and d) to reduce the unemployment among landless peasants.

$H_a1$: The Panuco River Irrigation Project met its initial objectives: a) to develop an intensive irrigation system, b) to contribute to national

food security, c) to reduce the uneven income distribution between the rural and urban populations, and d) to reduce the unemployment among landless peasants.

**Hypothesis Testing**

For operational purposes the null hypothesis is broken down into four subhypotheses; each null subhypothesis corresponds to each objective of the PRIP. The subhypothesis were formulated following the reasoning of an evaluator who expects that the initial expectations were covered and the objectives were accomplished. The order for the hypothesis testing, the null subhypothesis statement and the variables used for hypothesis testing are the following:

a) The first subhypothesis is related to the objective "to develop an intensive irrigation system". This null subhypothesis states that *ejidatarios* perceive that PRIP did not develop an efficient irrigation delivery system ($H_0$: $\pi=\pi_0$). The variables selected are related to the *ejidatarios'* perception of the state of the irrigation infrastructure and the efficiency of the irrigation system, farmers' participation and the *ejidatarios'* willingness to pay.
b) The second relates to the PRIP contribution to the national food security. The null subhypothesis states

that *ejidatarios* did not produce more food crops for the national food security in 1995 than in 1987 ($H_0$: $\mu_2=\mu_1$). The variables included in the hypothesis testing were regarding the improvement of yields per hectare and total amount of food crops per *ejidatario* and value of crops per *ejidatario* between 1987 and 1995.

c) The third objective states that PRIP would contribute to the reduction of the uneven income distribution between the rural and urban populations. The null subhypothesis tested is that *ejidatarios* did not increase their income from 1987 to 1995 ($H_0$: $\mu_1>\mu_2$). Student t-tests are performed on the annual and on-farm income mean differences between 1987 and 1995.

d) The fourth objective states that PRIP would contribute to the reduction of unemployment among landless people. The null subhypothesis states that the *ejidatarios* off-farm work increased from 1987 to 1995, $H_0$: $\mu_1<\mu_2$. The off-farm job (temporary, permanent, and own business) and the land renting were chosen as variables to test the null subhypothesis. Three aspects of the off-farm employment were analyzed: the percentage of *ejidatarios* with an off-farm job (temporary or permanent), the number of days worked off-farm in a salaried job and the off-farm income difference between 1987 and 1995. The aspects of land renting were the percentage of *ejidatarios* who rented their land and the amount of

money received for land renting.

## D. Study Methods

This study is mainly based on two surveys. A survey was administrated to 238 *ejidatarios* in 1987 and another to 150 *ejidatarios* in 1995. These two samples contained a 57 *ejidatario* paired subsample who were interviewed in 1987 and 1995. The study took the form of a panel study. The paired sample was divided into 9 clusters. The statistical analysis was mainly performed on the 57 *ejidatario* subsample and its 9 strata.

Many factor influence the situation of poor participants in PRIP, however this study is based in the following variables.

# CHAPTER II

# LITERATURE REVIEW

Many factors influenced the *ejidatarios'* situation in 1987 and in 1991, but this dissertation especially focuses on the achievement of the four PRIP objectives. The literature review includes aspects related to the PRIP objectives and its strategy to achieve those objectives. This study recognizes that there were many external factors that influenced the operation and accomplishments of the PRIP, such as the North American Free Trade Agreement and the globalization of the economy, however, their influence was not part of this dissertation.

Along the citations, the author of this study expresses some comments about how the topic of the literature review are related to the Panuco River Irrigation Project and, particularly, to this research. For this reason, no citations are made.

## A. Contribution of Irrigation to Food Production

Irrigated agriculture has been disproportionately productive compared to rainfed agriculture. At present, only about 18 percent of the world's cultivated land is

irrigated, but it produces roughly 33 percent of this planet's human food supply (Freeman and Lowdermilk, 1994: 113). This may explain why the PRIP planners anticipated high crop yields when the project would achieve their maximum potential.

Rainfall is not always available in many sub-tropical and arid areas, thus adequate moisture is needed to produce a reliable crop and must be added through irrigation. Two hundred sixty million hectares of irrigated lands around the world have played a crucial role in enabling the farming community to produce an abundance of food at low and relatively stable prices (FAO, 1996). The total area of irrigated agriculture had an almost threefold increase in production between 1950 and 1980 throughout the world (Ostrom, 1992:1). The PRIP intended to transform a low-input, low-yield traditional farming system into a high-yield farming system.

Despite yield increases in irrigated lands, there is still a great deal of unrealized potential that needs to be assessed. However, irrigation potential of a given country or region is extremely difficult to assess, given the conceptual and technical complexities involved. Available estimates often produce widely different results, but they all suggest that the potential for irrigation expansion is considerable (FAO, 1996). Frequently, this potential is fully developed by only some of the project participants of irrigation projects, but the majority of the participants

are not able to achieve take advantage of this potential, like in the PRIP.

A comprehensive World Bank/UNDP study (quoted by FAO, 1996) indicates that irrigation can be expanded over 110 million hectares --or a 59 percent increase of the current irrigated land-- in developing countries. The largest potential for increase lies in Asia (69 million ha increase), followed by South America (20 million ha mainly in Brazil). The largest potential in relation to present levels is in sub-Saharan Africa (from 3.4 million to 16.5 million ha, or 470%, mainly in Angola) (FAO, 1996). The PRIP was programmed to irrigate 144,000 hectares, however it never achieve its full potential. By 1987, only 83,000 hectares could be irrigated.

## B. Large Irrigation Projects

The PRIP objectives were related to food security, construction of infrastructure, income distribution and reduction of the unemployment. Other explicit or implicit objectives of the irrigation projects have been: 1) accelerate the process of socioeconomic transformation of the respective communities, 2) contribute significantly to the country's drive for self-sufficiency in food production and, 3) create employment for rural population, 4) reduce risk for agriculture, 5) reduce poverty, and 6) activation of resource mobilization. Objectives may vary from project

to project and from country to country, but these aspects are central and continuously mentioned (Coward, 1994; Kolawole, 1994).

Failure to have a set of realistic goals and objectives precludes stakeholders from committing themselves to irrigation projects. If planners fail to include all stakeholders' expectations from the beginning, undesirable consequences may follow, such as concentration of proposed benefits to a small group of participants (Kolawole, 1994: 103).

Scholars in the international development arena generally agree that irrigation projects may produce great benefits for the Third World countries. However, there has been lengthy discussion about which is better: large irrigation projects based on large dams involving large groups of farmers or small irrigation projects based on water pumping, deep wells, etc., that benefit small groups of farmers. In the PRIP area exist both kind of irrigation systems, but it is unclear as to which is better.

The official opinion of international donor agencies favors large scale irrigation projects. A study (Jones, 1995: 69-72) of 208 irrigation projects funded by the World Bank concludes that large irrigation projects have a strong tendency to get better economic returns than small projects. The bigger the project, the higher the likelihood of favorable economic outcomes. However, it is recognized that the costs imposed by larger projects -farmland and towns

flooded, people displaced, and lands waterlogged because of overirrigation and salted because of poor drainage- are more significant than those for small projects and attract more unfavorable attention, but the larger projects' economic benefits are greater, too (Jones, 1995). The PRIP was built under the idea that bigger was better.

On the other hand, there is a extensive disagreement with the international aid agencies' policies. Some scholars (Ostrom, 1992; Freeman and Lowdermilk, 1994; Uphoff, 1989; Chambers, 1981) argue that one of the major biases in irrigation development has been the belief that larger projects produce more benefits, social and economic. However, the benefits of many large projects often do not exceed the monetary costs, even without considering social damages. Small irrigation projects have demonstrated their viability and their profitability (Shivakoti, 1991).

In spite of massive investments in irrigation, which have consequently generated higher agricultural yields, many large-scale irrigation projects have not been sustainable. That is, after the project was completed, the net flow of costs exceeded the net benefits. In fact, many large-scale irrigation projects have generated disappointing operational results (Ostrom, 1992:2). When the PRIP was built, the sustainability was measured by the direct economic returns, but not by the long term environmental consequences.

Other more radical opinions (Kandell, 1993) in the international arena argue that big dams financed by the

World Bank have become an anathema. Dams can displace as many people and destroy as much property as war or a natural disaster (hurricane, tornado, etc.). Dams permanently disfigure the landscape and may eventually be crippled by the buildup of silt in their reservoirs. Their performance often falls short of the lofty economic targets set by government planners (Kandell, 1993: 107). Two of the irrigation units in PRIP have a dam. When those dams were built an important number of people was displaced. These people become beneficiary of the irrigation project.

Irrigated agriculture creates new forms of uncertainty while overcoming the uncertainties associated with rainfed agriculture. In bureaucratically rigid irrigation projects, large-scale surface irrigation systems may produce management uncertainties --e.g. on-time water delivery-- which may become greater than the original uncertainty when it would rain (Freeman and Lowdermilk, 1994: 120). Many irrigation systems in Mexico are in this situation.

## C. Irrigation Project Objectives

In this study, four of the main objectives of the irrigation projects are reviewed in more detail: a) building an irrigation delivery system, b) contribution of larger amounts of food products to national food selfsufficiency, c) provision of land and means of production to unemployed people --settlement and land reform, and d) improvement of

beneficiaries' income distribution and their living conditions.

**Building an Irrigation Delivery System**

An irrigation delivery system can be defined as a created entity with complex independent social, economic, legal, biochemical, and physical factors, processes, and procedures designed to transport water from a known source to the root zones of plants and remove excess water through horizontal or vertical drainage. At the farm level, the water input is combined with other farm inputs and managed to produce crops of economic value. Thus, a system approach to irrigation management encompasses the total set of process interactions involved in irrigated agriculture --not just the water input (Nobe and Sampath, 1986: 5). This means that construction of a irrigation delivery system should not be exclusively identified as the construction of irrigation infrastructure. The PRIP planners felt that agricultural services were important to help *ejidatarios* take advantage of the irrigation system.

Design of an irrigation management system is often as important as the construction of infrastructure. An irrigation management system involves the management of multiple resources, including not only water, but also information, people, and other inputs (Lenton, 1986: 47). This is one thing that irrigation management agencies in the

Third World countries do not understand.

One of the most basic objectives of an irrigation project is water control. Water control performance can be evaluated through three indicators: reliability (temporal parameter), adequacy (volume balance, including seepage, operational, and application losses), and equity (spatial parameter) (Reddy, 1986: 101). The government agency that manages the PRIP uses as a main indicator "field efficiency" in primary and secondary infrastructure. These agencies consider field efficiency as the ratio of water delivered divided by the water diverted. For example, 75% of field efficiency implies that only 75 cubic meter of water out of 100 cubic meters are delivered.

Maintenance is also a basic investment problem. Little or no funds are generally allocated for system maintenance when budgets and designs are made for irrigation projects. Solving the maintenance problem is not an easy task since it involves a number of interrelated problems. For example, inadequate maintenance causes inefficient water deliveries and discourages farmer participation. In addition, inefficient deliveries discourage payment of fees which will reduce the funds available for maintenance (Easter and Welsch, 1986a: 19-21).

Rules and procedures for water pricing will affect both the distribution of water and irrigation users' benefits. Charges for water can serve as instruments to resolve some of the conflicts related to the equitable distribution of

irrigation services. In addition, water prices can help improve the efficiency of water distribution. Defining a water price could be a simple task, defining an adequate price is always a difficult task (Easter and Welsch, 1986b). Water prices were always low at the PRIP because the federal government subsidized the water fee. Now the Mexican government is increasing the water fee to recover the operational cost of the irrigation system.

Cost recovery and income redistribution are objectives usually considered to fix water fees. The degree of cost recovery is an equity concern because it is considered "fair" that the beneficiary pays all or part of the cost of service. Water pricing can help to influence in specific ways the distribution of income toward certain groups, subsidizing or taxing water and services. The formulation of equity objectives is assumed to involve political concerns and not be just an economic issue (Ostrom, 1992).

Farmers are willing to pay for water when the returns from agricultural production are enough to cover their costs, including water. It means that prices of agricultural products, prices of inputs including credit, technology, interest paid for credit, and other production components may affect the farmer's willingness to pay (Ostrom, 1992: 88).

**Food Security**

Dramatic increases in the quantity of foods available, particularly in developing countries, are more often the results of expanding irrigated land, the development of new high-yield grain varieties, and/or addition of other agricultural inputs, such as fertilizers and pesticides. The spread of irrigation "contributed between 50 and 60 percent of the massive increase in agricultural output of the developing countries from 1960 to 1980." (Crosson and Rosenberg, quoted by Ostrom, 1992: 1) However, the increase of agricultural outputs is not the most critical factor to make food available. For example, political factors more often restrict the availability of food than the availability of irrigation (e.g., the trade barriers).

The benefits of exploiting irrigation potentials are considerable. According to the World Bank/UNDP study (FAO, 1996), the exploitation of 110 million ha in developing countries could produce approximately 300-400 million tons of grain -enough to provide the basic diet for 1.5 billion to 2 billion people. This would require an investment estimated to be US$500-1000 billion dollars. If irrigation expands at the rates it has over the past 30 years, the full productive potential of these 110 million ha could be realized between 2015 and 2025 (FAO, 1996).

Despite the huge investments and subsidies, irrigation performance indicators are falling short of expectations for

yield increases. The area irrigated and technical efficiency of water use are the central problems. It is estimated that as much as 60 percent of the water diverted or pumped for irrigation is wasted (FAO, 1995: 10). In the PRIP, the National Water Commission calculated that 47% of the water was wasted in 1995.

There is considerable evidence that potential gains from irrigation are far from being fully realized (Small and Carruthers, 1991: 3). For example, inadequate water management is considered to be the largest single factor in expanding the gap between actual and potential rice yields (Small and Carruthers, 1991: 4).

**Settlement and Land Reform in Irrigation Projects**

In most of the government-sponsored irrigation projects, long-term settlement is a strategic element. The main purpose of settlement is to spread the benefits of the increased agricultural production across a wider portion of the needy population. Unemployed and/or landless peasants are the primary target beneficiaries of the land in new irrigation projects (Kolawole, 1994: 102). However, for those who are resettled against their will, the construction of an irrigation dam can cause significant suffering because they may lose all the capital they have accumulated for many years (Kandell, 1993). The PRIP benefited to 8,500 farmers with land, many of them were relocated from the area of the

reservoir, but many others from outside the region.

Resettlement is defined as the adjustment process of the people relocated by an irrigation development project and their integration into the mainstream of production resources (Kolawole, 1994). The most important aim of an irrigation resettlement program is developing new and viable socioeconomic systems for those being resettled (Cernea, 1994: 146).

Two of the eligibility criteria often established in large irrigation projects are that a settler must be landless and must have a large family in order to receive the benefits from irrigation projects. Recruitment using these criteria yields a heterogeneous set of individuals coming from different regions based upon kinship groupings, and ethnic and religious backgrounds. Many settlers have very limited economic resources. No capital exists when large numbers of heterogeneous individuals are placed in strange terrain. With few acquired farming skills and with large families to feed (by project requirement), the initial settlers are challenged just to make ends meet and keep the land they were assigned. Many do not succeed and, eventually, sell their land and return to the ranks of the landless (Ostrom, 1992). The background of the PRIP participants was broad.

Resettlement of irrigation areas often requires the establishment of a new land tenure system. The new definition of property rights of individual farmers is a

precondition to launch any program to support new settlers (Kolawole, 1994: 108). If it does not happen, settlements may affect the most elemental norms of human rights (Kandell, 1993). Governments dictate the norms of living and working of the beneficiaries of irrigation projects. The PRIP expropriated the land of the landlords --many of them had more than a thousand hectares, later it was given to *ejidatarios*, who did have any land before. Each *ejidatario* was given with 10 hectares of irrigated land and the old land owners had the right to 20 hectares of land.

After analyzing many settlement projects including settlement associated with irrigation projects, Scudder (1994: 160) proposes four stages to analyze a dynamic model of settlement process:

1. Planning, initial infrastructural process development, and settler recruitment;
2. Transition;
3. Economic and social development; and
4. Handing over and incorporation.

These stages are just a general model that may vary according to the characteristics of each process. Sometimes, a group of settlers cannot go beyond the second stage. Other times, settlers can skip one stage and go to the next step successfully. This theoretical model of settlement -suggested by Scudder (1994)-- can be applied to

the situation of a small group of settlers or to the situation of the complete population settled by an irrigation project. For example, most of the settled population may be in the third stage while some small groups of settlers may still be in the first. After more than twenty years from the construction of the irrigation project, PRIP *ejidatarios* are in a broad range of situation and stages.

It is important to understand that development is not a linear process or a fixed sequence of phases. Each human group has its own developmental cycle and moves at its own pace from one stage to another. The path followed by one group is not necessarily the same for other groups (Axinn, 1977). When this developmental cycle is understood, it may help settlers of a particular irrigation project to overcome the difficulties of the adaptation process to the new environment.

The first stage depends mostly on the planners' vision to select the right people to be brought to the region of the irrigation project. In the second stage, the settlers are still moving from one habitat to another. This transitional period must come to an end before settler families can be expected to significantly increase their productivity. The duration of this stage may vary, but it usually lasts from one to five years. While the second stage is characterized by a population of risk-averse settlers, in the third stage a population is ready to take

on more risk. Instead of producing primarily for subsistence, as in the stage two, settlers act on a wide range of investment strategies in stage three to achieve higher levels of productivity through diversification of the family estate (Scudder, 1994: 162-164).

One of the main recommendations for an irrigation resettlement is to diversify farming systems to increase the development potential of new lands (Scudder, 1994; Axinn, 1977). There are four main reasons for diversifying farming systems of settler families by encouraging multiple crops and combining farming and livestock components. First, such agricultural systems tend to be more resilient and ecologically more stable. Second, they are more productive, providing settler families with higher net incomes. Third, diversified farming systems distribute family labor more evenly throughout the annual cycle, providing each family member with a variety of activities. Only through the introduction of properly planned additional enterprises is it possible to fill the gaps of underemployment in the slack periods of the agricultural year. In addition, diversification provides foodstuffs for non-farm families and raw materials for agroindustries, building a base for more rapid development (Scudder, 1994: 175). It seems to be that this is not happening in the PRIP, because *ejidatarios* are basing their farming system.

Finally, a settlement cannot be considered a success until the control of project activities is handed over to

settlers and their local organizations; a second generation of settlers starts to take over; and the project is incorporated within the encompassing region (Scudder, 1994: 167). This process takes time and needs the participation of all the stakeholders. This stage has started in the PRIP, but it is still underway.

**Improvement of Beneficiaries Income Distribution and Living Conditions**

The primary purpose of most irrigation projects is production, because the irrigation project design policy is dominated by "production thinking" (Chambers quoted by Sampath, 1990: 76-77). Production thinking is defined as a pre-disposed point of view that explains poverty in terms of population, environment, and other physical factors, and finds the mathematics of food and population easy to grasp and attractive to accept. It may explain why there is a persistent bias in most international agencies against equity objectives. In the case of the PRIP, an equity objective and a productivity objective were established since the beginning. The equity objectives stated that PRIP would contribute "to reduce the uneven distribution between the urban and the rural populations." The productivity objective said "to contribute to the national food security." (World Bank, 1989: p. i)

The fact that many landscapes of the world are now

dominated by dams, reservoirs, and canals cannot hide a disquieting fact: many irrigation projects have not served the needs of farmers and agricultural production (Ostrom, 1992: 2). A study of the Chad Basin Development Authority (CBDA) concludes that social welfare is probably the most neglected aspect of irrigation development in Nigeria (Kolawole, 1994: 111). The primary preoccupation of planners is to increase agricultural productivity. It was once believed that an increase in agricultural productivity would lead to the generation of some beneficial economic linkages, such as a proportionate rise in incomes following rapid expansion in employment opportunities, as well as significant improvements in the standard of living of the settlers.

Welfare can be defined as the way in which basic human needs are met. Basic needs often mean material needs -- food, housing, income, etc. Yet, basic needs also include non-material needs --need for affection, identity, belonging, self-worth, etc. The emphasis on consumerism and materialism in modern culture has tended to ignore non-material needs, and even confused the two (Nozick, 1993: 37). The PRIP establish an objective to increase the income within the participants' farm. It was assumed that it would bring automatic improvement in the participants' well-being.

However, the evaluation of a development project should start by assessing the accomplishment of its initial objectives. After that, a project can be evaluated by its

omissions and limitations. The previously mentioned study of the CBDA finds that this large-scale irrigation project failed because it did not achieve its initial objective of generating employment and higher incomes for the target population (Kolawole, 1994: 146). For this reason, this dissertation tries to determine if the PRIP met its initial objectives.

## D. Stakeholders Participation on Irrigation Projects

The Overseas Development Administration (ODA, 1995) defines stakeholders as persons, groups, or institutions with interests in a project or program. Primary stakeholders are those ultimately affected, either positively (beneficiaries) or negatively (for example, those involuntarily resettled). Secondary stakeholders are the intermediaries in the aid delivery process. This definition of stakeholders includes both winners and losers, and those involved or excluded from decision-making processes.

ODA (1995) characterizes key stakeholders as those who can significantly influence, or are important to, the success of the project. "Influence" refers to how powerful a stakeholder is; "importance" refers to those stakeholders whose problems, needs, and interests are the priority of the projects --if these "important" stakeholders are not assisted effectively then the project cannot be deemed a "success" (ODA, 1995).

"Influence" is also the power which stakeholders have over a project --to control what decisions are made, facilitate project implementation, or exert pressure which affects the project negatively or positively. "Influence" is perhaps best understood as the extent to which people, groups, or organizations (i.e., stakeholders) are able to persuade or coerce others into making decisions and following certain courses of action (ODA, 1995).

Power may derive from the nature of a stakeholder's organization, or their position in relation to other stakeholders (for example, line ministries, which control budgets and other departments). Other forms of influence may be more informal (e.g., personal connections to ruling politicians). It may also be necessary to consider stakeholders whose power, and therefore influence, will increase because of resources introduced by the project (ODA, 1995).

It is important to distinguish importance from influence. There will often be stakeholders, especially unorganized primary stakeholders, upon which the project places great priority (e.g., women, resource poor farmers, ethnic minorities). These stakeholders can be important, but may have weak capacity to participate in the project and limited power to influence key decisions (ODA, 1995). The PRIP gives the power to the government agencies by design. Even though *ejidatarios* were important they did not have influence on the decision making.

The interest of this study is centered on two kinds of stakeholders, the *ejidatario*-farmers, who were beneficiaries of the Panuco River Irrigation Project, and the Mexican government, through the Secretariat of Agriculture and Water Resources (SARH). These agencies implemented the Panuco River Irrigation Project. The World Bank is another key stakeholder in the PRIP; however, it is not a direct subject of this study.

**Participation of International Donor Agencies**

A significant portion of international donor assistance has been used to establish irrigation systems. Irrigation received nearly 30 percent of World Bank agricultural lending during the 1980s. Spending commitments for irrigation by all donor agencies exceeded US$ 2 billion annually in the past decade (FAO, 1995: 10). The World Bank alone provided over US$ 11 billion in loans for irrigation and drainage projects between 1947 and 1985 and another $7.5 billion for area development projects that frequently included substantial irrigation activities (Ostrom, 1992:2). The cost of the PRIP construction was initially calculated in $197.4 million dollars, however the final cost was 446.7 million dollars.

**The National Governments Participation**

FAO (1995: 2) justifies the participation of governments in large irrigation projects, by stating that water control projects frequently require enormous investments. The economies of scale are such that a single supplying entity is often the most economically efficient organizational arrangement. The fact that many investments in large irrigation projects are huge, and have a long time-horizon, often discourages the input of private capital, and requires large amounts of public investment. Ultimately, water is vital to life and governments have a responsibility to manage water for the national welfare (FAO, 1995). When PRIP was constructed, the dominating development paradigm presupposed that the national governments had to rule the irrigation projects as a condition to achieve the development.

Assuming that governments have to participate in irrigation projects seeking improved social well-being, the next question becomes: under what kind of policy? Randal's discussion of the theoretical concept of Social Welfare Function (SWF) is a useful devise for developing the theoretical principle of Maximum Social Well-Being (MSW)[4] (Randal, 1987: 122-133). There is no direct use of SWF for

[4] Randal uses a graphic representation of the *Grand Utility Frontier* to discuss SWF and MSW. For the purpose of this research, only the outcome will be discussed.

quantitative analysis, but its theoretical examination may help to derive some possible irrigation related policy outcomes.

Efficiency alone provides no guidance as to how a society may rationally choose among criteria for economic policy. The criteria to judge policy solutions are: a) Economic Efficiency, b) Constant Proportional Shares, c) Pareto-Safety, d) Maximum Social Well-being, e) Maximum Value of Social Product, and f) Composite Criteria (Randal, 1987: 125). All of these criteria can be applied when an irrigation policy is selected or a new irrigation project is established. Randal (1987: 137-146) defines these criteria as following:

> a) "*Economic Efficiency* as a criterion, alone, is a criterion that eliminates inefficient (i.e., wasteful) solutions, but it provides no distinction between policies that result in economic injury for some and policies that result in economic injury for no one."
>
> b) "*Constant Proportional Shares* criterion defines an improvement as any solution that results in greater income for one, so long as everybody's income increases proportionally. Under this criterion, everyone must benefit from a policy change, and each must benefit in strict proportion to his initial income."
>
> c) "The criterion of *Pareto-safety* defines an improvement (i.e., a Pareto-improvement) as any change that would increase the income of at least one person while not reducing anybody's income. Pareto-Safety permits relative redistribution of income as the total income of society grows, but no redistribution so great that any party actually receives less income. To this extent, the criterion of Pareto-safety at least partly embeds and reinforces past patterns of economic injury."
>
> d) The criterion of *Maximum Social Well-being* "permits real economic injury, within limits. Those limits are defined by the shape of the social indifference curve,

itself. In general, economic injury to individuals is permitted, so long as a social consensus exists so that the outcome represents an improvement in social well-being."

e) "Under the criterion of *Maximum Value of Social Product*, an improvement need not necessarily represent a movement toward efficiency. However, the optimal solution must be efficient. Economic injury is permissible, so long as the sum of the dollars gained by the gainers exceeds the sum of the dollars lost by the losers."

f) The reasonable objections to the various possible single criteria have led to propose the use of multiple or *Composite Criteria*. For example, the use of the criterion of maximum value of social product, with the provision that policies that would make the poor worse-off are unacceptable. That kind of criterion could be described as the maximum value of social product, subject to Pareto-safety for the poor but not for the rich. It is quite possible to generate other composite criteria.

These and other kinds of criteria may be combined to formulate irrigation policies. However, the complexity of the process is often simplified to one criterion that subordinates the rest of the criteria. For example, it seems that the PRIP was established based on the Maximum Value of Social Product criterion, however, in recent years efficiency criterion has become the leading criterion to implement the policy of irrigation management transference. Policy selection has not always been realized in the same way. Government policies have varied across time. For a long time, irrigation policy making was dominated by Keynesian theories that supported the state intervention in the economy. Some of those theories were derived from Keynes' theories on social expenditures (Correa et al.,

1993). Recently, the world scenario has been dominated by the idea that the state should reduce its activities and responsibilities to law-making and enforcement (Acuña and Smith, 1994).

The Keynesian theory of the welfare state promotes the social and economic intervention (public investment, public production of good and services, etc.) of the state to resolve conflicts of interests, placing them under the state tutelage in frequent response to priorities determined by political and electoral objectives (Acuña and Smith, 1994: 56; Correa, et al., 1993: 23-24; Bedoy, 1993: 125).

Neoliberal policies have become dominant in most of the developed countries and many developing countries. The term "neoliberalism" refers to the economic theory that promotes and defends the *laissez faire*, the free market, privatization of the economy, deregulation of mercantile exchange, international trade liberalization, fiscal discipline, reduction of public expenditures on social welfare, foreign direct investment, elimination of any subsidy, decentralization of policy making, and so on (Acuña and Smith, 1994: 55; Gamarra, 1994:2-8; Correa, et al., 1993: 23; Bedoy, 1993: 133).

This has occurred because governments have been inefficient at managing the infrastructure and providing efficient services and promoting the social and economic development of the population (World Bank, 1994: 7). Neoliberalism encourages governments to give up their

responsibilities in managing irrigation systems and turn them over to the user associations (Shivakoti, 1991: 111; Uphoff and Esman, 1974: 75).

The facts are forcing governments and donors to re-think the economic, social, and environmental implications of large, publicly-funded, and operational irrigation projects (World Bank, 1994). In the past, domestic spending for irrigation dominated agricultural budgets in countries throughout the world. For example, from 1940s to the beginning of the 1980s, 80 percent of Mexico's public expenditures in agriculture have been for irrigation projects (FAO, 1995: 9-10). However, in the last decade, the state financial resources for irrigation and other agricultural services were increasingly reduced. This situation especially affected low income farmers.

**Farmer Participation**

Uphoff (1982, 1985, 1986, and 1989) and Ostrom (1992 and 1993) have insisted that farmer participation is one of the key factors to managing infrastructure projects. This is particularly true for irrigation projects. When farmer participation is limited, their project benefits are also limited. Active participation is the only way that beneficiaries can achieve their expectations. By design, the PRIP excluded the participation of participant farmers.

Farmer participation is an effective way to increase

irrigation performance (Lenton, 1986: 58). It requires the provision of effective incentives and conditions that enable farmers, both individually and collectively, to accept and fulfill irrigation management responsibilities.

Many irrigation systems that have been constructed in developing countries since the 1950s involve both users and suppliers who have relatively short-term horizons; their actions, however, have long-term effects on both social and physical capital (Ostrom, 1992: 42).

Organization of farmer-users can be the difference between success and failure in achieving efficiency and equity (Shivakoti, 1991: 102-104). When the organization responds to users' interests, there is a higher chance of success, but when the organization is imposed upon by the state or any outside donor, irrigation systems often fall far from beneficiaries' expectations.

The persistent problems with the design, construction, operation, management, and use of irrigation projects have led donors and national governments to reevaluate the emphasis on engineering in irrigation planning and to stress the importance of organizing farmers to make the most effective use of the capital investment (World Bank, 1994; Ostrom, 1992; Uphoff, 1986). In the PRIP, both the engineering and organization have been important to define the current situation of the project and its beneficiaries.

The motivation to invest in social capital exists in established irrigation projects where (1) farmers have long-

term horizons, (2) they face so much scarcity that they are motivated to invest in organizing themselves, and (3) they are assured that organization could make a substantial difference in their yields (Ostrom, 1992).

## E. Evaluation of Irrigation Projects

There has been an increasing awareness of the importance of evaluation of development projects around the world. Most of the international donor institutions have promoted the idea that all development projects should be evaluated. However, evaluation is still short of being accepted as a way to improve planning, implementation, and operation of development projects. The PRIP did not have a particular system of evaluation.

In most Third World countries, there is a lack of "culture of evaluation" (Valtierra, 1989). Sometimes evaluation is overlooked because of the lack of knowledge to perform it. In other cases, there are vested interests that do not allow the evaluation of programs because it may affect the interests of powerful social groups or of corrupt officials.

The evaluation research as a discipline emerged in the 1970s (Weiss, 1972; Freeman et al., 1979; Rossi and Freeman, 1993). Evaluation research proposes a systematic way to evaluate social programs, basically promoted by governments. In developed countries, prior to evaluation research, the

evaluation of programs was mostly performed on a non-scientific basis. In most Third World countries, evaluation is still conducted on an empirical basis (Valtierra, 1989).

Evaluation studies the impact of development projects and requires the revision of the projects objectives and strategy used to achieve those objectives. Evaluators normally formulate positive research hypotheses regarding the project achievements. An initial assumption is that development projects achieve their initial objectives. These assumptions and requirements are conditional considerations of evaluation, however evaluation should not be limited to those considerations. For this reason, the research hypothesis of this study initially asserts that the PRIP met its initial objectives.

The main proposition of evaluation research is to take some elements of biological experimentation and apply them to social research. However, evaluation research recognizes the impossibility of having a completely controlled social experiment. Therefore, these social research designs are called quasi-experimental designs (Rossi and Freeman, 1993).

These quasi-experimental designs were initially applied to health programs, later to educational programs, and in the 1980s to agricultural and rural development programs (Rossi and Freeman, 1993; Casley and Lury, 1982; Casley and Kumar, 1987). Quasi-experimental designs are longitudinal studies where one or more variables are measured at least twice over time. A simple quasi-experimental design can be

a cohort study or a panel study. In this type of design, a variable of a social group is measured. Later, a change is induced in the variable by an external agent. After some time, the same variable is measured again in the same group of people two or more times. If a population is studied two or more times (e.g., census), the study is a trend. If the same group but not the same individuals are interviewed, the study is a cohort. If the same individuals are interviewed, the study is a panel. A panel study is a better longitudinal study than cohort and trend studies because it is the most sophisticated survey design for more explanatory purposes (Barbie, 1990: 57). This dissertation research assumes the form of a panel study.

A complex quasi-experiment needs at least two groups: one is a treatment group (beneficiaries) and the other is a control group (non-beneficiaries). A common characteristic (e.g., income) of both groups is selected and measured to know how different or similar both groups are. An external agent (government) induces a change (a development program) into the selected characteristic of the treatment group. After that the characteristic of interest is measured in both groups, treatment and control. The difference between the initial situation of the treatment group and its current situation, and the difference between the treatment group and the control group are attributed to the induced change (Valtierra, 1989; Campbell and Stanley, 1988). The figure 1 illustrates a complex quasi-experimental design applied to

an agricultural development project (modified after Valtierra, 1989: 59).

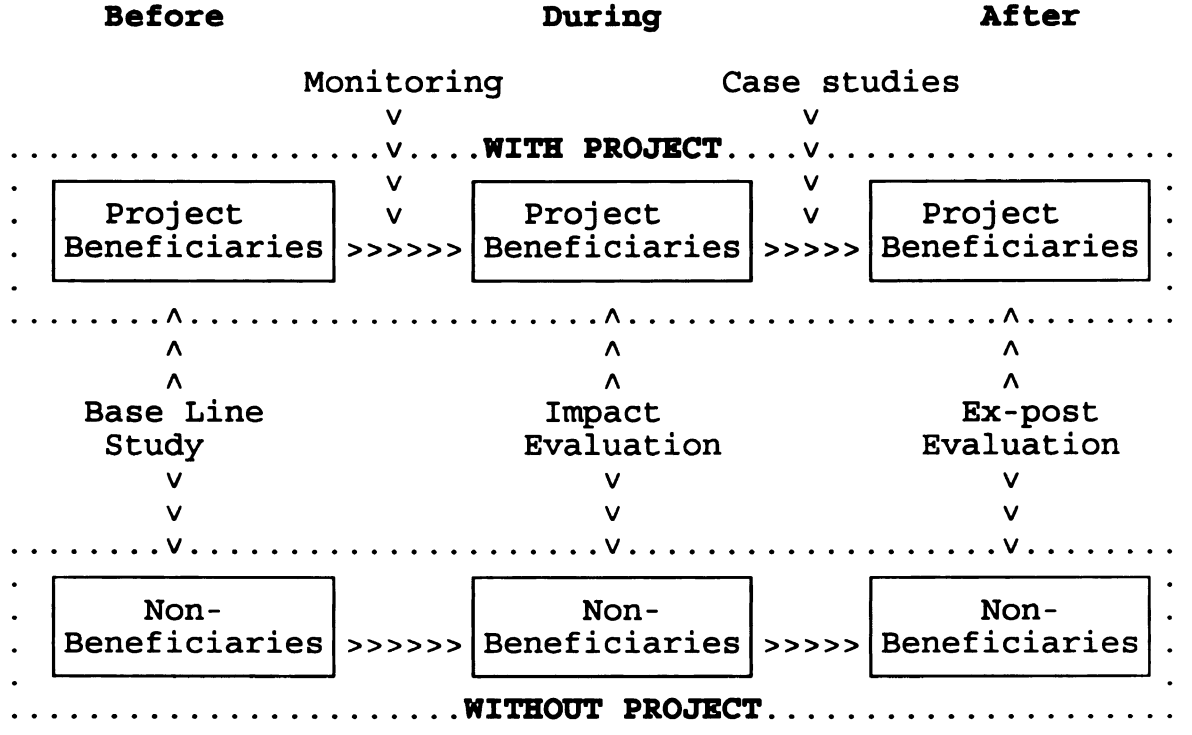


**Figure 1. Diagram of a Quasi-Experimental Model of Evaluation and Monitoring of an Agricultural Development Project**

Evaluation research advocates claim that evaluation research promotes the combination of qualitative and quantitative methods of data collection (Cook and Reichardt, 1986; Patton, 1987; Reichardt and Rallis, 1994). However, there is a general tendency to favor quantitative methods over qualitative (Casley, 1987; Casley, 1988; Casley and Kumar, 1989). Surveys have been the most broadly used method for evaluation research (Rossi et al., 1983; Smith,

1992; Valtierra, 1989). A survey is an appropriate method of research when individual people are the units of analysis, and when there is a large population which is difficult to observe (Barbie, 1989: 237). This study mainly relies on two surveys, but other methods were used, such as group interviews and interviews with qualified informants.

One of the main advantages of survey methods over qualitative methods is that the comparison of data in different times is easier, even though researchers or evaluators may be different every time. This is demonstrated in the evaluation of the Puebla Project. This evaluation has been probably the most ambitious process of evaluation ever performed on a development project in Mexico. Four major evaluation surveys collected the same basic information in 1967, 1970, 1983, and 1985. In 1985, the four surveys were reanalyzed and compared (Díaz et al., 1992; Díaz et al., 1993). The comparison of the four evaluations would have been more difficult if qualitative methods were utilized. However, this does not imply that it is impossible to use qualitative methods for a panel study.

## CHAPTER III

## STUDY SITE

The Panuco River Irrigation Project (PRIP) is located in northeastern Mexico, about two hundred miles south from the Mexican-U.S. border. The geographic coordinates are 108° WG, 22° N. The three irrigation units that compose the Panuco Projects are situated on the border of three Mexican states: Tamaulipas, Veracruz, and San Luís Potosí (see figure 2). The climate is tropical semiarid with 900 mm of rain a year and a mean temperature of 25°C. The Panuco River Basin is the fourth largest basin in Mexico. It covers 85,000 square kilometers and drains 18,500 million cubic meters of water per year. Its main tributaries are Moctezuma, Chicayan, Tantuan, Tampaón and Guayalejo Rivers.

PRIP has been one of the largest irrigation projects that the Mexican government has built in the last three decades. The Mexican government built most of the irrigation infrastructure between 1926 and 1966 (2,543,302 hectares) (Orive, 1970: 179). During the "mega irrigation projects" period between 1941 and 1958, Mexico expanded irrigation on 1,922,432 ha of land. In 1990, there were 3,346,936 ha of irrigated land (Morett, 1992: 175). If the full potential of PRIP is considered (144,000 ha), it

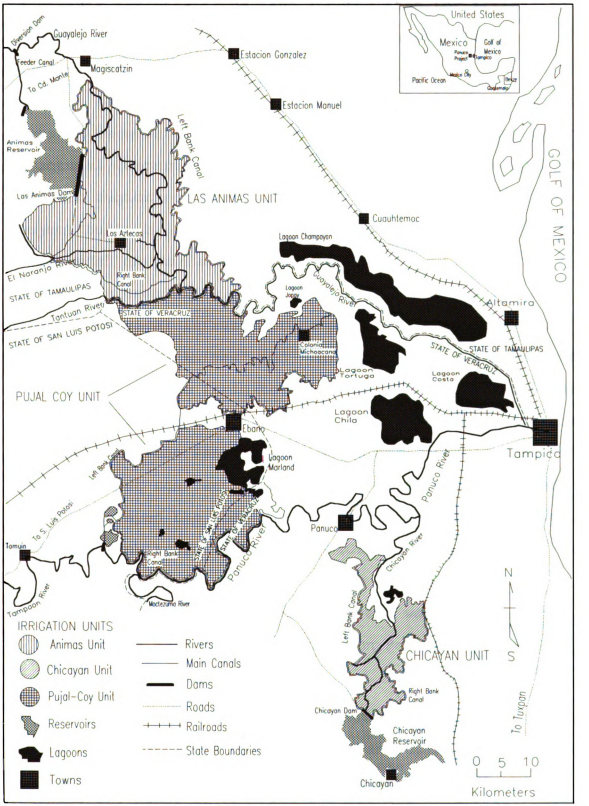


**Figure 2. Map of the Panuco River Irrigation Project (Base Map from World Bank (1989) modified after maps courtesy of the Secretariat of Agriculture and Water Resources (1994))**

represents 18% of all the land incorporated for irrigation between 1967 and 1990. Instead, if the actual irrigated land is considered, PRIP represents 10%.

The Panuco River Irrigation Project was chosen for this research because of its complexity. PRIP shares many of the structural features and problems of the irrigations systems in other regions of Mexico, specifically those irrigation project built by the Commissions of Hydrological Watersheds[5] (Barkin and King, 1978).

PRIP's complexity includes several redesigns of the original physical infrastructure project of two dams that irrigate the "Las Animas" and "Chicayan" units, and one very large pump house to irrigate the "Pujal-Coy" unit. However, PRIP's social situation is even more complex. For instance, the dams along the Panuco River Basin were studied during the 1960s, but constant opposition from big landlords and ranchers delayed the construction of PRIP until 1974, when the World Bank approved the loans (Orive-Alba, 1970: 235; World Bank, 1989: 33).

The Panuco River Irrigation Project was designed in 1971/72 by the Mexican Government. On February 19, 1974,

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[5] Commissions of Hydrological Watersheds were regional agencies created to coordinate the integral development of the main Mexican river basin areas (Panuco, Balsas, Papaloapan, Lerma-Santiago, etc.). These commissions followed the model of the Tennessee River Valley Authority (Barking and King, 1978). The commissions were created between the 1950s and 1960s. However, in the 1980s, most of them were dismantled, when the Mexican government abandoned the development approach by hydrological watersheds.

the World Bank approved a loan. The initial estimate of the project cost was US$ 197 million to be disbursed between 1974 and 1980. In 1978, a World Bank evaluation estimated that the construction costs were 35% over the budget, although only 65% of the infrastructure was constructed at the time. The World Bank provided an additional loan of US$ 25 million to complete the construction of PRIP. The final total cost was US$ 446 million, 126% more than the initial budget (World Bank, 1989: 33-34).

In PRIP, the Mexican government expected to overcome most of the physical and social problems of prior irrigation projects. PRIP had four basic objectives (World Bank, 1989: i):

a) To develop an intensive irrigation system,
b) To contribute to the national food security,
c) To reduce the uneven income distribution between the rural and urban populations, and
d) To reduce the unemployment among landless peasants

The four objectives were closely related. The first was the starting point, the construction of irrigation infrastructure was a means to achieve the other three objectives. The second was a societal objective to produce more food for an increasing Mexican population. To achieve the third objective, the Mexican government helped *ejidatarios* increase their income opportunities on their farms. The fourth objective was related to how the *ejidatarios'* farm provided permanent employment to

*ejidatario* families.

The implementation of PRIP had two main components: the construction of irrigation infrastructure for 144,000 ha[6] and the agrarian reform process to give land to 8,500 *ejidatario*-farmers. Both processes had to be completed in eight years, between 1974 and 1982 (World Bank, 1989: 34).

PRIP involved one of the larger agrarian reform processes ever[7] for a Mexican irrigation project. The Mexican government and the World Bank provided *ejidatarios* with enough resources to create a prominent agricultural development enclave close to the Mexico-U.S. border market. Each *ejidatario* received 10 hectares of irrigated lands (the national average of land per *ejidatario* is 6.3 hectares, 4.4 hectares of them rainfed, and only 1.09 hectares irrigated). The PRIP policy makers hoped to provide enough land to generate the income needed to maintain an average *ejidatario* family. Even though, the family has changed after the beginning of the PRIP, the main structure of the family has

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[6] The initial PRIP area was 137,000 hectares. Later, the Animas Unit was expanded by 7,000 hectares.

[7] According to Orive-Alba (1970: 199-212) the 1969 amendments to the Water Law allowed the Mexican government and private owners to trade water for land in the new irrigation districts, but not within the old districts. With this measure, the Mexican government could extend the benefits of irrigation to more people. In 1969, the new legislation was only applied to the Carrizo Irrigation District.

been maintained[8].

PRIP promoted a drastic change in the previous land use pattern. The previous land use was: 44,800 hectares under cultivation (4,800 hectares were irrigated and 40,000 hectares rainfed), the grazing area was 38,800 hectares of natural grasses, and the area with native vegetation covered about 53,400 hectares. The traditional farming system of subsistence crops and non-intensive cattle production did not utilize the real potential of land. Planners estimated that this land could produce very high yields of cash crops, for example onions and vegetables, which had a good market on the US border. The area of crops was expanded from 44,800 hectares to 115,922 hectares in 1982 (49,229 rainfed hectares and 66,693 irrigated hectares) (World Bank, 1989: 40).

The cropping intensity[9] was calculated at 61% before the PRIP. It means that only six out of every 10 hectares were cultivated from year to year and the other four were not cropped. Planners anticipated that cropping intensity would increase up to 127% because many of the new irrigated lands could be cultivated twice a year (World Bank, 1989:

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[8] There is no information regarding the demographic characteristics of the PRIP participants before or at the beginning of the project. The appendices B and C contain the participant characteristic in 1987 and 1995.

[9] Cropping intensity refers to the numbers of crops per year in an area, if all the land in the area is cropped once a year, the cropping intensity is 100%. If it is under 100%, some land is not cropped. If it is above 100%, some land is being cropped more than once a year.

42).

In 1983, PRIP reached a peak of cropping intensity at 118%. After that year, there has been a constant decline. The crop pattern has reverted back to the previous PRIP configuration because many farmers converted their crop land into grazing land and cash crops (e.g., tomatoes) have been substituted by subsistence crops (e.g., corn) (World Bank, 1989: 40).

Another important component of the PRIP strategy was the compulsory organization of all the *ejidatarios* into collective *ejidos*. Under this process, groups of approximately 50 *ejidatarios* were organized into collective *ejidos* to constitute medium enterprises. The purpose of those collective *ejidos* was to utilize all the resources provided by the Mexican government and the World Bank in an efficient way. Land, infrastructure, water, credit, machinery, fertilizers, etc., were provided for collective work. During the cropping season, every *ejidatario* received a salary for each day of work. At the end of the cropping season, each member of the collective *ejido* received a proportional share of the harvest.

After a few years of working together, *ejidatarios* began to abandon the collective work after the bankruptcy of most collective *ejidos*. The first *ejidos* started to distribute their land among individual *ejidatarios* starting at the beginning of the 1980s. In the 1990s, most of the *ejidatarios* were working alone. In 1995, a few *ejidos* still

worked collectively.

The PRIP was created under a paternalistic development approach. Under this approach, the Mexican government provided some other agricultural services, such as credit, crop insurance, administration of irrigation infrastructure, agricultural research and extension, commercialization, input supply, and machinery lease. In 1995, only commercialization of grains was provided on a limited basis by a state company, CONASUPO. The rest of the services are no longer being provided by the government.

Credit was a great means of support for *ejidatarios*, who did not have economic resources. After *ejidos* abandoned collectivism, a government bank (BANRURAL) organized groups of eight to ten *ejidatarios* into *grupos solidarios* (solidarity groups). The objective of solidarity groups was to guarantee the repayment of BANRURAL loans. In the period between 1992 and 1993, the federal government stopped providing agricultural credit for all the *ejidatarios*. Currently, farmers can obtain credit if they have collateral to guarantee the repayment of loans.

The crop insurance -while it existed- was always a matter of dispute between *ejidatarios* and government. The National Agricultural Insurance Company (ANAGSA) was dissolved by President Salinas at the end of the 1980s because of corruption among the insurance company employees. From that point, most *ejidatarios* have not had insurance for their crops and livestock.

In the case of the extension service, after several years of relatively good performance, most of the extensionists were fired between 1992 and 1994. All extensionists who kept their jobs were assigned to bureaucratic activities far away from the farmers' fields.

In 1990, the Mexican government initiated a program to transfer the irrigation infrastructure management to the user associations. According to a former official of the Water National Commission, the PRIP is one of the last irrigation districts programmed to be transferred to users' associations because it is one of the most problematic irrigation districts in Mexico. On a national level, in March of 1994 more than 75% of the irrigation districts had been transferred to user associations (Palacios, 1994:115). However, by July of 1994, only one out of more than ten PRIP modules[10] had been transferred, "Jaboncillo" (2,872 hectares).

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[10] The Mexican government administers irrigation throughout Irrigation Districts. PRIP is administrated by the 092 Irrigation District Office which is located in the city of Tampico. Irrigation districts are divided into Irrigation Units. Irrigation units have subdivisions called modules. A module diverts water from a secondary canal and its users are scheduled to receive water at the same time.

# CHAPTER IV

# METHODOLOGY

This research is based on surveys of poor farmers, i.e. *ejidatarios*, at the Panuco River Irrigation Project (PRIP) in 1987 and 1995. A survey method based on a structured questionnaire was chosen for this research because it is assumed that *ejidatarios* are able to measure differences in their living conditions and in the irrigation project conditions from 1987 to 1995.

## A. Research Design

The present research was designed as a longitudinal study. This type of research looks at the changes of a particular population over time. Longitudinal studies have some advantages compared to cross-sectional designs because they are explanatory instead of descriptive.

This research specifically is a panel study. In 1987, an evaluation research was performed to study a sample of 238 *ejidatarios* on the Panuco River Irrigation Project (Diaz, et al., 1988; World Bank, 1989; Diaz and Valtierra, 1992). A similar study was performed with a sample of 150 *ejidatario*-farmers in 1995. These samples had a 57 paired

subsample of *ejidatarios* who were interviewed in 1987 and 1995. In a panel study, a collection of the same data is gathered from the same sample of respondents at least twice across time.

## B. Methods of Data Collection

This study was based on a structured survey. A structured questionnaire was selected because: a) a structured questionnaire was used in the 1987 data collection, therefore, using a questionnaire in the 1995 survey would make the comparison between both sets of information more reliable; b) a questionnaire helped to overcome time and financial constraints of this type of research for a dissertation; c) questionnaires also offer some advantages when information is collected from large random samples because they standardize variables for computerized statistical processes.

This questionnaire was used in both surveys during direct interviews with each farmer selected. The questionnaire was broken down into three sections: the first section dealt with social and welfare aspects; the second looked at several irrigation aspects of the irrigation system; and the third helped define the type of farming system according to *ejidatarios'* annual net income and its breakdown (agricultural, livestock, off farm, and various incomes). The questionnaire included three types of

questions: open-ended questions, closed-ended questions, and tabular questions. In the open-ended questions, a list of possible answers was provided, and only one had to be selected. There were a few open-ended questions that generally asked "why" and followed a closed-ended question. Some tables were designed to gather data on *ejidatarios'* productive activities (e.g., crop production and livestock production) (see Appendix A).

The questionnaire was designed to be interactive between the interviewer and the respondents. The function of interviewers was to help respondents in a joint effort to remember the data of interest. The most difficult part was gathering data on agricultural costs (labor, inputs, services, etc).

One of the main challenges was to match the 1995 questionnaire with the 1987 questionnaire, given the specific objectives of each survey. Conceptual, wording and formatting problems needed to be overcome. In some instances, it was necessary to aggregate and disaggregate data to make the surveys comparable.

## C. Operationalization of the Main Variables

The following concepts are main variables selected for this study. The definitions of concepts explain the sense in which the variables were considered for this study. Many other variables are influencing the complex situation that

is studied in this research. These variable are not ignore but they could not be studied at this time, such as the influence of the North American Free Trade Agreement (NAFTA) and the federal policy in this regional development project (e.g., credit, insurance, agricultural product pricing, etc.).

Family Household. In this study the *ejidatario* family was examined as a socioeconomic unit that organizes its life around agricultural cycles, farming and growing domestic animals. The family makes its living from agriculture. It was not part of this research to delineate a detailed description of the characteristics of the *ejidatario* family. However, it was necessary to be able to profile the farming system in the selected periods (See appendices B and C).

For the purpose of this research, a practical definition of household was needed to collect the field information, particularly information regarding the household income. The prototype of a "Western" nuclear family integrated by a married couple and their children does not fit the reality of most of the Mexican farmers. Most of the rural families in Mexico are extended families. A typical rural family includes a married couple (i.e., husband and his wife) with children, husband's relatives, wife's relatives, and other members without parental relationships. In this sense, all persons who contributed to or depended on a common family fund, or *gasto familiar*, were included as members of the household. The contribution

to the *gasto* included working on the family parcel, taking care of the family livestock, or giving money earned from a salaried activity off the farm. In some cases, it was a little difficult to include or exclude a person from the family. For example, children who were studying in other cities far away from home; children who were working in the U.S.A or Mexico City; married children who lived in the same house, but contributed nothing to or derived nothing from the family fund. It is understood that the structure of the family household has changed over the time period studied, however the information about the household was collected using the same parameters to make the comparison between 1987 and 1995 possible.

Household Income. Household income is constituted by all the income from family members, monetary or in kind. Calculation of the *ejidatarios'* income was a challenge because poor farmers do not keep any record of their cash flows from within or out of the farm. However, the 1987 survey[11] demonstrated that *ejidatarios* could normally remember most of what they did in the previous year, how much money and time they spent, and how much they earned on their on-farm economic activities. It is just a matter of asking the right questions in the right way. To help *ejidatarios* remember, this study chose to break down annual

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[11] Similar surveys were successfully performed to evaluate the Puebla Project and the PIDER in Ometepec, Guerrero. (Diaz, 1992; Diaz and Valtierra, 1985).

income by sources of income (crops, livestock, off-farm, and other incomes). Detailed breakdowns of crop and livestock production were also prepared. Crop production processes were divided into different stages: land preparation, sowing, fertilization, pesticide spraying, and harvest. Data collection included purchased and owned inputs (fertilizers, seeds, etc.), purchased and owned services (e.g., machinery), family and salaried labor, and opportunity cost of land (see Appendix A).

In terms of crop production, this study encompassed data from the last two cropping seasons, 1994 spring-summer and the 1994-1995 fall-winter. In the case of other economic activities (e.g, salaried jobs), data included all costs and gross incomes from the previous twelve months.

Opportunity Cost. The concept of opportunity cost played an important role in this survey, since many poor *ejidatarios* consume or produce several non-traded goods. Opportunity cost was calculated when *ejidatarios* used their own resources instead of purchasing them in the free market. For example, an opportunity cost was assigned to family labor. An opportunity cost was also assigned to products harvested and consumed within the household. For example, if a family consumes their chickens, the opportunity cost of these chickens was added to the value of livestock production.

The opportunity cost assigned to each non-traded good was similar to the value that the product has on the local

market. The logic was based on how much money farmers would have to spend for an input if they did not have this input, or how much money they would have to pay a worker for applying fertilizers if farmers and their families did not. This approach differed from a classic economics approach.[12]

Farmers' Perception of Welfare Improvements. Farmers were asked if they have perceived any improvement or deterioration in the last eight years. They were asked to make an overall assessment taking into account several aspects, such as food consumption, house improvements, education, and others that they wanted. The questions were based on the assumption that farmers could make an overall judgment regarding their welfare indicators based on their own parameters and preferences for what is better or worse. There was no empirical checking to see if the farmers' perception agrees with the researchers' perception, which may imply a different research project beyond the scope of this study.

Perceived Efficiency of Irrigation Service. *Ejidatarios'* perceptions include several aspects of irrigation management, such as timeliness, adequacy[13], and

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[12] A classic approach on opportunity cost can be found in: Gittinger, Price. 1994. Economic Analysis of Agricultural Projects. The World Bank. Washington, D.C.

[13] Plusquellec et al. (1994: 10) define water timeliness as the frequency and duration of the water delivery and adequacy as the sufficient volume of water to irrigate crops.

water pricing. In the 1987 and 1995 surveys, the farmer's opinions and assessments were the only parameters collected to know the adequacy and timeliness of irrigation water[14]. During the field research no further empirical evidence was collected, like water volume measurement, evapotranspiration, or other indicators to check if farmers' judgments were accurate.

Additionally, there were several questions in which *ejidatarios* were asked for "complex" evaluations, for example, "Is irrigation water delivered on time?" It was assumed that the farmers' answer involved overall assessments based on their experience and knowledge of their crops, environment and irrigation system.

## D. Sampling Methods

Sampling is part of any social research; however, it is a central piece of a panel study, because a great deal of theoretical and operative aspects of a panel study depend on the sampling methods.

This study was based on two surveys performed in 1987 and 1995 respectively. The first survey was contracted for the World Bank and performed by a team of researchers from the Graduate College (Colegio de Postgraduados (CP)). The

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[14] This study has similar approach on adequacy and timeliness as Shivakoti's study (1991).

World Bank set a sample size of 238[15] *ejidatarios* for the 1987 survey. The World Bank decided that 50% of the *ejidos* had to be surveyed, in approximately 80 *ejidos*. In each *ejido* one member of the board of representatives and two randomly chosen *ejidatario*-farmers were interviewed.

The CP took responsibility for the sample representativeness. First, the number of *ejidos* was divided according to the number of beneficiaries in each irrigation unit. Second, *ejidos* were randomly selected from the PRIP area. The third step was to randomly select three *ejidatarios* in each *ejido*.

The 1987 sample of *ejidatarios* was selected taking into account three aspects of the *ejidatario* population: a) geographic distribution, b) *ejidos* were classified into old *ejidos* and new *ejidos*[16], and c) the sample was divided into four groups according to their level of development[17].

It is important to note that the 1987 sample consisted of 238 *ejidatarios*, plus twelve *pequeños propietarios* (private owners) and nine *colonos* (new private settlers). Both *pequeños propietarios* and *colonos* were not included in

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[15] The original sample was 239 ejidatarios, but one questionnaire is missing from the file.

[16] Old ejidos were established before the creation of the PRIP in 1974, and new ejidos were formed by the PRIP after 1974.

[17] The level of development was determined empirically with the collaboration of technicians of the Secretariat of Agriculture and Water Resources. The levels of development were incipient, in process, almost developed, and fully developed.

this study because the 1987 sample size of both groups was too small to be statistically representative.

The 1995 survey sample was of 150 *ejidatarios*. The sample was broken into three subsamples: 1) a random paired sample of 57 *ejidatario*-farmers interviewed in the 1987 survey; 2) a random sample of *ejidatario*-farmers who were not interviewed in the 1987 evaluation; and 3) a random sample of members of an irrigation user association that manages irrigation infrastructure.

The sampling procedure was based on the 1987 annual income as the most representative variable of the variation among individuals of *ejidatario*-farmer population. The following formula was used to determine the sample size.

$$n = \frac{N\, Z^2_{\alpha/2}\, s^2}{Nd^2 + Z^2_{\alpha/2}\, s^2}$$

Where: n = size sample
N = population of *ejidatarios* at the beginning of PRIP
$Z_{\alpha/2}$ = Value of a normal random variable from normal table at 100 (1- $\alpha$)%.
$s^2$ = income variance of the population of *ejidatarios* interviewed in 1987.
d = precision or maximum expected difference between the actual value and the estimator ($\theta - \hat{\theta}$).

Taking into account the variability of income, the precision was calculated at 21% from the mean income, $d_{.21}$ = 15,540 x 0.21= 3,263. It means that the true mean value will be in the interval 15,540 +/- 3,263.

The confidence level of 90% (1 - $\alpha$ = 0.90) was used to

calculate the sample size. Substituting the values from the 1987 survey in the formula.

$$n = \frac{8{,}500\ (1.64)^2\ (24{,}816)^2}{8{,}500\ (3{,}263)^2 + (1.64)^2\ (24{,}816)^2} = 153$$

$N = 238$
$Z_{\alpha/2} = 1.64$
$s = 24{,}816$
$\bar{x} = 15{,}540$
$d_{.21} = 3{,}263$

The final size sample for the 1995 survey was 150 *ejidatarios*, which is 98% of the 153 *ejidatarios* indicated using the previous formula.

## E. Data Collection Process

The 1987 survey contracted for the World Bank can be considered the first stage of the present study. The preparation for the 1995 survey began by reviewing results from the 1987 survey (Diaz, et al. 1988) and two evaluation reports (World Bank, 1989; Diaz and Valtierra, 1992).

During the summer of 1994, an exploratory visit to the PRIP region helped to perceive the current situation of *ejidatarios*. During this field work, several activities were undertaken: interviews with officials of government institution and farmer leaders, field transects, and the collection of collateral information (maps, statistical information, previous studies, etc). This information

helped to design the survey questionnaire for *ejidatarios*.

Once the questionnaire was approved by Michigan State University[18], the field work of this research was executed in August of 1995. Four interviewers besides the researcher participated in the conduction of direct interviews with *ejidatarios*. Even though interviewers were agronomists and had previous experience in survey interviews, they were trained in managing the questionnaires, coding the answers, conducting an interview in the Panuco region, and how to handle critical situations before or during the interviews.

The mechanics of the field work consisted of the following: a sample of *ejidos* was selected; once interviewers arrived at a village, they sought out the *ejidatarios* interviewed in 1987. If the selected *ejidatarios* were not in the village or unwilling to participate, they were replaced by an *ejidatario* who lived close to them. The interviews were completed primarily at the respondents' homes. There were a few cases in which interviews were conducted at a different setting. An average interview lasted one hour and thirty minutes. Only two of the *ejidatarios* selected refused to participate.

The questionnaire was designed to have most of the closed-ended questions coded and ready to be entered into a computer database. The most difficult sections of the questionnaire were cropping and livestock costs. These

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[18] The University Committee on Research Involving Human Subjects (UCRIHS) at Michigan State University.

sections generally needed some additional mathematical calculation with the *ejidatarios'* raw data before the questionnaire was ready to be coded. Once interviewers coded the questionnaires, the researcher checked them to see if they were properly filled out and free of inconsistent information. If any major disagreement over the data collected arose, interviewers were sent back and to check the information in question with the farmer.

### F. Software used for Statistical Data Processing

The software used for statistical data processing was DBASE III, SAS (Statistical Analysis System) version 6.04 for DOS, and SPSS (Statistical Packet for Social Science) version 7.0 Win 95.

### G. Advantages and Limitations of the Present Study

A longitudinal study has numerous advantages compared to a cross-sectional study. The achievements of an agricultural development project can be affected by many factors, especially the weather. For instance, weather may produce dramatic variations from one agricultural season to another, even in the cases where agriculture is irrigated. If the longitudinal study counts with two data sets, one set could be gathered in a good agricultural season and the other in a bad agricultural season or in an average season.

This situation may affect the conclusions and lessons that can be obtained from the longitudinal study with only two data sets.

The eight years between both surveys may be considered as sort time in terms of the project irrigation life time. However, in this case many things happened at the regional and national level during those eight years.

One limitation of this study was that there was not a baseline study conducted in 1974 by the World Bank at the time the project was first implemented. While there was some information collected (i.e., soils, water, previous agricultural production functions, etc.) none was collected regarding the participants themselves. Because of this, the first evaluation study in 1987 is used as the base line study to measure the impact of the project changes between 1987 and 1995.

Another limitation for this study to become a comprehensive evaluation was that it did not include an environmental impact assessment. There were two reasons for this situation: a) PRIP did not set any environmental objectives and b) this study had important limitations in time and money.

# CHAPTER V

# FINDINGS

The null hypothesis for this study states that "the Panuco River Irrigation Project (PRIP) did not meet its initial objectives". The testing of this hypothesis is divided into four subhypothesis, one for each of the four PRIP objectives. The first two sections of this chapter deal with the general hypotheses: (1) PRIP did not develop an efficient irrigation delivery system ($H_0$: $\pi$=.5) and (2) *ejidatarios* did not produce more food crops for the national food security in 1995 than in 1987 ($H_0$: $\mu_2=\mu_1$). This analysis is followed by the hypothesis testing of two subhypotheses related to the *ejidatario* participants: *ejidatarios* did not increase their income from 1987 to 1995 ($H_0$: $\mu_1>\mu_2$), and *ejidatarios* off-farm work increased from 1987 to 1995, ($H_0$: $\mu_1<\mu_2$).

It is important to underline two aspects of this research. First, the data analyzed in this chapter was gathered in two surveys performed in 1987 and 1995, with 238 *ejidatarios* and 150 *ejidatarios* respectively. A paired subsample of 57 *ejidatarios* were interviewed in both surveys. Most of the analysis presented in this chapter focuses on the 57 *ejidatario* paired subsample. Second, this

research only dealt with one group of project participants, the *ejidatarios*. The other groups of participant farmers living in the PRIP were not studied, such as the *pequeño propietarios* (private owners), *colonos* (settlers) or the *arrendatarios* (renters). This was because *ejidatarios* were the largest group of beneficiaries in the PRIP and the 1987 sample of the other groups of farmers were not statistically representative to make a meaningful comparison between 1987 and 1995.

The 57 *ejidatario* paired sample was stratified into nine clusters or strata according to their 1987 annual net income. The sample was ordered from the *ejidatario* with the lowest annual net income to the highest annual income. Clusters included *ejidatarios* with similar income levels. The limits within the clusters were identified on a list of the 1987 *ejidatarios'* annual income. The stratification helped reduce the variability among *ejidatarios* within the same cluster. The following were the income ranges of the clusters:

1) less than -5,000 pesos (n=2)
2) from -4,999 to -1 pesos (n=10)
3) from 0 to 4,999 pesos (n=12)
4) from 5,000 to 9,999 pesos (n=9)
5) from 10,000 to 14,999 pesos (n=7)
6) from 15,000 to 19,999 pesos (n=5)
7) from 20,000 to 24,999 pesos (n=5)
8) from 25,000 to 49,999 pesos (n=4)
9) more than 50,000 (n=3)

In order to perform a consistent comparison, all the monetary values in this chapter were converted into 1995 constant pesos. The 1987 pesos were multiplied by the inflation rate to obtain the 1995 constant pesos. According to the Mexican Central Bank (Banco de Mexico)[19], 1.00 pesos on December of 1987 represented 5.0007[20] pesos in August of 1995.

### A. Development of an Intensive Irrigation System

The point of departure to create the PRIP was the construction of irrigation infrastructure to provide an efficient service to water users. The research hypothesis assumes that PRIP achieved its initial objective "to develop an intensive irrigation system" on 144,000 hectares that would be the basis of the development of the regional agriculture. The construction of infrastructure was only the first step towards building an intensive irrigation system. An intensive irrigation system could exist only if the water was efficiently delivered to the final user on time and in the adequate quantities. The *ejidatarios'* perception of the efficiency of water delivery service was the main variable of the hypothesis testing. *Ejidatarios* were asked for an overall assessment of the irrigation

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[19] The information was taken from the Banco de Mexico Web Site on the Internet (www.banxico.org.mx).

[20] This figure was rounded to 5.00 pesos

system efficiency that took into account the state (deterioration) of the infrastructure, the timeliness of the service, the adequacy of the amount of water and the price of water.

The statistical analysis was performed on the *ejidatarios'* overall assessment of the efficiency at two levels: the first was on the results of 57 paired sample, and the second was on the nine strata of this paired sample (Table 1). In addition, the variable "efficiency" was broken down into timeliness of the water delivery service and adequacy of the water supply. The analysis of these particular aspects helped support the statistical analysis of the *ejidatarios'* overall assessment of efficiency.

**Table 1. *Ejidatarios'* Perception of the Efficiency of the Irrigation System in 1995**

| | EFFICIENT | | INEFFICIENT | | ROW TOTAL | | |
|---|---|---|---|---|---|---|---|
| STATUS | freq | row % | freq | row % | freq | row % | Binomial P-value |
| 1 | 2 | 100.0 | | | 2 | 100.0 | .2500 |
| 2 | 7 | 87.5 | 1 | 12.5 | 8 | 100.0 | .0350 |
| 3 | 4 | 33.3 | 8 | 66.7 | 12 | 100.0 | .9269 |
| 4 | 4 | 44.4 | 5 | 56.6 | 9 | 100.0 | .7286 |
| 5 | 4 | 57.1 | 3 | 42.9 | 7 | 100.0 | .5000 |
| 6 | 3 | 60.0 | 2 | 40.0 | 5 | 100.0 | .4999 |
| 7 | 2 | 40.0 | 3 | 60.0 | 5 | 100.0 | .8124 |
| 8 | 2 | 50.0 | 2 | 50.0 | 4 | 100.0 | .6875 |
| 9 | 2 | 66.7 | 1 | 33.3 | 3 | 100.0 | .5000 |
| COLUMN TOTAL | 30 | 54.5 | 25 | 45.5 | 55 | 100.0 | |

The null hypothesis to be tested was that PRIP did not develop an efficient irrigation delivery system ($H_0$: $\pi=\pi_0$) against the alternative hypothesis, $H_a$: $\pi>\pi_0$. The point estimate of $\pi$ is $\hat{\pi}$, which is the proportion of *ejidatarios* who felt that the irrigation system was efficient in 1995. The $\pi_0$ symbol denotes the particular number from which the deviation in the population is going to be measured[21].

The *ejidatarios'* answers were grouped into two categories: those who felt that PRIP was efficient and those who felt that PRIP was inefficient. A one-tailed normal approximation to the binomial distribution (Battacharyya and Johnson, 1977: 203; Agresty and Finlay, 1986: 133) was chosen to test the total proportion of *ejidatarios* who received an efficient irrigation delivery service[22]. This test was selected because the sample size was large (n>30). The parameters for this test are: $\pi=.545$, $\pi_0=.5$, and n=57. The following formula was used for the test:

$$Z = \frac{\hat{\pi} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$$

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[21] The value of .5 was selected because the actual proportion is unknown and the ejidatarios' answers were grouped as binary.

[22] A chi-square test was used for this hypothesis testing because most of the cells in the table have frequencies lower than 5 observations, thus the results may not be valid.

Where: $\hat{\pi}$ = the observed proportion
$\pi_0$ = the percentage selected to detect a deviation from
n = sample size

Substituting the values into the formula:

$$Z = \frac{.545 - .5}{\sqrt{\frac{.5(1-.5)}{57}}} = \frac{.045}{.066} = 0.681$$

This calculated Z-value is smaller than $Z_{.05}=1.64$ from the Z-distribution table. As a result, the null hypothesis is accepted[23] and thus the alternative hypothesis is rejected. The percentage of *ejidatarios* who think that PRIP is an efficient irrigation system is not high enough to say that most of the *ejidatarios* have received an efficient water delivery service.

The binomial test was selected to test the null hypothesis for each of the 9 strata because there are less than 5 *ejidatarios* for each cell in the table. The conditions to apply the binomial distribution state that "if the probability of being classified in a given category equals $\pi$ for each observation, then the probability that X out of n independent observations are classified in that

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[23] The statistics literature states that a null hypothesis is rejected or is not rejected (Agresti and Finlay, 1986: p.146; Bhattacharyya and Johnson, 1977: p. 175). For the purpose of this dissertation the null subhypotheses are considered rejected or accepted.

category, denoted by P(X), equals" (Agresty and Finlay, 1986: 143)

$$P(X) = \frac{n!}{X!(n-X)!}\,\pi^{X}\,(1-\pi)^{n-X} \qquad X = 0,1,2.....n$$

The test consists of adding the probabilities of all the numbers equal or greater than the X number found in each cell. For example, the X number is equal to 7 in the second stratum, the test requires adding P(X) when X equals 7 and 8. The precalculated values from the binomial distribution tables (Hamburg and Young, 1994: A6-A10) when n=8 and $\pi$=.5 are:

$$P = P(7) + P(8) = .0312 + .0039 = .0351$$

The calculated probability is lower than .5 which means that the probability that the null hypothesis may be true is low, thus the null hypothesis is rejected for the second stratum. Likewise, the probabilities were calculated for the rest of the strata. The results are displayed in the eight column of Table 1. These results show that the P-value is lower than .5 for the first and second stratum. Most of the *ejidatarios* in these two strata felt that they had an efficient water delivery service in 1995. On the other hand, the calculated P-value is higher than .5 for the other seven strata (from the third to the ninth strata), indicating that there is a high probability that this null

subhypothesis could be true.

The reaction of the *ejidatarios* to the lack of efficiency was that they felt overcharged for lack of service. These farmers are not willing to pay higher water fees under the current condition of the water delivery service. Some of these *ejidatarios* expressed that they would be happy to pay the annual water fee if the PRIP water delivery service became more efficient. In PRIP, 49% of the *ejidatarios* felt that they were overcharged for water because of the poor-quality of water delivery service. Most of these farmers were opposed to any water price increase. A similar proportion of *ejidatarios* (47%) felt that they were fairly charged and were willing-to-pay a higher price.

This is especially important at this moment when the government is transferring the infrastructure management to water user associations that do not receive any governmental subsidy to operate irrigation infrastructure. The "Jaboncillo" module that was transferred to a water user association in 1994 had the highest water fee in the PRIP area in 1995. An increase in the water fees may constitute a threat to the efficiency of the water delivery service provided by the water user association because not all of the users are willing to pay higher water fees.

**Adequacy of Water Supply**

Adequacy of water supply is one aspect used to measure

the efficiency of water delivery service. Adequacy was defined as the volume of water needed to irrigate crops. Adequacy is sometimes a critical factor, especially when the seasonal weather is dry. *Ejidatarios* pay an annual fee for a prescribed amounts of water, but they can buy more water if they need more water. The water fee and the amount of water received per hectare varied from one irrigation unit to another, depending on the operational cost of each irrigation unit. In 1995, the annual fee in the Pujal Coy Unit was $70 pesos per 2,000 $m^3$ of water, $70 pesos per 5,000 $m^3$ in the Animas Unit, and $125 pesos per 3,000 $m^3$ in the Chicayan Unit. Additional water could be purchased at $30 pesos per 1,000 $m^3$, however *ejidatarios* rarely bought additional amounts of water.

The same normal approximation to the binomial test was used to analyze the proportion of *ejidatarios* who considered the amount of water received adequate for cropping (Table 2). The parameters for the test are $\hat{\pi}$=.685, n=54, and $\pi_0$=.5. Substituting these values into the formula of the normal distribution:

$$Z = \frac{.685 - .5}{\sqrt{\frac{.5(1-.5)}{54}}} = \frac{.185}{.068} = 2.72$$

The calculated Z-value is larger than $Z_{.05}=1.64$, indicating that *ejidatarios* received an adequate amount of water for their crops. Most of the *ejidatarios* had a favorable opinion about this aspect of the water delivery service efficiency. Adequacy appears to not be a crucial factor since *ejidatarios* can purchase additional quantities of water as they need it. Some of the *ejidatarios* felt that they did not receive the volume of water for which they have paid for. They felt that the volume of water was not accurately measured by PRIP operators.

**Table 2. Adequacy of the Amount of Irrigation Water in 1995**

| | ADEQUATE(1) | | NON-ADEQUATE | | ROW TOTAL | | Binomial P-value (1) |
|---|---|---|---|---|---|---|---|
| STATUS | freq | row % | freq | row % | freq | row % | |
| 1 | 2 | 100.0 | | | 2 | 100.0 | .2500 |
| 2 | 8 | 100.0 | | | 8 | 100.0 | .0039 |
| 3 | 9 | 75.0 | 3 | 25.0 | 12 | 100.0 | .0729 |
| 4 | 2 | 25.0 | 6 | 75.0 | 8 | 100.0 | .9649 |
| 5 | 6 | 85.7 | 1 | 14.3 | 7 | 100.0 | .0625 |
| 6 | 3 | 60.0 | 2 | 40.0 | 5 | 100.0 | .4999 |
| 7 | 3 | 60.0 | 2 | 40.0 | 5 | 100.0 | .4999 |
| 8 | 2 | 50.0 | 2 | 50.0 | 4 | 100.0 | .6875 |
| 9 | 2 | 66.7 | 1 | 33.3 | 3 | 100.0 | .5008 |
| COLUMN TOTAL | 37 | 68.5 | 17 | 31.5 | 54 | 100.0 | |

A binomial test was performed to evaluate the answers of *ejidatarios* in each stratum. The eighth column of Table

2 shows the results of the binomial test regarding the adequacy of the water in the PRIP. There is a clear tendency in the lower strata (first, second, third and fifth strata) to show that the percentage of *ejidatarios* who considered the water supply adequate was significantly higher than 50% of the *ejidatarios*. In the other strata (fourth, sixth, seventh, eighth, and ninth), the percentage of *ejidatarios* was lower than 50%.

**Timeliness of Water Delivery**

After more than ten years of agriculture in the Panuco Region, *ejidatarios* have learned when and how often their crops need water. A PRIP rule states that water users need to request water three days in advance to receive the water on time.

The *ejidatarios'* opinion about the timeliness of the irrigation service was divided into two categories, timely and non-timely. A normal approximation to the binomial test was performed on the 57 paired sample and the strata values.

The parameters for the Z-test are $\pi$=.593, $\pi_0$=.5, and n=54. Substituting this values in the formula:

$$Z = \frac{.593 - .5}{\sqrt{\frac{.5(1-.5)}{54}}} = \frac{.093}{.068} = 1.37$$

This calculated Z-value is smaller than $Z_{.05}=1.64$. Therefore, there is no evidence that .593 would be statistically higher than .5. According to this result the null hypothesis is accepted. The PRIP did not offer a timely water service delivery to most of the *ejidatarios*.

The binomial test results are displayed in the eighth column of Table 3. There is a clear tendency that lower income *ejidatarios* received water on time in 1995. More than 50% of the *ejidatarios* in the first, second, third, and fifth strata received water service delivery on time. In the opposite situation were those in higher income strata. A significantly low number of *ejidatarios* in the fourth and sixth through ninth strata felt that they received irrigation water to their lands in a timely manner.

**Table 3. Timeliness of the Irrigation Service Delivery in 1995**

| | TIMELY(1) | | NON-TIMELY | | ROW TOTAL | | Binomial P-value (1) |
|---|---|---|---|---|---|---|---|
| STATUS | freq | row % | freq | row % | freq | row % | |
| 1 | 2 | 100.0 | | | 2 | 100.0 | .2500 |
| 2 | 6 | 75.0 | 2 | 25.0 | 8 | 100.0 | .1445 |
| 3 | 9 | 75.0 | 3 | 25.0 | 12 | 100.0 | .0729 |
| 4 | 3 | 37.5 | 5 | 62.5 | 8 | 100.0 | .8555 |
| 5 | 5 | 71.4 | 2 | 28.6 | 7 | 100.0 | .2266 |
| 6 | 3 | 60.0 | 2 | 40.0 | 5 | 100.0 | .4999 |
| 7 | 1 | 20.0 | 4 | 80.0 | 5 | 100.0 | .9686 |
| 8 | 2 | 50.0 | 2 | 50.0 | 4 | 100.0 | .6875 |
| 9 | 1 | 33.3 | 2 | 66.7 | 3 | 100.0 | .8750 |
| COLUMN TOTAL | 32 | 59.3 | 22 | 40.7 | 54 | 100.0 | |

In 1995, during the survey, a remarkable difference was observed between the opinions of those users living at the head of the canal and those living at the end regarding timeliness of water delivery[24]. Head-end-canal users almost always felt that they received water on time, while the tail-end-canal users felt that they almost never received their water on time. In some of the tail-end-canal sections, water delivery was so unreliable that many *ejidatarios* did not want the PRIP irrigation service.

**Perceived Deterioration of the Irrigation Infrastructure**

PRIP has not been as efficient as it was planned to be. One of the main reasons has been the increasing deterioration of the irrigation infrastructure. The efficiency of the irrigation water delivery greatly depends on the conditions of the infrastructure. If the infrastructure is deteriorated, the system is unable to deliver the requested quantity of water on time. This situation has a significant impact on crop yields at the PRIP.

In 1995, irrigation infrastructure suffered from varying degrees of deterioration. According to the perception of 60% of the *ejidatarios*, the primary

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[24] This was an empirical observation that was not documented with information from the surveys.

infrastructure[25] was seriously damaged. A higher percentage of *ejidatarios* (71%) assessed that secondary infrastructure[26] was seriously damaged. In the case of tertiary infrastructure[27], a lower percentage of *ejidatarios* (42%) felt that this type of infrastructure was seriously deteriorated. Tertiary infrastructure is not as badly deteriorated as the other types of infrastructure because it has benefitted from work by *ejidatarios*, who maintain some parts of these structures.

In interviews with government officials, most of them felt that the entire irrigation infrastructure needed to be reconstructed. A former federal official of the CNA felt that the infrastructure of the Panuco River Irrigation Project was so deteriorated that it was going to be difficult to transfer the irrigation management to the user associations. One local official of the CNA confirmed that practically all of the PRIP irrigation infrastructure needed repair. The question is: Who will pay for the rehabilitation of the infrastructure, since federal budgets are too small and the *ejidatarios* do not have money?.

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[25] Primary infrastructure includes dams, main canals, house of pumps, ditches.

[26] Secondary infrastructure include all the diversion canals, gates, weirs, and offtakes.

[27] Tertiary infrastructure is the irrigation infrastructure in the ejidatarios' fields.

### *Ejidatarios'* Participation in Maintenance

The PRIP infrastructure is suffering from many years of neglected maintenance by the government and the lack of beneficiaries' participation in infrastructure maintenance. The main cause of this situation was the paternalistic development approach of PRIP that dominated the relationships between government and PRIP beneficiaries. The lack of users' participation was not new in 1987 or in 1995. The government constructed the PRIP infrastructure without beneficiaries participation. In the 1995 survey, most *ejidatarios* (95%) expressed that they did not participate in the construction of irrigation infrastructure, while 5% participated as salaried workers in the construction of canals (e.g., as bricklayers). In the past few years, there has been an increase in the beneficiaries participation, however, it is still far from what is needed. In 1995, only 43% of the *ejidatarios* contributed with an average of 29 hours of work per year to maintain tertiary infrastructure, while more than half of the *ejidatarios* (53%) contributed nothing to irrigation maintenance and operation.

*Ejidatarios* assumed that water fees covered the total cost of operation and maintenance. However, according to local officials of the National Water Commission (CNA), water fees were too low and only covered 30% of the PRIP

operational cost in 1994[28]. By design, the government subsidized most of the PRIP operation. As a result, the infrastructure continued to deteriorate because there were never enough resources for maintenance.

In 1995, a series of group interviews were conducted as part of this study. *Ejidatarios* expressed some concerns with the idea of transferring the infrastructure management from the federal government to the users. *Ejidatarios* were not willing to take the responsibility for managing and operating the irrigation project. They felt that the infrastructure was too deteriorated and they did not have the money to repair it. *Ejidatarios* also expressed a remarkably strong feeling of lack of ownership of the irrigation system because the government has always managed the irrigation project without the farmers' participation. In 1995, most *ejidatarios* (69%) felt that government should be responsible for infrastructure maintenance and few of them (7%) felt that infrastructure maintenance should be the users' responsibility.

### B. Contribution to National Food Security

The Panuco River Irrigation Project was created to produce cash crops (e.g., vegetables) and high yield grains (e.g., sorghum). Once PRIP started to operate, the

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[28] In 1987, according to the World Bank (1989:58) the water fee only represented 9% of the operational cost.

traditional system of grazing on natural pastures was rapidly substituted with annual crops and the traditional big ranchers were replaced with collective *ejidos*.

The second null subhypothesis states that *ejidatarios* did not produce more food crops for the national food security in 1995 than in 1987 ($H_0$: $\mu_2=\mu_1$ vs. $H_a$:$\mu_2>\mu_1$). The main variables selected to test this subhypothesis were the total amount of food (kilos) per crop produced per *ejidatario*[29] and the value of this produce per crop per *ejidatario* (the fourth and fifth columns in Table 4). T-tests were used to compare the mean differences to determine if the *ejidatarios* produced more kilos of each crop in 1995 than they did in 1987 and if *ejidatarios* made more money per crop in the same period. Other two related variables were chosen to complement the statistical analysis: the percentage of *ejidatarios* cultivating a crop and the area per crop per *ejidatario*. A normal approximation to the binomial test was performed on the first variable and a t-test on the mean difference was performed on the second variable. The following formulas were used to perform the t-test and the normal approximation to the binomial distribution test:

$$t = \frac{\bar{D}}{s \,/\, \sqrt{n}}$$

[29] No differentiation was noted between the selfconsumption and the production for selling because most of the PRIP ejidatarios do not produce for selfconsumption.

**Table 4. Main Crops Cultivated by *Ejidatario*-Farmers in 1987 and 1995 (Paired Subsample)**

| CROP | 1987 | | | | 1995 | | | |
|---|---|---|---|---|---|---|---|---|
| | % of ejidat* | ha per ejidat** | Kg per ejidat | income per ejidat*** | % ejidat* | ha per ejidat** | Kg per ejidat | income per ejidat*** |
| CORN | 75.4 | 4.56 | 4,042 | 909.84 | 49.1 | 3.30 | 3,919 | 403.67 |
| SOYBEANS | 14.0 | 0.54 | 323 | 257.97 | 1.8 | 0.31 | 18 | -580.52 |
| SORGHUM | 8.8 | 0.89 | 883 | 266.63 | 14.0 | 0.79 | 1,175 | 236.72 |
| BEANS | 7.0 | 0.30 | 39 | 8.78 | 0.0 | 0.00 | 0 | 0.00 |
| CARTHAMUS | 5.3 | 0.46 | 188 | 76.87 | 0.0 | 0.00 | 0 | 0.00 |
| SUGAR CANE | 5.3 | 0.09 | 7,579 | 230.53 | 12.3 | 1.17 | 90,369 | 1,680.81 |

* This is a percentage of *ejidatarios* of the 57 paired sample
** The total amount of hectares was divided by 57 *ejidatarios*
*** The monetary values are in 1995 constant pesos

Where: D = the sample mean of the difference income
s = standard deviation of the difference income
n = number of observations in the paired subsample

$$Z = \frac{\hat{\pi} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$$

Where: $\hat{\pi}$ = the observed proportion
$\pi_0$ = the percentage selected to detect a deviation from
n = sample size

The crop production was disaggregated by crop to look at the variability of the different crops from 1987 to 1995. In the following analyses, detailed descriptions of the results are completed on corn and sugar cane because of their importance. The rest of the crops are grouped under a subheading.

**Corn**

Corn was the most popular crop among *ejidatarios*. *Ejidatarios* planted corn because corn is highly tolerant to harsh weather conditions, with few inputs and little work. In addition, corn was easy to sell to the state commercialization company, CONASUPO (The National Company of Popular Supplies) and to private brokers.

Corn was the *ejidatarios'* most important crop in 1987 and in 1995. However, the percentage of *ejidatarios* who cultivated corn experienced a dramatic reduction from 75% in

1987 to 49% in 1995. A normal approximation to the binomial distribution was performed on this variable. The calculated Z-value was -4.61. This is lower than the z-value from tables ($-Z_{.05}$=1.16). Even though corn remained the *ejidatarios'* main crop, the percentage of *ejidatarios* growing corn significantly decreased from 1987 to 1995.

The area cropped per *ejidatario* decreased by 1.26 hectares from 4.56 to 3.30 hectares. However, the t-test performed on this variable shows that this difference was not statistically significant at .05 level. The calculated t-value was 1.55, which is lower than the t-value from tables at .05 level (1.64). In this case, the variability of the area cropped from one *ejidatario* to another made the mean difference not significant, yet it did reflect a 28% reduction in total area cropped.

The amount of corn produced per *ejidatario* decreased by 121 kilos per *ejidatarios*, from 4,040 to 3,919 kg. The t-test calculated on the mean difference shows that the amount of corn produced contributed to the national food security, however, was not significantly different from 1987 to 1995.

*Ejidatarios'* earnings for corn decreased, each corn grower made $909.12 pesos in 1987 and $403.67 pesos in 1995. The mean difference of $505.45 pesos was tested. The calculated t-value (-2.25) was lower than the negative t-value (-1.64) from the tables at .05 level with df=57-1. The statistical analysis showed that there was a significant decrease in the *ejidatarios'* earnings from 1987 to 1995.

At the level of the 9 strata, the number of corn growers increased in the first and the ninth strata while decreasing in the other seven clusters. The most dramatic changes occurred in the second and ninth strata. In the second stratum, there was a significant reduction in the number of *ejidatarios* growing corn, from 8 to two, and in the average number of hectares of corn, from 9.96 hectare per *ejidatario* to 3.5 hectares. In the ninth strata, the number of *ejidatarios* increase from 1 to 3 and the hectares per *ejidatario* from 2.8 to 8.33.

Corn lost importance because 67% of the *ejidatarios* received credit in 1987, however by 1995 none *ejidatario* had credit to cultivate corn. In addition, in 1987 most of the *ejidatarios'* corn was traded by a state company (CONASUPO), by 1995 this company reduced its operations in the region to very low levels.

**Sugar Cane**

Sugar cane cultivation was completely different from all other crops. Sugar cane production experienced a "boom" in the Chicayan irrigation unit between 1987 and 1995. Many *ejidatarios* felt that sugar cane is the most profitable crop and, thus, their best alternative to crop their land.

The percentage of *ejidatarios* growing sugar cane increased from 5.3% in 1987 to 12.3% in 1995. The normal approximation to the binomial test indicates that there was

a significant increase during this eight-year period.

The average number of hectares of sugar cane per *ejidatario* increased from .09 to 1.17 hectares, in 1987 and in 1995 respectively. The results of the t-test demonstrate that the calculated t-value is equal to 2.64, which is higher than the $t_{.05}$=1.64 from the t-distribution tables indicating that the difference was significant.

The sugar cane production increased from 7,579 kg to 90,368 kg per *ejidatario*. The mean difference between these years was 82,789 kg per *ejidatario*. The calculated t-value was equal to 2.58, which is higher than the t-value at .05 level. The amount of sugar cane contributed to the national food security significantly increased during this period.

The main reason for this change in sugar cane cultivation was that in 1987 the local sugar mill was owned by the Mexican Government. This sugar mill had a lot of problems with its operation and the promotion of sugar cane production. Between 1987 and 1995, the sugar mill was sold to private investors as part of the national policy to downsize the government. Since then, the sugar mill has operated more efficiently and has benefitted the *ejidatarios* who grow sugar cane. In 1995, growing sugar cane was the only alternative for *ejidatarios* to get credit and to make a profit within their farm. Unfortunately, the sugar mill only operates in the Chicayan irrigation unit and does not purchase sugar cane from other regions.

**Other Crops**

Four other crops were important in understanding the *ejidatarios'* cropping pattern in 1987: soybean, sorghum, beans, and carthamus. In 1995, beans and carthamus were no longer part of *ejidatarios'* cropping pattern and soybeans almost disappeared from the list as well.

Finally, the percentage of *ejidatarios* who cultivate sorghum increased from 8.8% to 14%, which was not a significant increase. The amount of sorghum produced per *ejidatario* increased by 293 kg between 1987 and 1995, again not statistically significant. The average earnings from sorghum was also not significant during this time frame.

## C. Reduction of the Uneven Income Distribution between Rural and Urban Population

The fourth objective of the PRIP was "to reduce the uneven income distribution between rural and urban populations." This objective was to be achieved by helping project participant *ejidatarios* increase their income. PRIP anticipated that the *ejidatarios'* economic income would increase each year from the initiation of the project (1974-1977) through the full development of the irrigation system, between 1990 and 1994 (World Bank, 1989). After this point, the *ejidatarios'* economic benefits from agriculture were expected to be sustainable.

The null subhypothesis states that "*ejidatarios* did not increase their income from 1987 to 1995 ($H_0$: $\mu_1 > \mu_2$)[30]." The rejection would be determined by comparing the *ejidatarios'* annual net income and on-farm income in 1987 and in 1995. This comparison was performed at three levels. In the first, the two larger samples were compared (i.e., 238 *ejidatarios* in 1987 and 150 *ejidatarios* in 1995). In the second level, the comparative analysis was performed on a 57 *ejidatario* paired subsample. In the third level of analysis, the 57 *ejidatario* paired subsample was divided into nine clusters based on their 1987 annual income.

**Comparison of the *Ejidatarios'* Income between 1987 and 1995: General Samples**

Most of the Mexican *ejidatarios* have small farms and are low-income farmers. They basically depend on agriculture and animal production for their livelihood. When *ejidatarios* do not make enough money within their own farms they look for off-farm jobs (e.g., urban salaried job) to earn extra money to cover their basic needs. On-farm activities provide income stability, but not necessarily the majority of the money needed for family subsistence.

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[30] For a question of time sequence, $\mu_1$ was chosen to designate the 1987 ejidatarios' income and $\mu_2$ for the 1995 ejidatarios' income.

Annual Net Income

The annual net incomes for 1987 and 1995 were very similar as shown in Tables 5 and 6. The *ejidatarios'* annual income in 1987 was $15,539.54 pesos. In 1995, *ejidatarios* made $15,356.02 pesos. The difference between both years was only $183.52 pesos. A t-test was performed to determine if the income difference was statistically significant.

The null hypothesis tested was "*ejidatarios* did not increase their income from 1987 to 1995, $H_0: \mu_1 > \mu_2$" while the alternative hypothesis was $H_a: \mu_1 \leq \mu_2$, where $\mu_1$ was the *ejidatarios'* 1987 annual income and $\mu_2$ was the *ejidatarios'* 1995 annual income. The alternative hypothesis reflected the planners' expectation that PRIP would help the *ejidatarios* sustain or increase their income from 1987 to 1995. A one-tailed t-test was performed for the hypothesis testing. The parameters for the t-test were the 1987 mean income ($\bar{X}_1$) of $15,539.56 pesos, its correspondent standard deviation ($S_1$) of $24,816.03 pesos and the sample size ($N_1$) of 150. The *ejidatarios'* 1995 annual net income ($\bar{X}_2$) was $15,356.03 pesos, the standard deviation ($S_2$) was equal to $21,547.96 pesos and the total sample ($N_2$) was 150 observation units.

**Table 5. Synopsis of the *Ejidatario*-Farmers' Net Income in 1987 (General Sample, n=238)**

| INCOME CONCEPT | N | MEAN INCOME (1995 pesos) | PERCENTAGE |
|---|---|---|---|
| **AGRICULTURAL PRODUCTION** | | | |
| GROSS AGRICULTURAL INCOME | 225 | 10,035.24 | |
| TOTAL AGRICULTURAL COSTS | 225 | 6,789.49 | |
| NET AGRICULTURAL INCOME | 225<br>(238) | 3,245.76<br>(3,068.47)* | |
| **ANIMAL PRODUCTION** | | | |
| GROSS LIVESTOCK INCOME | 183 | 12,886.86 | |
| TOTAL LIVESTOCK COSTS | 183 | 5,688.72 | |
| NET LIVESTOCK INCOME | 183<br>(238) | 7,198.14<br>(5,534.70)* | |
| **NET ON-FARM INCOME**** | 230<br>(238) | 8,902.41<br>(8,603.17)* | 55.36 |
| **OFF-FARM INCOME** | | | |
| NET OFF-FARM INCOME | 178<br>(238) | 6,650.76<br>(4,974.09)* | 32.01 |
| **VARIOUS INCOME** | | | |
| VARIOUS NET INCOME | 65<br>(238) | 7,185.00<br>(1,962.28)* | 12.63 |
| **ANNUAL NET INCOME** | **238** | **15,539.56** | **100.00** |

* Numbers within parenthesis are the means for the total *ejidatario* sample (238)

** Net On-Farm Income is the sum of net agricultural income and net livestock incomes.

**Table 6. Synopsis of the *Ejidatario*-Farmers' Net Income in 1995 (General Sample, n=150)**

| INCOME CONCEPT | N* | MEAN INCOME (1995 pesos) | PERCENTAGE |
|---|---|---|---|
| **AGRICULTURAL PRODUCTION** | | | |
| GROSS AGRICULTURAL INCOME | 103 | 30,687.13 | |
| TOTAL AGRICULTURAL COSTS | 103 | 25,750.80 | |
| NET AGRICULTURAL INCOME | 103<br>(150) | 4,936.33<br>(3,389.62)* | |
| **ANIMAL PRODUCTION** | | | |
| TOTAL GROSS INCOME | 130 | 7,017.25 | |
| TOTAL LIVESTOCK COSTS | 130 | 4,916.18 | |
| NET LIVESTOCK INCOME | 130<br>(150) | 2,101.08<br>(1,820.92)* | |
| **NET ON-FARM INCOME**** | 144<br>(150) | 5,427.65<br>(5,210.54)* | 33.93 |
| **OFF-FARM INCOME** | | | |
| NET OFF-FARM INCOME | 86<br>(150) | 14,062.69<br>(8,062.61) | 52.51 |
| **VARIOUS INCOME** | | | |
| VARIOUS NET INCOME | 68<br>(150) | 4,594.59<br>(2,082.87) | 13.56 |
| **ANNUAL NET INCOME** | **150** | **15,356.03** | **100.00** |

* Numbers within parenthesis are the means for the total *ejidatario* sample (150)

** Net On-Farm Income is the sum of net agricultural income and net livestock incomes.

$$t = \frac{\bar{X}_2 - \bar{X}_1}{\sqrt{\frac{s^2_1}{n_1} + \frac{s^2_2}{n_2}}}$$

Substituting the values in the formula:

$$t = \frac{15,356.03 - 15,539.56}{\sqrt{\frac{24,816^2}{238} + \frac{21,548^2}{150}}} = -0.077$$

The negative value of $t_{.05}$=-1.64 with df=n-1=56 was lower than the calculated t-value=-0.077. The 1987 *ejidatarios'* annual income was statistically similar to the 1995 annual income. The null hypothesis was rejected, instead the alternative hypothesis was accepted. *Ejidatarios* were able to sustain their annual income from 1987 to 1995.

Based exclusively on this mean value, it appears that nothing changed in the *ejidatarios'* income. However, a mean income value is often a zero-sum trade-off as some increased their income and other decreased in similar proportion. This zero-sum gain often hides large economic inequalities within a population. Uneven income distributions can have the same mean income as fair income distributions. Therefore, it was necessary to conduct some further statistical tests to determine how specific parts of the participants' annual income make up have changed over time.

Student t-tests were performed on the *ejidatarios'* on-farm income (i.e., cropping and livestock) and off-farm income (salaried jobs and their own businesses) to identify particular variations within the annual net income mean.

On-Farm Net Income

A major goal of the Panuco River Irrigation Project was to improve the income of landless people by giving them ten hectares of irrigated land and providing them with support services to run their new farms. The government assumed that the *ejidatario'* farm would be the primary source of income, while the off-farm activities would complement the *ejidatario's* income.

The mean on-farm net income decreased $3,392.63 pesos from 1987 to 1995 (Tables 5 and 6). A student t-test showed that in the *ejidatarios'* on-farm income was statistically significant. The point estimates of the 1987 on-farm mean income were $\bar{X}_1$=8,603.17, $s_1$=20,344.91, $n_1$=238 and the 1995 on-farm income estimates were $\bar{X}_2$=5,210.54, $s_2$=13,150.48 and $n_2$=150.

Substituting the values in the t-test formula:

$$t = \frac{5,210.54 - 8,603.17}{\sqrt{\frac{24,344^2}{238} + \frac{13,150^2}{150}}} = -1.78$$

When this t-value (-1.78) is compared to the t-value from the distribution table, $-t_{.05}=-1.64$ for df=n-1=56, it falls out of the rejection region (RR≥-1.64). Therefore, the null hypothesis ($H_0$: $\mu_1>\mu_2$) is accepted. The *ejidatarios'* crop and livestock production were negatively impacted in the Panuco Region between 1987 and 1995. PRIP failed to help *ejidatario*-farmers increase their agricultural incomes.

**Comparison between the PRIP *Ejidatarios'* Income and National Income Parameters**

The mean income of a sample is more meaningful when it is compared to national parameters. The sample parameters of this study are compared to the national average income and the poverty line for the Mexican rural population. The results show that the PRIP *ejidatarios* are poor, according to the national parameters.

The most recent information was the "*Encuesta Nacional de Ingresos y Gastos de los Hogares, 1992*" (National Survey of Household Income and Expenses, 1992) (Tellez, 1994: 48). The results of this national survey reported that the 1992 annual net income per rural household was $12,604 pesos, which is equivalent to $21,049 pesos in 1995 constant pesos.

The PRIP *ejidatario* annual household income was

$15,539.56 pesos in 1987 and $15,356.03 pesos in 1995[31]. In both years, the PRIP *ejidatario* households made less money than the national average income of rural households[32].

The *ejidatarios'* annual net income was also compared to the poverty line of the Mexican rural population. The poverty line in 1995 pesos was calculated to be $3,292.44 pesos per person per year[33]. The household poverty line was calculated by multiplying the per-person poverty line by the number of family members.

In 1987, an *ejidatario* household had 5.14 members, therefore, the poverty line was $16,923.14 in 1995 pesos. In 1995, the average size of an *ejidatario* family was 5.46 members, resulting in a poverty line of $17,976.72 pesos. In 1987, *ejidatarios* made $15,539.56 pesos, which was below the poverty line. A similar situation occurred in 1995, when *ejidatarios* made $15,356.03 pesos, which was also below the poverty line.

However, not all the *ejidatarios* fell below the poverty line. In 1987, almost three quarters (74%) of the *ejidatario* households were below the poverty line. In 1995,

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[31] The rural poverty line was calculated with data provided by Jarque (1992). The poverty line in 1992 was 164,291 pesos per person per month. Converting this poverty line into 1995 constant pesos, the poverty line was equivalent to $3,292.44 pesos per person per year in 1995.

[32] All incomes were calculated in 1995 constant pesos.

[33] This poverty line was calculated with data reported by Jarque, 1994: 472.

the situation of the *ejidatario* families was relatively similar, since 69% of them were under the poverty line. At the national level, only 16% of the population was under the extreme poverty line (Tellez, 1994: 46).

There was no available information regarding the participant' income before the creation of PRIP, they might have been even poorer. The only reference made to the *ejidatarios'* prior situation was a question on the 1987 survey. Most *ejidatarios* (58%) felt that they were better off in 1987 than they were before the PRIP and a small portion of them (15%) believed that they were worse off.

**Comparison of the *Ejidatarios'* Income between 1987 and 1995: Paired Subsample**

This research was designed as a longitudinal study in which the same population was studied in surveys administered in 1987 and 1995. Both surveys included a 57 *ejidatario* paired subsample of individuals who were interviewed in 1987 and 1995. This paired subsample allowed for a comparison of the incomes of the same individuals in two different years.

Annual Net Income

The mean income difference of the paired subsample was calculated by subtracting the 1987 annual net income from

the 1995 annual net income (Tables 7 and 8). When the income difference was a negative number, there was an income reduction between 1987 and 1995 and a positive number meant an income increase for the same period. The null subhypothesis stated that "*ejidatarios* did not increase their income between 1987 and 1995". According to the paired difference t-test the income mean difference had to be significantly smaller than zero ($H_0$: $\mu_2-\mu_1<0$) (Agresty and Finlay, 1986: 176).

$$t = \frac{\bar{D}}{s \,/\, \sqrt{n}}$$

Where: D = the sample mean of the difference income
s = standard deviation of the difference income
n = number of observations in the paired subsample

The parameters of the paired subsample used to perform the t-test were the annual mean income difference of $3,665.77 pesos, and a standard deviation of the income difference of $37,905.27 pesos. Substituting the values in the formula:

$$t = \frac{3{,}665.77}{37{,}905.27 \,/\, \sqrt{57}} = 0.73$$

The calculated t-value was larger than the $-t_{.05}=-1.64$ from the t-table, falling within the rejection region. In

**Table 7. Synopsis of the *Ejidatario*-Farmers' Net Income in 1987 (Paired Subsample, n=57)**

| INCOME CONCEPT | N | MEAN INCOME (1995 pesos) | PERCENTAGE |
|---|---|---|---|
| **AGRICULTURAL PRODUCTION** | | | |
| GROSS AGRICULTURAL INCOME | 53 | 9,478.11 | |
| TOTAL AGRICULTURAL COSTS | 53 | 7,080.94 | |
| NET AGRICULTURAL INCOME | 53<br>(57) | 2,397.17<br>(2,228.94)* | |
| **ANIMAL PRODUCTION** | | | |
| GROSS LIVESTOCK INCOME | 44 | 16,757.95 | |
| TOTAL LIVESTOCK COSTS | 44 | 8,170.45 | |
| NET LIVESTOCK INCOME | 44<br>(57) | 8,587.50<br>(6,628.96)* | |
| **NET ON-FARM INCOME**** | 55<br>(57) | 9,180.00<br>(8,857.90)* | 61.27 |
| **OFF-FARM INCOME** | | | |
| NET OFF-FARM INCOME | 45<br>(57) | 5,482.00<br>(4,327.89)* | 29.94 |
| **VARIOUS INCOME** | | | |
| VARIOUS NET INCOME | 16<br>(57) | 4,528.44<br>(1,271.14)* | 8.79 |
| **ANNUAL NET INCOME** | **57** | **14,456.93** | **100.00** |

* The numbers within the parenthesis are the means for the total subsample (n=57).

** Net On-Farm Income is the sum of crop and livestock incomes.

**Table 8. Synopsis of the *Ejidatario*-Farmers' Net Income in 1995 (Paired Subsample, n=57)**

| INCOME CONCEPT | N* | MEAN INCOME (1995 pesos) | PERCENTAGE |
|---|---|---|---|
| **AGRICULTURAL PRODUCTION** | | | |
| GROSS AGRICULTURAL INCOME | 35 | 23,710.60 | |
| TOTAL AGRICULTURAL COSTS | 35 | 22,208.71 | |
| NET AGRICULTURAL INCOME | 35<br>(57) | 1,501.89<br>(922.21)* | |
| **ANIMAL PRODUCTION** | | | |
| TOTAL GROSS INCOME | 48 | 10,695.10 | |
| TOTAL LIVESTOCK COSTS | 48 | 6,572.08 | |
| NET LIVESTOCK INCOME | 48<br>(57) | 4,123.02<br>(3,472.02)* | |
| **NET ON-FARM INCOME**** | 53<br>(57) | 4,725.87<br>(4,394.23)* | 24.25 |
| **OFF-FARM INCOME** | | | |
| NET OFF-FARM INCOME | 37<br>(57) | 17,123.05<br>(11,114.96)* | 61.33 |
| **VARIOUS INCOME** | | | |
| VARIOUS NET INCOME | 31<br>(57) | 4,805.48<br>(2,613.51)* | 14.42 |
| **ANNUAL NET INCOME** | **57** | **18,122.70** | **100.00** |

* The numbers within the parenthesis are the means for the total subsample (n=57).

** Net On-Farm Income is the sum of crop and livestock incomes.

this case, the null hypothesis was rejected as the *ejidatarios'* 1995 income was not significantly lower than their 1987 income. However, this result was partially influenced by the great income variability among *ejidatarios* as the standard deviation was ten times larger than the mean. The 1995 annual net income was not significantly different from the 1987 annual net income.

In terms of sustainability, the result of the t-test illustrate that *ejidatarios* sustained their annual net income level from 1987 to 1995. This confirms the results of the t-test performed on the general samples.

On-Farm Net Income

A similar procedure was performed on the *ejidatarios'* on-farm income in order to test whether there was a significant difference between the 1987 and 1995 income levels or not ($H_0$: $\mu_2-\mu_1<0$ vs. $H_a$: $\mu_2-\mu_1 \geq 0$). The point estimates of the *ejidatarios'* on-farm income difference were: a mean of -$4,463.67 pesos, the standard deviation of the income difference was $19,722.24 pesos and a sample size was 57 *ejidatarios*.

$$t = \frac{-4,463.67}{19,722.24 \; / \; \sqrt{57}} = -1.71$$

The t-value for the mean difference (-1.71) was significantly smaller than the t-value $-t_{.05}= -1.64$. This value falls out of the rejection region ($rr \geq -1.64$) at 0.5 level with df=n-1=56, thus there is evidence that the null hypothesis may be true, thus the alternative hypothesis is rejected. *Ejidatarios* made significantly less money on their farms in 1995 than they did in 1987. This test confirms that PRIP failed to help *ejidatarios* increase their farm income.

**Comparison of the *Ejidatarios'* Income between 1987 and 1995: Stratified Paired Subsample**

Most development projects are designed to benefit specific groups called target populations. This is especially true in all development projects that have a regional influence. However, frequently it is found that a few people receive most of the project benefits. The following statistical analysis shows who improved and who decreased their income from 1987 to 1995.

The 57 *ejidatarios* paired subsample was stratified to determine whether the whole population of *ejidatarios* received benefits or only a small group took advantage of the PRIP support. T-tests were performed on the annual and the on-farm income differences for each cluster. The results of the t-tests are shown in Tables 9 and 10.

Annual Net Income

The annual household income of the stratified paired sample is shown in Table 9. A t-test was carried out to determine if *ejidatarios* of different income strata improved their annual income from 1987 to 1995. The alternative hypothesis for all of the strata is that "*ejidatarios* increased their annual income from 1987 to 1995 ($H^a$: $\mu_2-\mu_1 \geq 0$." The t-value was calculated with the following formula:

$$t = \frac{\bar{D}}{s / \sqrt{n}}$$

The seventh column in Table 9 shows the calculated t-values, that needed to be compared to the t-values from the seventh column. The comparison between these values illustrates that most *ejidatarios* sustained or improved their income levels between 1987 and 1995. On the other hand, *ejidatarios* in strata 6, 8 and 9 made significantly less money in 1995 than they did in 1987.

Theories of social polarization argue that the poor get poorer and the rich get richer. The numbers in Table 9 contradict this theoretical statement. The poorer *ejidatarios* in 1987 increased their annual income in 1995, while *ejidatarios* in the higher income levels reduced their annual income during the same period of time. However, it does not mean that poorer *ejidatarios* in 1987 became rich in

**Table 9. *Ejidatarios'* Annual Mean Income Differences between 1987 and 1995 (Stratified Paired Subsample)**

| STRATUM | N | ANNUAL MEAN INCOME | | MEAN OF THE DIFFERENCE $\bar{D}$ | STANDARD DEVIATION OF D | CALCULATED t-value | $t_{.1}$ with df=n-1 |
|---|---|---|---|---|---|---|---|
| | | 1987 | 1995 | | | | |
| 1 | 2 | -5,185.00 | 9,468.50 | 14,653.50 | 11,629.79 | 1.78 | 3.078 |
| 2 | 10 | -2,188.50 | 27,388.00 | 29,576.50 | 48,368.83 | 1.93 | 1.383 |
| 3 | 12 | 3,067.50 | 22,459.75 | 19,392.25 | 35,239.32 | 1.91 | 1.363 |
| 4 | 9 | 6,607.22 | 16,174.56 | 9,567.33 | 15,796.52 | 1.82 | 1.397 |
| 5 | 7 | 11,912.86 | 7,582.29 | -4,330.57 | 11,813.24 | -0.97 | -1.440 |
| 6 | 5 | 17,425.00 | 9,124.60 | -8,300.40 | 8,497.32 | -2.18 | -1.533 |
| 7 | 5 | 23,014.00 | 14,945.20 | -8,068.80 | 22,763.14 | -0.79 | -1.533 |
| 8 | 4 | 31,196.25 | 17,002.50 | -14,193.75 | 16,359.54 | -1.74 | -1.638 |
| 9 | 3 | 116,551.67 | 27,884.67 | -88,667.00 | 18,330.4 | -8.38 | -1.886 |
| TOTAL | 57 | 14,456.93 | 18,122.70 | 3,665.77 | 37,905.27 | 0.73 | -1.282 |

* The difference income mean was calculated subtracting the 1995 from the 1987 income for each *ejidatario*. All the monetary values are in 1995 constant pesos.

1995, as the next analysis shows. *Ejidatarios* improved their income, however most of them still remained below the poverty line.

The annual income of each strata was compared to the poverty line --the number of family members multiplied by the poverty line per person per month ($3,292.44 pesos in 1995). In 1987, the average annual incomes of the first six strata were under the poverty line while the income of the last three strata were above the poverty line. In 1995, only the second and the ninth strata were over the poverty line, while the rest of the strata were not. The third stratum had a particularly interesting situation in 1995. *Ejidatarios* in this cluster were below the poverty line in spite of their high income ($22,459.75 pesos). They also had the largest number of family members (7.17).

On-Farm Net Income

The PRIP focused its activities on improving *ejidatarios* income within their farms. *Ejidatarios'* on-farm income had a positive change in the first three strata, while the *ejidatarios* in the last six strata reduced their on-farm income from 1987 to 1995 (Table 10). A student t-test was performed to determine if *ejidatarios* improved their on-farm income from 1987 to 1995.

**Table 10. *Ejidatarios'* On-Farm Mean Income Differences between 1987 and 1995 (Stratified Paired Subsample)**

| STATUS | N | ON-FARM INCOME MEAN | | MEAN OF THE DIFFERENCE $\bar{D}$* | STANDARD DEVIATION OF D | CALCULATED t-STUDENT | $t_{.1}$ with df=n-1 |
|---|---|---|---|---|---|---|---|
| | | 1987 | 1995 | | | | |
| 1 | 2 | -6,185.00 | 6,868.50 | 13,053.50 | 9,367.04 | 1.97 | 3.078 |
| 2 | 10 | -4,206.50 | 2,650.00 | 6,856.50 | 7,823.08 | 2.77 | 1.383 |
| 3 | 12 | -40.42 | 2,146.58 | 2,187.00 | 16,358.65 | 0.46 | 1.363 |
| 4 | 9 | 1,361.11 | 13.44 | -1,347.67 | 5,827.67 | -0.69 | -1.397 |
| 5 | 7 | 7,633.57 | 1,478.00 | -6,155.57 | 9,289.45 | -1.75 | -1.440 |
| 6 | 5 | 12,027.00 | 1,160.60 | -10,866.40 | 7,236.70 | -3.38 | -1.533 |
| 7 | 5 | 12,851.00 | 10,513.20 | -2,337.80 | 18,996.71 | -0.28 | -1.533 |
| 8 | 4 | 23,463.75 | 10,496.25 | -12,967.50 | 16,074.52 | -1.61 | -1.638 |
| 9 | 3 | 91,963.33 | 24,551.33 | -67,412.0 | 4,725.03 | -24.71 | -1.886 |
| TOTAL | 57 | 8,857.90 | 4,394.23 | -4,463.67 | 19,722.24 | -1.71 | -1.282 |

* The difference income mean was calculated subtracting the 1995 from the 1987 income for each *ejidatario*. All the monetary values are in 1995 constant pesos.

The comparison of the calculated t-value with the t-values from the tables with n-1 degrees of freedom shown in Table 10 indicate that the *ejidatarios* in the fifth, sixth and ninth strata suffered a significant reduction in their on-farm income between 1987 and 1995. *Ejidatarios* in the first through fourth clusters, and the seventh and eighth clusters either maintained or increased their income during the 1987-1995 period.

### D. Reduction of Unemployment among Landless

The null subhypothesis states that "the *ejidatarios'* off-farm work increased from 1987 to 1995, $H_0$: $\mu_1<\mu_2$." The PRIP beneficiaries' background helped to determine if the PRIP effectively selected landless and unemployed people. The *ejidatarios'* off-farm employment and the land renting were used as indicators to test the null hypothesis. Three aspects of the off-farm employment were analyzed: the percentage of *ejidatarios* with an off-farm job (temporary or permanent), the number of days worked off-farm in a salaried job and the off-farm income difference between 1987 and 1995. The analysis of land renting in this study includes the percentage of *ejidatarios* who rented their land to others and the amount of money received for land renting.

**Background Characteristics of the PRIP Participants**

The recruitment of participants started with some groups of landless people in the Pujal-Coy area. These groups were demanding that the federal government provide them with land. Beneficiaries had very heterogenous backgrounds, skillful and unskillful people, farmers and laborers, people from irrigated agricultural areas and from rainfed agricultural areas.

At the beginning, the desertion rate among *ejidatarios* was very high. Many participants were not interested in farming and only looked at PRIP as an opportunity to obtain free land. Once they received the land they sold it, even though it was illegal. Others simply abandoned their land, while others rented their land out because they had businesses in the nearby cities.

The previous job experience had an impact on the success of many of the PRIP beneficiaries. The beneficiaries had very different job experiences. Some of them were working in jobs related to agriculture and others had urban jobs.

Landless people were the main beneficiaries of the land reform, 65% of the participants were agricultural laborers, called *peones agrícolas*. Most of them were working on the big ranches in the Panuco region. Some others were migrant

agricultural laborers[34] who were temporarily in the Panuco region when they received the land from PRIP. Most of these people did not have experience in running a farm by themselves.

Some participants of the PRIP (21%) were previously farmers and owned land in other places, but they came to Panuco to obtain more land. These people came from different places, but they at least had some farming experience.

The third group of participants (14%) were the most heterogeneous. This groups was composed of urban workers (e.g., bricklayers, artisans, bureaucrats, etc.). The majority had no experience as farmers.

Previous experience in irrigation management was another important background characteristic that had a great impact on the success of the PRIP beneficiaries. Some beneficiaries had farmed in large irrigation systems, like the PRIP. Others were farmers in small irrigation systems and some did not have experience in farming or irrigated farming systems.

*Ejidatarios* were divided into three categories. The first category included farmers (43%) who had previous experience with large irrigation projects, like the Panuco River Irrigation Project. The second category consisted of

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[34] In Mexico, the migrant agricultural laborers are workers who move from farm to farm for the purpose of harvesting the crops.

a group (14%), who had experience with small irrigation systems (e.g., well irrigation systems). The third group was (43%) made up of individuals with no prior working experience with irrigation. Even though some groups needed training in irrigation management, only a small group of *ejidatarios* (17%) received some training at the beginning of their settlement. After more than ten years, most *ejidatarios* (64%) felt that they had acquired expertise in irrigated farming systems. However, their learning process was slow and often distressful, relying primarily on "trial and error".

### *Ejidatarios'* Off-Farm Jobs

The PRIP planners initially assumed that ten hectares of land along with government support were sufficient to allow *ejidatarios* to maintain their families without having an off-farm job. Off-farm jobs could help *ejidatarios* to earn extra money, but they would not be the main source of income. Off-farm jobs played an important role in the *ejidatario* family's subsistence. Whenever *ejidatarios* lost their agricultural produce, they looked for an off-farm job. *Ejidatarios* often use their income from salaries to subsidize on-farm inputs. For example, *ejidatarios* would use income gained from work as bricklayers during the off-season to buy fertilizers for their crops.

In 1987, a high proportion of *ejidatario* families (79%)

held one or more off-farm jobs --58% had temporary jobs, 9% permanent jobs, and 23% their own businesses. The situation changed in 1995 when the percentage of households with off-farm jobs decreased to 65% (total population). A normal approximation to the binomial test was applied to determine if the percentage of *ejidatarios* with off-farm jobs significantly increased from 1987 to 1995.

$$Z = \frac{\hat{\pi} - \pi_0}{\sqrt{\frac{\pi_0(1-\pi_0)}{n}}}$$

Where: $\hat{\pi}$ = the observed proportion
$\pi_0$ = the percentage selected to detect a deviation from
n = sample size

Substituting the values into the formula:

$$Z = \frac{.79 - .65}{\sqrt{\frac{.65(1-.65)}{57}}} = \frac{.14}{.063} = 2.22$$

The calculated Z-value (2.22) is greater than the $Z_{.05}$=1.64. Thus, the percentage of *ejidatarios* with an off-farm job decreased significantly from 1987 to 1995 at .05 level of significance.

In 1987, *ejidatarios* of the paired subsample worked 141 days in off-farm salaried jobs (temporary plus permanent) and 214 days in 1995. It represents an increase of 52% in

the number of days worked off-farm by *ejidatarios* from 1987 to 1995.

A t-test was performed on the mean number of days worked off-farm. The z-value calculated was 2.71 which is greater than $z_{.05}$=1.64. There is a significant difference between the number of days worked off-farm in 1987 and in 1995. In the case of the 9 strata of the paired sample, there was a significant increase in the number of days worked off-farm in the strata number 1, 2, 3, and 4 from 1987 to 1995. The strata 5, 6 and 7 did not have a significant difference in the same period. Finally, the 8 and 9 strata had a significant decrease in the number of days worked off-farm. There is evidence that lower income strata had a significant tendency toward an increase in the number of days in off-farm jobs while the higher income strata showed a tendency toward a reduction of their off-farm work.

The reason for these changes is that the composition of the off-farm employment changed substantially from 1987 to 1995. The major change occurred in the percentage of households with one or more permanent salaried jobs which increased from 9% to 23%, especially in the lower strata. In contrast, the percentage of *ejidatario* households with temporary salaried jobs went from 58% to 40%, in 1987 and 1995 respectively. These changes suggest that *ejidatarios* and their families spent more time outside of their farms in 1995 than in 1987.

**Off-Farm Net Income (general samples)**

In Mexico, it is difficult to find a rural area where farmers' households exclusively depend on income from their own farms. However, if farmers earn enough money on their farms, few look for outside employment.

Throughout Mexico, farmers and their families prefer to work on their own farms, but the weather and other circumstances negatively affect agricultural production and force *ejidatarios* to seek off-farm jobs. Many *ejidatario*-farmers get off-season jobs to survive during the rest of the year when they do not have work on their own farms. This is especially true when they do not have a large enough harvest to recover their production costs. Temporary jobs provide farmers with some cash income to purchase food and other farming inputs. Scarcity of resources eventually compels families to look for temporary or permanent salaried jobs to cover the temporary or permanent cash flow deficits of their farms.

Off-farm income increased from $4,974.09 pesos in 1987 to $8,062.61 pesos in 1995, as it was shown above in Tables 5 and 6. A t-test helped to determine if the increase was statistically significant. The parameters of the 1987 off-farm income are $\bar{X}_1$=4,974.09, s=$_1$8977.22, $n_1$=238 and for 1995, $\bar{X}_2$=8,062.61, $s_2$=17,734.18, $n_2$=150.

Substituting these values in the formula:

$$t = \frac{8,062.61 - 4,974.09}{\sqrt{\frac{8,977^2}{238} + \frac{17,734^2}{150}}} = 1.98$$

The calculated t-value (1.98) is larger than the $t_{.05}$=1.64. *Ejidatarios* made significantly more money from off-farm sources in 1995 than they did eight years earlier, in 1987 from similar off-farm sources.

**Off-Farm Net Income (paired subsample)**

A t-test was performed on the mean off-farm income difference of the paired subsample to confirm what was found in the analysis of the general samples. The calculated estimates for a paired difference t-test were $\overline{D}$ = 6,787.07, s = 25,511.23 and n=57.

$$t = \frac{6,787.07}{25,511.23 \ / \sqrt{57}} = 2.01$$

The results indicate that the calculated t-value (2.01) is much higher than the t-value at .05 level (1.64) with df=56. This indicates that the income difference is greater than zero. The t-test showed that there was a significant increase in the off-farm income from 1987 to 1995. This

corroborates the previous conclusion that off-farm activities had increased in importance during the 1987-1995 period.

**Off-Farm Net Income (stratified subsample)**

The off-farm income was significantly higher for *ejidatarios* in 1995 than in 1987 (Table 11). However, not all of the income clusters increased their off-farm income in the same proportion. The first five strata had a positive increase in their off-farm income from 1987 to 1995, while the last four strata made less money from off-farm income sources.

Paired difference t-tests were performed to determine if these income differences were significant. Comparing the calculated t-values in the seventh column against the t-value from tables with df=n-1 in the eight column, it was found that the *ejidatarios* of the third and fourth strata significantly increased their off-farm income from 1987 to 1995. Most of the strata (1, 2, 5, 6, 8 and 9) did not have a significantly different off-farm income at .1 significance level with df=n-1. The *ejidatarios* of these strata sustained their off-farm income. Only the seventh cluster experienced a significant reduction of their off-farm incomes between 1987 and 1995. No tendency was found between lower or higher income strata regarding their off-farm income.

**Table 11. *Ejidatarios'* Off-Farm Mean Income Differences between 1987 and 1995 (Stratified Paired Subsample)**

| STATUS | N | OFF-FARM INCOME MEAN | | MEAN OF THE DIFFERENCE $\bar{D}$ | STANDARD DEVIATION OF D | CALCULATED t-STUDENT | $t_{.1}$ with df=n-1 |
|---|---|---|---|---|---|---|---|
| | | 1987 | 1995 | | | | |
| 1 | 2 | 1,000.00 | 2,600.00 | 1,600.00 | 2,262.74 | 1.00 | 3.078 |
| 2 | 10 | 1,613.00 | 21,943.00 | 20,330.00 | 47,204.22 | 1.36 | 1.383 |
| 3 | 12 | 2,606.67 | 17,099.00 | 14,492.33 | 28,319.39 | 1.77 | 1.363 |
| 4 | 9 | 4,283.33 | 13,516.67 | 9,233.33 | 12,771.22 | 2.17 | 1.397 |
| 5 | 7 | 4,279.29 | 5,368.57 | 1,089.29 | 7,686.69 | 0.37 | 1.440 |
| 6 | 5 | 4,889.00 | 4,164.00 | -725.00 | 2,727.60 | -0.59 | -1.533 |
| 7 | 5 | 10,163.00 | 1,872.00 | -8,291.00 | 7,003.51 | -2.65 | -1.533 |
| 8 | 4 | 6,812.50 | 3,581.25 | -3,231.25 | 5,887.96 | -1.10 | -1.638 |
| 9 | 3 | 8,755.00 | 0.00 | -8,755.00 | 8,635.11 | -1.76 | -1.886 |
| TOTAL | 57 | 4,327.89 | 11,114.96 | 6,787.07 | 25,511.23 | 2.01 | -1.282 |

* The difference income mean was calculated subtracting the 1995 from the 1987 income for each *ejidatario*. All the monetary values are in 1995 constant pesos.

**Land Renting**

Land renting included the rent of *ejido* land for cropping and the rent of grasses for cattle grazing. Normally, outsiders rent land from *ejidatarios*, but land renting can happen between an *ejidatarios* and another *ejidatario* member of the same *ejido*. Without owning land, land renters can manage thousands of hectares. There were cases in which all the *ejidatarios* of one *ejido* rented their land to outsiders. Land renting is the effect of multiple causes, but it indicates that *ejidatarios'* farms were not profitable and/or *ejidatarios* did not have sufficient resources to operate their farms.

Despite the fact that *ejido* land renting was prohibited by law, *ejidatarios* rented their land to other farmers since the beginning of the PRIP. In 1991, a constitutional amendment allowed *ejidos* to sell or to rent their land. Since then, land renting has increased tremendously, even though *ejidatarios* receive very low rent fees for their lands. In 1995, the rent fee of one hectare of irrigated land ranged from $300 to $400 pesos a year (approximately $60 U.S. dollars in 1995). *Ejidatarios* were aware that the rent fee was low, but it was secure money.

In 1987, few *ejidatarios* (12%) partially or totally rented their land for cropping or grazing. By 1995, 37% of the *ejidatario* beneficiaries of the PRIP rented land to private farmers or international companies. A normal

approximation to the binomial test was performed to determine if the percentage difference of *ejidatarios* who rent their land was statistically significant.

$$Z = \frac{.37 - .12}{\sqrt{\frac{.12(1-.12)}{57}}} = \frac{.25}{.043} = 5.81$$

The resulting difference is significant at .05 significance level. A significantly higher percentage of *ejidatarios* rented their land in 1995 than in 1987.

*Ejidatarios* made $517.54 pesos in 1987 and $1,779.30 pesos in 1995 for land renting, an income difference of $1,261.76 pesos. A t-test was performed on the land renting income difference of the 57 paired subsample. The parameters used to perform the test were $\bar{D}$ = 1,261.76 pesos, s = 3,274 and n=57.

$$t = \frac{1,261.76}{3,274 \ / \sqrt{57}} = 2.91$$

The calculated t-value is higher than the $t_{.05}$ with df=n-1 from tables, therefore, *ejidatarios* made more money from land renting in 1995 than in 1987.

The analysis of land renting of the 9 income strata (Table 12) shows that the percentage of farmers who rent

their land to outsiders significantly increased in most of the strata (from the second to the eighth stratum). The ninth cluster had a significant decrease in the percentage of farmers renting their land. The only strata without significant change was the first stratum, which did not have income for land renting in either 1987 or 1995.

The mean income for land renting increased in seven of the nine strata (from the second to the eighth stratum). The first stratum did not have income from land renting in 1987 and in 1995. The ninth stratum decreased their income. A t-test was performed on each of the mean income differences to determine if they were significant. The results of the t-test are shown in the eighth column of Table 12. The results were compared to the $t_{.1}$ with df=n-1. The mean income difference was significant in the second, third and sixth strata. In the rest of the strata the income differences were not significant.

The paradox was that the highest ratio of land renting occurred in the "Las Animas" irrigation unit, which has the best natural resources of the three irrigation units in PRIP. In 1995, 51% of the *ejidatarios* rented their lands in Las Animas, 38% in Pujal Coy, and 18% in Chicayan. Coincidentally, the "Las Animas" unit had the highest percentage of *ejidatarios* who were resettled from other states, followed by the Pujal Coy unit and then by the Chicayan unit.

**Table 12. *Ejidatarios'* Mean Income Differences for Land Renting between 1987 and 1995 (Stratified Paired Subsample)**

| STRATUM | 1987 | | 1995 | | income difference * | Standard deviation | t-value calculated |
|---|---|---|---|---|---|---|---|
| | % ejida-tarios | rent * income | % ejida-tarios | rent * income | | | |
| 1 | 0.0 | 0.00 | 0.0 | 0.00 | 0.00 | 0.00 | . |
| 2 | 20.0 | 405.00 | 50.0 | 2,570.00 | 2,165.00 | 2,430.14 | 2.82 |
| 3 | 8.3 | 33.33 | 50.0 | 1,872.50 | 1,839.17 | 2,133.68 | 2.99 |
| 4 | 33.3 | 894.44 | 55.5 | 2,333.33 | 1,438.89 | 3,915.90 | 1.10 |
| 5 | 0.0 | 0.00 | 28.6 | 735.71 | 735.71 | 1,427.91 | 1.36 |
| 6 | 20.0 | 400.00 | 60.0 | 3,000.00 | 2,600.00 | 2,678.62 | 2.17 |
| 7 | 0.0 | 0.00 | 40.0 | 1,520.00 | 1,520.00 | 2,439.67 | 1.39 |
| 8 | 0.0 | 0.00 | 25.0 | 1,125.00 | 1,125.00 | 2,250.00 | 1.00 |
| 9 | 33.3 | 5,000.00 | 0.0 | 0.00 | -5,000.00 | 8,660.25 | -1.00 |
| TOTAL | 14.0 | 517.55 | 42.1 | 1,779.30 | 1,261.75 | 3,274.32 | 2.91 |

* All the monetary values are in 1995 constant pesos.

## E. Summary

The limited benefits to the poor farmers in irrigation projects have been continually reported, but governments have done little to understand the problem, explore the causes, or address the problems of the poor participants in irrigation projects.

The Panuco Project is an excellent example of the situation of poor farmers in large irrigation projects which is similar to the situation of poor farmers in other parts of Mexico and around the World. PRIP was created in 1974. It is composed of three irrigation units Las Animas, Pujal-Coy and Chicayan. It intended to irrigate 144,000 ha and benefit 8,500 *ejidatarios*.

This research project looks at the following: Can Mexican irrigation projects, like the Panuco River Irrigation Project, deliver intended benefits to poor farmers, called *ejidatarios*?.

The research objectives of this study are: 1) To evaluate if the benefits from large scale government supported irrigation projects have been sustainable, using the Panuco River Irrigation Project as an example and 2) To evaluate whether the Panuco River Irrigation Project was able to meet its original objectives: a) To develop an intensive irrigation system, b) to contribute to national food security, c) To reduce the uneven income distribution between the rural and urban populations, and d) To reduce

unemployment among landless peasants.

The overall null hypothesis was that the Panuco River Irrigation Project did not meet its initial objectives and was shown to be true. Four null subhypotheses were also formulated, for each of the project's objectives: a) *Ejidatarios* perceived that PRIP did not develop an efficient irrigation delivery system, b) *Ejidatarios* did not produce more food crops for the national food security in 1995 than in 1987, c) *Ejidatarios* did not increase their income from 1987 to 1995, and d) Finally, the fourth null subhypothesis is that the *ejidatarios* off-farm work increased from 1987 to 1995. The results of the hypothesis testing indicate that the four null subhypothesis were accepted.

These results and the previous results presented in this chapter regarding on-farm income show that ejido farm lost its importance as the primary source of employment and income for the *ejidatarios* in the Panuco Project. This was envisioned by the planners of the PRIP when developed the project.

# CHAPTER VI

# CONCLUSIONS AND RECOMMENDATIONS

## Conclusions

The Panuco River Irrigation Project is a good example of what happened with many of large irrigation projects in Mexico. Some of the of important characteristics of these projects were the construction of large scale irrigation infrastructure, huge government investments with international financial aid, settlement and relocation of large groups of people, complete transformation of the landscape, and governmental assistance to project beneficiaries. The Mexican government hoped these large irrigation projects would benefit their participant farmers by improving their income and well-being and the rest of the country by providing additional amounts of food. PRIP is probably one of the most dramatic failures of this approach in Mexico.

The main purpose of this study was to determine whether or not the Panuco River Irrigation Project met its initial objectives. The specific interest of this study was to determine the impact of the PRIP on participant *ejidatario*-farmers, who were the main beneficiaries of this project.

The PRIP planners established four basic objectives: a) to develop an intensive irrigation system, b) to contribute to national food security, c) to reduce the uneven income distribution between the rural and urban populations, and d) to reduce unemployment among landless peasants. This study was based on the overall null hypothesis that states "the PRIP did not meet its initial objectives", plus four subhypotheses based on each PRIP's objectives: a) PRIP did not develop an efficient irrigation delivery system ($H_0$: $\pi$=.5), b) *ejidatarios* did not produce more food crops for the national food security in 1995 than in 1987 ($H_0$: $\mu_2=\mu_1$), c) *ejidatarios* did not increase their income from 1987 to 1995 ($H_0$: $\mu_1>\mu_2$), and d) *ejidatarios* off-farm work increased from 1987 to 1995, ($H_0$: $\mu_1<\mu_2$).

Based on the findings reported in the Chapter V, it was not possible to reject the overall null hypothesis that "the PRIP did not meet its initial objectives." This does not mean that everything went wrong for the complete PRIP or for every participant. Some *ejidatarios* received important benefits from PRIP and are today prosperous farmers, but they are a minority of the *ejidatarios*.

The first null subhypothesis was accepted because the evidence suggested that PRIP did not develop an efficient irrigation delivery system. An irrigation system cannot be used intensively if it cannot deliver sufficient amounts of water to the users' fields on time. PRIP did not deliver water to the users on time (59%), even when *ejidatarios*

requested water within several days in advance. *Ejidatarios* (68%) had a more favorable opinion of the adequacy than the timeliness, however the system did not deliver an adequate amount of water for many users (32%). The managers of the system struggled with water losses in the distribution system because of the extremely deteriorated infrastructure. The deterioration of the irrigation infrastructure played an important role in making PRIP inefficient. Infrastructure maintenance was never adequately funded as the water fees were too low and the government provided very limited budgets. Many years of neglected maintenance by government and the lack of users participation have left the irrigation infrastructure system in a deplorable state. Many water users were not willing to pay the water fee because of the lack of efficiency of the irrigation water system.

The second alternative subhypothesis was rejected because the *ejidatarios* did not contribute more food for the national food security from 1987 to 1995, except for sugar cane. It seems that *ejidatarios* are abandoning agriculture to devote their efforts to more profitable activities (i.e., off-farm jobs).

At the beginning of the PRIP, the agriculture of this region experienced great transformations. The low-input individual cattle production systems was substituted for heavy-input crop production systems in collective *ejidos*. The transformation of rainfed land into irrigated land created high expectations of increased crop yield. These

expectations were only fulfilled in the initial stages of PRIP. In 1987, 95% of the *ejidatarios* were still cropping their land. By 1995, the percentage of *ejidatarios* who cropped their land decreased to 69%. In this year, the low input farming systems dominated the agricultural panorama of PRIP. For example, corn growers tilled their land once instead of twice --as was recommended for preparation of lands by the local experimental station in PRIP-, and did not apply either fertilizers or pesticides or use hybrid seeds, etc. In the worst cases, the *ejidatarios* rented, sold or abandoned their land.

There are some indications that the problems with agricultural production cannot be completely attributed to the PRIP operations. For example, the decline of agricultural profits was higher than the decline of crop yields. This was because prices of crops did not increase at the same pace as the cropping production costs. *Ejidatarios* were aware of this situation as indicated by the fact that many of them blamed the government for incongruent management of the inflation and the agricultural pricing policy. The government fixed the prices of the crops, while the prices of agricultural inputs were unrestricted (fertilizers, pesticides, etc.). This kind of faulty national policy appears to have nullified any positive achievement of regional development projects, like the PRIP.

Another factor that influenced the reduction of crop production was that in 1987, *ejidatarios* received

agricultural services provided by government agencies, such as credit, crop insurance, extension service, commercialization of agricultural products and supply of agricultural inputs. By 1995, *ejidatarios* no longer received these services.

The panorama of the PRIP agriculture looks discouraging to *ejidatarios* and other potential beneficiaries of irrigation projects. However, the sugar cane production demonstrates that *ejidatarios* can crop their land with have good returns when they have access to adequate schemes of financing, receive the opportune technical assistance, and their crops are conveniently insured.

This situation will not change, unless *ejidatarios* have access to agricultural services and the national policy of agricultural pricing changes to support poor farmers. If this does not occur, the PRIP farmers will not be able to continue cropping their land. The PRIP was not exclusively created to provide residence to *ejidatarios*. PRIP intended to enable *ejidatarios* for the purpose to crop their lands and produce food for them and the rest of the Mexican population.

The third null subhypothesis accepted because the statistical test showed that there was no significant change of the *ejidatarios'* annual income from 1987 to 1995, but the *ejidatarios'* on-farm income significantly decreased in the same time period. It is necessary to underline that the PRIP was created to help *ejidatarios* increase their income

by working on their farms, having irrigated land as their main asset.

The statistical analysis of the *ejidatarios'* annual income showed no change between 1987 and 1995. It looked as if the *ejidatarios* were able to maintain their income during this time period. However, further analysis showed that the mean incomes were the result of a zero-sum gain. Some *ejidatarios* increased their annual income, while others reduced theirs or some increased their off-farm income while they reduced their on-farm income. These and other kinds of trade-offs were hidden under the mean income figures. For this reason, the paired subsample was stratified into 9 clusters. The analysis of the 9 clusters showed important insights hidden under the average sample.

The analysis of the stratified paired subsample identified three groups of strata. The first group was comprised of the first four strata (1-4). The second group was constituted by the cluster 5 and 6, and the third group included strata 7, 8 and 9. The first and the third groups of strata were relatively homogenous groups, while the second had no distinctive characteristics.

Between 1987 and 1995, the lower income clusters were able to turn their economic situation around from a net loss to a positive income flow, while higher income clusters had their annual income substantially reduced. The poorer did not get poorer. The poor did not become rich, but they at least were able to maintain their families by working off-

farm.

One may think that an increase in on-farm income came along with a decrease in off-farm income or vice versa. This study shows that the PRIP *ejidatarios* who improved their on-farm income also improved their off-farm income. The lower strata increased their annual income along their on-farm and off-farm income, while the higher strata reduced their annual income because their on-farm and off-farm incomes were abated. The major gains of the lower income clusters came from off-farm sources. The major losses of the higher income clusters occurred in their on-farm activities, i.e., crop and animal production. This analysis shows that *ejidatarios* change their strategies of survival from time to time according to the problems they face. *Ejidatarios* could resist a reduction of their income from one year to another, however the bottom line for was a minimum biological needs (i.e., food consumption). When those biological need were being affected, *ejidatarios* looked for alternative ways to maintain their families and survive as farmers.

The comparison of the *ejidatarios* net income with the extreme poverty line and the national mean rural income, made the income analysis even more dramatic. The PRIP *ejidatarios* were divided into two groups: the not so poor and the very poor. The group of the not so poor *ejidatarios* (74% in 1987 and 69% in 1995) were below the poverty line, while the other group --the rest of the *ejidatarios*-- had an

annual income slightly above the poverty line. The average *ejidatarios'* annual income was below the poverty line, in 1987 and 1995. Thus, PRIP did not help *ejidatarios* to lift themselves above the poverty line. However, surprisingly most of the *ejidatarios* (63%) felt that they were better-off in 1995 than in 1987, and only one fifth of them (21%) felt that they were worse-off. This *ejidatarios'* perception was product that they had an off-farm job or were working individually their land after the bankruptcy of collective ejidos.

The fourth null subhypothesis is accepted because the PRIP did not reduce the unemployment among landless people. The PRIP planners anticipated that *ejidatarios* would be mainly employed on their farms and off-farm salaried jobs would occasionally help them with extra money. To make this possible, the Mexican government gave *ejidatarios* ten hectares of irrigated land, organized them into collective *ejidos*, and provided agricultural services to collective *ejidos*.

A paternalistic relationship between the government and PRIP participants did not allow *ejidatarios* to become full-time, selfsufficient farmers. *Ejidatarios* as well as the government did not fulfill their objectives. *Ejidatarios* were unable to adapt to the new environment because they had limited skills to produce irrigated agriculture, and the government agencies did not provide *ejidatarios* adequate training and sufficient support in the form of agricultural

services to overcome their lack of experience. The main result was that collective *ejidos* went bankrupt and agricultural activities did not provide *ejidatarios* with enough food and money to maintain their families throughout the year. Off-farm jobs and land renting were the only ways in which many *ejidatarios* could maintain their families and them only at or below the national poverty level.

The fourth null subhypothesis accepted because off-farm jobs became the *ejidatarios'* main source of income and employment in 1995. Despite the fact that the proportion of households with off-farm jobs significantly decreased from 1987 to 1995. The average number of days worked in off-farm jobs and the off-farm income significantly increased because *ejidatarios* switched from temporary jobs during the off-season to permanent jobs throughout the year. This was reflected in a significant increase of the off-farm income from 1987 to 1995. Lower strata had a tendency to increase their off-income while upper strata decreased their off-farm income in this time period.

Between 1987 and 1995, land renting had a very significant increase in terms of the percentage of *ejidatarios* renting their lands and the amount of money that they received for land renting. The only trend found was a generalized land renting among seven out of nine strata. However, no specific trend was found between lower and higher strata.

Land renting was an alternative for many *ejidatarios*

who were hoping to crop their land again and for many who did not have the resources for cropping, but wanted to keep their land for their children to inherit. The result has been that many *ejidatarios* become attached to a piece of land, which has kept their income at or below the poverty line.

In summary, this study showed the dramatic situation of participant *ejidatario*-farmers in the Panuco River Irrigation Project across time, which is similar to the situation of many participant poor farmers in other large irrigation project. This study shows that huge investments on large scale irrigation projects are not always the best ways to readdress poverty problems and produce more food for the national food security.

## Recommendations

The recommendations are divided into two parts. The first recommendations are regarding policy making, management, and operation of the PRIP to improve the *ejidatarios'* living conditions and their farm production. The second are recommendations for future studies.

The recommendations to improve irrigation management and operation of the PRIP are the following:

1. The PRIP stakeholders need a working agreement outlining a partnership to manage and operate their irrigation system. The most important factor is that

stakeholders make new commitments (action based) to overcome the current situation of the *ejidatarios*.

2. The participation of stakeholders, especially *ejidatarios*, in every level of the decision making process is very important to achieve participants' expectations and improve their well-being.
3. Because the Mexican government intends to transfer the management of the irrigation infrastructure to water user associations, several measures must be addressed before *ejidatarios* can manage the system:
   a) The irrigation infrastructure needs to be rehabilitated before it is transferred,
   b) The process of transference should be gradual to allow *ejidatarios* to become familiar with the operations and adapt their farming systems to the new conditions of operation,
   c) User associations and their members need to receive intensive training in irrigation management.
   d) The transference process should be participatory at all levels among all stakeholders.
   e) The Mexican government should provide supporting services for the first years of user associations' operations and avoid a long term "paternalistic" relationship.
4. The *ejidatarios'* farming system is increasingly based on monocropping. It is important to reverse this trend

by diversifying the *ejidatarios'* farm because it can produce irreversible damages to the natural resources. The productive diversification is fundamental for small farmers to resist market fluctuations. The combination of crop and livestock production system is a good alternative for many *ejidatarios* to stabilize their income flow and reduce risks.

5. The Mexican government has to define a more congruent pricing policy of agricultural products to encourage poor farmers to keep cropping their lands and rich farmers to improve and sustain their productivity.
6. Private investments of agroindustries can be one alternative to overcome many of the current constraints in the PRIP agriculture. The integration of those industries with farmer organizations can reduce market uncertainties and provide services that the government no longer provides (agricultural credit, technical assistance, and crop insurance). However, this alternative should be carefully analyzed to avoid problems of paternalism or overexploitation of human and natural resources.
7. Higher-income *ejidatarios* need assistance in recovering their previous agricultural productivity because crops and livestock remain their main source of income sources in 1995. To prosper, they need to shift from subsistence crops (i.e., corn) to cash crops (i.e., vegetables and sugar cane). Some of them demanded a

reliable water provision service, others availability of credit at market rates, and some other a congruent price policy, etc. These *ejidatarios* demanded efficient services not subsidies.

8. Considering their situation of low income PRIP participants in 1987 and 1995, it is difficult to know if lower income strata of *ejidatario*-farmers were still willing and able to produce crops and livestock again --even if agricultural services were available. For these low-income *ejidatarios*, the possibilities of becoming full-time farmers again are severely limited if there is no longer government support for agriculture.
9. The government can help the PRIP beneficiaries to obtain the necessary skills and have access to the specific services, private or governmental, they need to prosper in irrigated agricultural systems. The government support does not necessarily mean that the Mexican government has to provide highly subsidized services, as in the past.
10. The reorganization of *ejidatarios* is an important part of the future benefits that they can obtain. They need to be organized to become a political force to counterbalance the government control.
11. Agricultural credit was identified as a priority by most of the *ejidatarios* because they do not have enough money to operate their farms. Credit is a keystone in

the improvement of *ejidatarios* well-being.

## Future Research

The following recommendation are regarding to future studies.

1. A permanent system of monitoring and evaluation can produce the information needed to improve operation and management of the PRIP. The system of monitoring and evaluation can be composed by a series of studies to collect the basic information about environmental, social and economic impact of the PRIP. It is especially important to monitor the impact of PRIP on the beneficiaries' well-being.
2. The combination of different research methods is fundamental for future evaluation researches.
3. In 1994, the first user association that managed irrigation infrastructure in PRIP started its operations. Monitoring its performance during the first years of operations can help other user association that receive the management of infrastructure in the future.
4. According to some studies of other irrigation settlements projects (Scudder, 1994), a farming system is stable and sustainable until the second generation of settlers take over the production and the irrigation system. It would be interesting to study those farmers

who are the second generation of settlers to know how successful they are compared to the first generation.

5. It is important to conduct an environmental impact assessment of the PRIP. *Ejidatarios* and government officials did not express particular concerns regarding the environment, however, serious problems of erosion and other related problems (e.g., waterlogging and salinization) were observed in some areas during the field work of this study.

# APPENDICES

# APPENDIX A

## APPENDIX A

### SURVEY QUESTIONNAIRE[35]

Le estoy pidiendo su permiso y colaboración voluntaria para una encuesta que se esta realizando en toda el área del Proyecto de Irrigación de la Cuenca Baja del Río Pánuco. La información que le solicito es relacionada con el manejo de la irrigación, las labores a sus cultivos y aspectos sobre el bienestar de su familia. Los ejidatarios que se están entrevistando fueron seleccionados al azar entre todos los ejidatarios del área del Proyecto Pánuco. La duración promedio de la entrevista será una hora y media aproximadamente.

La información será usada para la tesis doctoral de ESTEBAN VALTIERRA, quien es un estudiante mexicano que estudia actualmente en la Universidad Estatal de Michigan (Michigan State University) en los Estados Unidos.

La entrevista no es obligatoria, pero le estamos pidiendo su colaboración voluntaria que será muy valiosa para el propósito señalado. Si se siente inconforme con la entrevista puede suspenderla en cualquier momento, no habrá ninguna penalización por ello.

La información que usted proporcione será estrictamente confidencial, nadie mas aparte de mi conocerá su información personal. Su nombre no podrá ser ligado con la información que usted proporcione debido a que su nombre será guardado separado de la información. La información será manejada de manera agregada, ello significa que su nombre no será mencionado en ningún análisis o reporte de investigación, a menos que usted mismo lo pida.

Muchas gracias por su participación

Nombre del ejidatario _____

Dirección _____ Localidad _____

Municipio _____ Estado_____

Nombre del Ejido _____

Unidad de Riego _____

Fecha de la entrevista _____

---

[35] This is the actual questionnaire in Spanish used in this study. The format of the questionnaire was slightly changed to meet format norms of the MSU Graduate School for doctoral dissertations, but all the questions are unchanged. Clarifications about this questionnaire can be made with the author of this dissertation.

**MANEJO Y OPERACION DEL SERVICIO DE RIEGO**
**TIERRA IRRIGADA**

1. ¿Cuanta superficie de tierra ejidal recibió al inicio del proyecto de irrigación Pánuco _____ ha de RIEGO **X1A**└┴┴┴┴┴┘
_____ ha de TEMPORAL **X1B**└┴┴┴┴┴┘
_____ ha de otra **X1C**└┴┴┴┴┴┘

2. Cual era la calidad de la tierra que recibió del Proyecto Pánuco **Y2**└┘
1) Pésima
2) Mala
3) Regular
4) Buena
5) Excelente

3. En caso de que no regaba toda la superficie inicial ¿cuales eran las razones para no regar parte o toda la superficie?
1) El terreno no estaba nivelado **Y3-1**└┘
2) Se le inundaba, no tenía buen drenaje **Y3-2**└┘
3) Solo parte de sus terrenos tenían infraestructura **Y3-3**└┘
4) No le alcanzaba el dinero para pagar el agua **Y3-4**└┘
5) No sabia como regar **Y3-5**└┘
6) Otra _____ **Y3-6**└┘

4. TENENCIA Y CLASE DE LA SUPERFICIE DE TIERRA AGRICOLA Y NO AGRICOLA

| SUPERFICIE | RIEGO | TEMPORAL | PASTOS | BOSQUES | IMPRODUCTIVO | TOTAL |
|---|---|---|---|---|---|---|
| EJIDAL | **er** | **et** | **ep** | **eb** | **ei** | **et** |
| PROPIA | **pr** | **pt** | **pp** | **pb** | **pi** | **pt** |
| RENTADA | **rr** | **rt** | **rp** | **rb** | **ri** | **rt** |
| APARCERIA | **ar** | **at** | **ap** | **ab** | **ai** | **at** |
| RENTADA A OTROS | **or** | **ot** | **op** | **ob** | **oi** | **ot** |
| DADA EN APARCERIA | **dr** | **dt** | **dp** | **db** | **di** | **dt** |

5. En caso de que la superficie de tierra actual que posea sea MENOS de la recibida inicialmente ¿A que se debió el cambio?
1) La dio en herencia a algún pariente **Y5-1**└┘
2) La regalo a otra persona no pariente **Y5-2**└┘
3) La vendió **Y5-3**└┘
4) Se la quito el gobierno por no explotarla **Y5-4**└┘
5) Se la quito una persona **Y5-5**└┘
6) Otra _____ **Y5-6**└┘

6. En caso de que tenga MAS superficie ¿Como adquirió la tierra adicional?
1) La compro **Y6-1**└┘
2) Se la regalaron **Y6-2**└┘
3) La heredo de algún pariente **Y6-3**└┘
4) Se apropió de terrenos sin dueño **Y6-4**└┘
5) Le dieron una extensión (el ejido o el gobierno) **Y6-5**└┘
6) La renta **Y6-6**└┘
7) Otra _____ **Y6-7**└┘

7. En caso de que la superficie actual de riego sea MENOS que la que regada inicialmente ¿Cual es la razón?

1) Porque tiene menos tierra **Y7-1**
2) Se destruyo la infraestructura primaria o secundaria **Y7-2**
3) Se destruyo la infraestructura terciaria **Y7-3**
4) Ya no puede pagar el agua **Y7-4**
5) Prefiere cultivos o actividades donde no se riegue **Y7-5**
6) El terreno se ensalitró **Y7-6**
7) El terreno se desnivelo **Y7-7**
8) Ya no cultiva el terreno **Y7-8**
9) Otra _____ **Y7-9**

8. En que caso que NO riegue toda la superficie tierra actual ¿Es la razón por la cual no riega toda su parcela?

1) El agua no alcanza a llegar a su parcela **Y8-1**
2) Su parcela esta arriba del nivel del canal **Y8-2**
3) El precio del agua es muy alto y no puede pagarlo **Y8-3**
4) El precio no es costeable **Y8-4**
5) La infraestructura esta destruida **Y8-5**
6) Su parcela no esta nivelada **Y8-6**
7) Otra _____ **Y8-7**

9. En caso de regar MAS superficie de tierra de la que inicialmente regaba ¿Por que ahora riega MAS?

1) El construyo la infraestructura terciaria con sus propios recursos **Y9-1**
2) El grupo organizado construyo la infraestructura necesaria **Y9-2**
3) El nivelo el terreno con sus propios recursos **Y9-3**
4) El gobierno construyo la infraestructura faltante al principio **Y9-4**
5) El gobierno le nivelo sus terrenos **Y9-5**
6) El precio del agua es mas bajo **Y9-6**
7) Ahora puede pagar el agua porque produce cultivos rentables **Y9-7**
8) Los terrenos que adquirió se pueden regar **Y9-8**
9) Otra _____ **Y9-9**

10. Con los recientes cambios al articulo 27 constitucional que permiten vender la tierra ejidal ¿Si alguien le quisiera comprar su tierra, usted estaría dispuesto a vender su parcela ejidal?

1) Si 2) No **Y10**

11. ¿Por qué? _____ **Y11**

_____

**CAPACITACION**

12. Antes de recibir su parcela, Usted tenía experiencia previa en el manejo de riego

1) Si, en un sistema similar al de Pánuco **Y12**
2) Si, en un sistema DIFERENTE al de Pánuco
3) No, ninguna experiencia

13. Después de que recibió la tierra ¿Usted recibió alguna capacitación para usar el riego y producir bajo el sistema de riego?

1) Si 2) No **Y13**

14. En que aspectos:
    1) Como conducir el agua hasta la parcela **Y14-1**
    2) Como hacer regaderas **Y14-2**
    3) Como determinar la lamina de riego **Y14-3**
    4) Como surcar el terreno para un riego adecuado **Y14-4**
    5) Como drenar un terreno **Y14-5**
    6) Acerca de todos los aspectos de como producir cultivos de riego **Y14-6**
    7) Acerca de unos pocos aspectos de como producir cultivos de riego **Y14-7**
    8) Otro _____ **Y14-8**

15. En caso de SI ¿Le ha sido útil esa capacitación? **Y15**
    1) No le fue útil en absoluto
    2) Poco útil
    3) Bastante útil
    4) Muy útil

16. Considera usted tener los conocimientos suficientes para hacer uso del riego? **Y16**
    1) Sus conocimientos son deficientes en todos los aspectos
    2) Tiene algunos conocimientos
    3) Suficientes en algunos aspectos y en otros deficientes
    4) Se considera un experto en irrigación

17. En caso de considerarse con insuficientes conocimientos ¿en que aspectos?
    1) Como conducir el agua hasta la parcela **Y17-1**
    2) Como hacer regaderas **Y17-2**
    3) Como determinar la lamina de riego **Y17-3**
    4) Como surcar el terreno para un riego adecuado **Y17-4**
    5) Como drenar un terreno **Y17-5**
    6) Acerca de algunos aspectos de como producir cultivos de riego **Y17-6**
    7) Otro _____ **Y16-7**

**ESTADO DE LA INFRAESTRUCTURA DE RIEGO Y SU MANTENIMIENTO**

18. ¿Usted participo para construir la infraestructura de riego en el Proyecto Pánuco?
    1) No contribuyo en nada **Y18-1**
    2) Mano de obra _____ horas **X18-2**
    3) Dinero _____ pesos **X18-3**
    4) Materiales _____ **Y18-4**
    5) Otro _____ **Y18-5**

19. En su opinión ¿Cuál es el estado de la infraestructura en la unidad de riego?
    1) Toda la infraestructura en terribles condiciones
    2) En partes con serios problemas y en partes bien
    3) Regular con mínimos problemas
    4) Muy bueno sin problemas
    5) Excelente

    ( ) Presas, casa de bombas y canal principal **Y19a**
    ( ) Canales secundarios de derivación **Y19b**
    ( ) Canales terciarios e infraestructura parcelaria **Y19c**
    ( ) Drenes **Y19d**
    ( ) Caminos de acceso **Y19e**

20. ¿Que tan frecuente la infraestructura recibe mantenimiento
    1) Nunca ha recibido
    2) Una vez al año
    3) Una vez cada dos o tres años
    4) Una vez cada cuatro o mas años
    5) Solo una vez desde que fue construida
    6) Otra _____
       ( ) Presas, casas de bombas y canal principal **Y20a**└─┘
       ( ) Canales secundarios de derivación **Y20b**└─┘
       ( ) Canales terciarios e infraestructura parcelaria **Y20c**└─┘
       ( ) Drenes **Y20d**└─┘
       ( ) Caminos de acceso **Y20e**└─┘

21. ¿Quién esta a cargo del mantenimiento de la infraestructura?
    1) El gobierno (la CNA o el Distrito de Riego)
    2) Los grupos organizados a nivel del modulo
    3) La organización de usuarios de la unidad de riego
    4) Una empresa privada pagada por los usuarios
    5) Una empresa privada pagada por el gobierno
    6) Otra _____
       ( ) Presa, casa de bombas y canal principal **Y21a**└─┘
       ( ) Canales secundarios de derivación **Y21b**└─┘
       ( ) Canales terciarios e Infraestructura parcelaria **Y21c**└─┘
       ( ) Drenes **Y21d**└─┘
       ( ) Caminos de acceso **Y21e**└─┘

22. ¿De quien considera usted que sea obligación darle mantenimiento a la infraestructura?
    1) Del Gobierno exclusivamente
    2) De los agricultores exclusivamente **Y22**└─┘
    3) Del gobierno con apoyo de los agricultores
    4) De los agricultores con apoyo del gobierno
    5) De ambos gobierno y agricultores por igual
    6) Otro _____

23. ¿Cuanto contribuye al mantenimiento de la infraestructura al año?
    1) Con dinero ¿Cuanto? $ _____pesos/año **X23a**└──────┘
    2) Con mano de obra ¿Cuantas horas? _____horas/año **X23b**└──────┘
    3) No contribuye en nada **Y23c**└─┘

24. ¿Cuanto estaría usted dispuesto a contribuir para darle un mantenimiento adecuado a la infraestructura?
    1) Con dinero $ _____pesos/año **X24a**└──────┘
    2) Con mano de obra _____horas/año **X24b**└──────┘
    3) No estaría dispuesto a contribuir en nada **Y24c**└─┘

25. ¿Todos los campesinos cooperan de igual manera?
    1) Si, porque es obligatorio
    2) Todos cooperan igual siempre y voluntariamente **Y25**└─┘
    3) Casi todo cooperan
    4) Solo la mitad coopera
    5) Casi nadie coopera
    6) Cada quien coopera con lo que puede
    7) La cooperación es de acuerdo a las limitaciones económicas de cada quien
    8) Nadie coopera, el gobierno pone todo
    9) Otra _____

26. Hay algún castigo para quienes no contribuyen al mantenimiento de la infraestructura
    1) No hay ningún castigo **Y26**└─┘
    2) A veces se les corta el agua
    3) Siempre se les corta el agua
    4) Se les impone una multa pequeña de dinero
    5) Una multa fuerte en dinero
    6) Otro _____

**PRECIO Y CALIDAD DEL SERVICIO DE DISTRIBUCION DEL AGUA**

27. ¿Cuál es el método de pago del agua
    1) Por una cuota anual por usuario sin limite de cantidad de agua $ _____ **X27-1**└─────┘
    2) Por una cuota anual por usuario con limite de cantidad de agua $ _____ **X27-2**└─────┘
    3) Por miles de metros cúbicos $ _____ **X27-3**└─────┘
    4) Por riego $ _____ **X27-4**└─────┘
    5) Por superficie $ _____ **X27-5**└─────┘
    6) Por hora $ _____ **X27-6**└─────┘
    7) Otra _____ $ _____ **X27-7**└─────┘

28. Considerando la calidad actual del servicio ¿Usted cómo considera el precio del agua?
    1) Excesivamente caro 4) Barato **Y28**└─┘
    2) Un poco caro 5) Muy Barato
    3) Justo

29. En caso de caro o barato ¿Cuál debería de ser el precio del agua?
    1) Por una cuota anual por usuario sin limite de cantidad de agua $ _____ **X29-1**└─────┘
    2) Por una cuota anual por usuario con limite de cantidad de agua $ _____ **X29-2**└─────┘
    3) Por miles de metros cúbicos $ _____ **X29-3**└─────┘
    4) Por riego $ _____ **X29-4**└─────┘
    5) Por superficie $ _____ **X29-5**└─────┘
    6) Por hora $ _____ **X29-6**└─────┘
    7) Otra _____ $ _____ **X29-7**└─────┘

30. ¿Es suficiente el agua que usted recibe para sus necesidades?
    1) Siempre es insuficiente 3) Usualmente es suficiente **Y30**└─┘
    2) A veces es insuficiente 4) Siempre es suficiente

31. ¿Qué porcentaje de agua más necesitaría usted para cubrir las necesidades de su cultivo? _____% **X31**└─────┘

32. ¿Considera usted que es oportuna la distribución del agua?
    1) Nunca es oportuna 2) Casi nunca es oportuna
    3) A veces es oportuna 4) Siempre es oportuno **Y32**└─┘

33. En caso de que mejorara el servicio, esto es que usted recibiera a tiempo y en la cantidad necesaria ¿cuánto estaría dispuesto a pagar por el agua de riego?

| | | |
|---|---|---|
| 1) Por una cuota anual por usuario sin limite de cantidad de agua | $ _____ | **X33-1** |
| 2) Por una cuota anual por usuario con limite de cantidad de agua | $ _____ | **X33-2** |
| 3) Por miles de metros cúbicos | $ _____ | **X33-3** |
| 4) Por riego | $ _____ | **X33-4** |
| 5) Por superficie | $ _____ | **X33-5** |
| 6) Por hora | $ _____ | **X33-6** |
| 7) Otra _____ | $ _____ | **X33-7** |

34. ¿Quien decide la reglas para repartir el agua, en tiempo cantidad

1) Todos los campesinos a través de asambleas **Y34**
2) La SARH-CNA
3) Los representantes de los agricultores
4) CNA junto con los representantes
5) El canalero
6) Otro _____

35. ¿Cuales el principal criterio para repartir el agua?

1) Hay un reglamento
2) Se obtiene el agua cuando se necesita **Y35**
3) Es a criterio del funcionario de CNA
4) Es a criterio de los representantes
5) Ciertos cultivos tienen preferencia
6) Se va regando por zonas predefinidas
7) Otro _____

36. ¿Cuál sería su opinión global del sistema?

1) Terriblemente deficiente
2) Deficiente
3) Justo
4) Bueno
5) Excelente **Y36**

**ORGANIZACION PARA EL RIEGO**

37. A través de quien consigue el agua

1) Autoridades ejidales
2) La Comisión Nacional del Agua
3) Representante de grupo
4) Asociación de usuarios
5) Otra _____ **Y37**

38. ¿Esta usted organizado para obtener el agua?

1) Si 2) No **Y38**

39. ¿En que tipo de organización?

1) Un grupo solidario
2) Unión de varios ejidos
3) Una asociación de usuarios
4) Otra _____ **Y39**

**SERVICIOS AGRICOLAS**

40. ¿Cual es su opinión de los siguientes servicios:

| | | |
|---|---|---|
| 1) Pésimo | ( ) CREDITO | **Y40-a** |
| 2) Malo | ( ) SEGURO | **Y40-b** |
| 3) Regular | ( ) ASISTENCIA TECNICA | **Y40-c** |
| 4) Bueno | ( ) COMERCIALIZACION DE PRODUCTOS | **Y40-d** |
| 5) Excelente | ( ) COMPRA DE INSUMOS | **Y40-e** |

41. ¿Cuales son los principales problemas de esos servicios? ordénelos de acuerdo a su prioridad.

( ) CREDITO _____ **Y41-a**└─┘ **Y41-aa**└─┘
_____

( ) SEGURO _____ **Y41-b**└─┘ **Y41-bb**└─┘
_____

( ) ASISTENCIA TECNICA _____ **Y41-c**└─┘ **Y41-cc**└─┘
_____

( ) COMERCIALIZACION DE PRODUCTOS _____ **Y41-d**└─┘ **Y41-dd**└─┘
_____

( ) COMPRA DE INSUMOS _____ **Y41-e**└─┘ **Y41-ee**└─┘
_____

42. ¿Cuál cree que es la solución a esos problemas

CREDITO _____ **Y42-a**└─┘
SEGURO _____ **Y42-b**└─┘
ASISTENCIA TECNICA _____ **Y42-c**└─┘
COMERCIALIZACION DE PRODUCTOS _____ **Y42-d**└─┘
COMPRA DE INSUMOS _____ **Y42-e**└─┘

43. ¿Quién considera que debe solucionar esos problemas

1) Los ejidatarios organizados
2) La Secretaria de Agricultura
3) La CONASUPO
4) El gobierno del estado
5) Otra institución
6) Otra _____

( ) CREDITO **Y43-a**└─┘
( ) SEGURO **Y43-b**└─┘
( ) ASISTENCIA TECNICA **Y43-c**└─┘
( ) COMERCIALIZACION DE PRODUCTOS **Y43-d**└─┘
( ) COMPRA DE INSUMOS **Y43-e**└─┘

44. ¿Cómo estaría usted dispuesto a contribuir para solucionar los problemas?

CREDITO _____ **Y44-a**└─┘
SEGURO _____ **Y44-b**└─┘
ASISTENCIA TECNICA _____ **Y44-c**└─┘
COMERCIALIZACION DE PRODUCTOS _____ **Y44-d**└─┘
COMPRA DE INSUMOS _____ **Y44-e**└─┘

**ASPECTOS SOCIALES Y DE BIENESTAR FAMILIAR**

45. De que estado es originario (ver código estados)_____ **Y45**└─┴─┘

46. ¿Desde que fecha esta viviendo en la localidad actual donde tiene su hogar? Mes _____ año _____ **X46a**└─┴─┘ **X46b**└─┴─┘

47. ¿Fecha en que su ejido fue fundado? Mes _____ **X47a**└─┴─┘
año _____ **X47b**└─┴─┘

48. ¿Cual era su ocupación previa antes de ser ejidatario?

**AGRICULTOR**
1) Ejidatario
2) Colono
3) Pequeño propietario
4) Mediero
5) Arrendatario

**OTRO EMPLEO O TRABAJO**
1) Peón o jornalero
2) Comerciante
3) Obrero industrial
4) Albañil
5) Artesano
6) Empleado privado
7) Empleado publico
8) Otro _____

**Y48a**└─┘
**Y48b**└─┘

**VIVIENDA Y SERVICIOS EN LA VIVIENDA**

49. ¿La casa en que vive es:
1) Rentada 2) Propia 3) Otra _____ **Y49**└─┘

50. Cuantos cuartos tiene su casa _____ **X50**└─┴─┘

51. ¿La casa es adecuada a sus necesidades actuales?
    1) Si -->pase a #  2) No **Y51**└─┘

52. En caso de NO ¿cual es el inconveniente? **Y52**└─┘
    1) Demasiado pequeña
    2) Mala distribución de las cuartos
    3) Materiales inadecuados para el clima
    4) No tiene un patio adecuado
    5) Esta muy deteriorada
    6) Otra _____

53. ¿Le ha hecho alguna mejora en los últimos ocho años? **Y53**└─┘
    1) Si  2) No ---> Pase a #

54. Que mejora le hizo
    1) Construyo un baño o letrina **Y54-1**└─┘
    2) Construyo mas recamaras **Y54-2**└─┘
    3) Le puso o cambio el piso **Y54-3**└─┘
    4) Le cambio el techo **Y54-4**└─┘
    5) Resano el interior **Y54-5**└─┘
    6) Otro _____ **Y54-6**└─┘

55. Su casa está en mejores condiciones que hace ocho años? **Y55**└─┘
    1) Mucho peor  4) Ligeramente mejor
    2) Poco peor  5) Mucho mejor
    3) Sigue igual

56. Con que servicios cuenta el casa
    1) Agua entubada **Y56-1**└─┘
    2) Letrina **Y56-2**└─┘
    3) Electricidad **Y56-3**└─┘
    4) Otro _____ **Y56-4**└─┘

57. Con que aparatos domésticos en la casa
    1) Refrigerador **Y57-1**└─┘
    2) Licuadora **Y57-2**└─┘
    3) Radio **Y57-3**└─┘
    4) Televisión **Y57-4**└─┘
    5) Estufa de gas **Y57-5**└─┘
    6) Otro _____ **Y57-6**└─┘

**ALIMENTACION**

58. ¿Como considera usted que es la alimentación de su familia? **Y58**└─┘
    1) Comen más de lo necesario  5) Muy deficiente
    2) Balanceada  6) Depende de la época del año
    3) Comen lo necesario  7) otra _____
    4) Deficiente

59. Podría indicarme por favor la frecuencia con que come los siguientes alimentos

| | Diario (1) | cada 3er día (2) | cada semana (3) | cada 15 días (4) | cada mes (5) | durante temporada (6) | cada año (7) | de vez en cuando (8) | Nunca (9) | |
|---|---|---|---|---|---|---|---|---|---|---|
| Carne de res | | | | | | | | | | Y59a |
| Carne Puerco | | | | | | | | | | Y59b |
| Pollo | | | | | | | | | | Y59c |
| Pescado | | | | | | | | | | Y59d |
| Leche | | | | | | | | | | Y59e |
| Queso | | | | | | | | | | Y59f |
| Huevo | | | | | | | | | | Y59g |
| Verduras | | | | | | | | | | Y59h |
| Fruta | | | | | | | | | | Y59i |
| Frijoles | | | | | | | | | | Y59j |
| Arroz | | | | | | | | | | Y59k |
| Pan | | | | | | | | | | Y59l |

60. Comparando su alimentación actual con hace ocho años, ha mejorado su alimentación

1) Mucho peor
2) Poco peor
3) Sigue igual
4) Ligeramente mejor
5) Mucho mejor

**Y60** ___

**VESTIDO Y CALZADO**

61. *****ATENCION*** Observar el calzado y vestido que el entrevistado esta usando al momento de la entrevista

1) Ropa de vestir
2) Ropa de trabajo
3) Ropa de calle
4) Otra _____

1) Zapatos de vestir
2) Zapatos de trabajo
3) Zapatos de calle
4) Otros _____

**Y61a** ___ **Y61b** ___

62. Considera usted que ahora viste y calza a sus hijos mejor que hace ocho años?

1) Mucho peor
2) Poco peor
3) Sigue igual
4) Ligeramente mejor
5) Mucho mejor

**Y62** ___

**ESCUELA**

63. Durante el ultimo año ¿ha tenido a algún hijo en la escuela? **Y63** ___

1) Si 2) No

64. ¿Ha podido comprarle todos sus útiles y cooperaciones escolares?

1) Nada
2) Casi nada
3) Solo la mitad
4) La mayor parte
5) Todos

**Y64** ___

65. Hace ocho años tenía a algún hijo en la escuela **Y65** ___

1) Si 2) No

66. En aquel entonces ¿podía pagar sus útiles y cooperaciones escolares? **Y66** ___

1) Nada
2) Casi nada
3) Solo la mitad
4) La mayor parte
5) Todos

**SALUD**

67. Se ha enfermado usted o alguien de su familia en el ultimo año? Cuantos días?

| | | |
|---|---|---|
| 1) El jefe de familia | _____ | X67-1 ⌊__⌋⌊__⌋⌊__⌋ |
| 2) Esposo (a) | _____ | X67-2 ⌊__⌋⌊__⌋⌊__⌋ |
| 3) Hijos | _____ | X67-3 ⌊__⌋⌊__⌋⌊__⌋ |
| 4) Otro pariente | _____ | X67-4 ⌊__⌋⌊__⌋⌊__⌋ |
| 5) Otro _____ | _____ | X67-5 ⌊__⌋⌊__⌋⌊__⌋ |

68. Las últimas veces que usted o su familia se has enfermado ¿a donde ha acudido regularmente a curarse? **Y68** ⌊__⌋

1) Se ha curado con remedios caseros
2) Hospital Privado
3) Hospital Publico
4) Clínica publica de la comunidad
5) Clinica publica en una comunidad cercana
6) Clinica o consultorio privado en la comunidad
7) Clinica o consultorio privado en una comunidad cercana
8) Solo fue a la farmacia (autoreceta o farmacéutico)
9) Curandero
0) Otra _____

69. Hace ocho años cual era la forma de curarse? **Y69** ⌊__⌋

1) Se ha curado con remedios caseros
2) Hospital Privado
3) Hospital Publico
4) Clinica publica de la comunidad
5) Clinica publica en una comunidad cercana
6) Clinica o consultorio privado en la comunidad
7) Clinica o consultorio privado en una comunidad cercana
8) Solo fue a la farmacia (autoreceta o farmacéutico)
9) Curandero
0) Otra _____

70. ¿Considera que su salud y la de su familia se han deteriorado en los últimos ocho años? 1) Si 2) No **Y70** ⌊__⌋

71. ¿Cual es la razón principal? **Y71** ⌊__⌋

1) Un miembro de la familia murió
2) El y su esposa están viejos
3) No tiene para pagar el doctor
4) Su alimentación es peor
5) Su producción agrícola ha empeorado
6) Otra _____

**EXPECTATIVAS DEL EJIDATARIO**

72. ¿Le gustaría que sus hijos se dedicaran (si son menores) o se dediquen (en caso de que sean agricultores) a la agricultura? 1. Si 2. No **Y72** ⌊__⌋

73. En caso de SI ¿Por qué? **Y73** ⌊__⌋

1. Porque se pueden obtener buenas ganancias
2. Porque les va a heredar su tierra y su equipo
3. Porque es una tradición familiar
4. Porque no les pudo dar educación
5. Es su única alternativa de empleo
6. Otro_____

74. En caso de NO ¿Por qué? **Y74**└─┘
1. Es un trabajo muy duro y mal pagado
2. Con el TLC la agricultura va a quedar en manos de gente ajena al ejido
3. Estudiaron para dedicarse a otra cosa
4. Es mejor el trabajo en la ciudad
5. Otra_____

75. En relación a hace ocho años, en cuanto a sus condiciones de vida? **Y75**└─┘
1. Vive peor
2. Vive igual
3. Vive mejor ahora
4. No sabe
5. No contestó

76. ¿Por qué? _____ **Y76**└─┘
_____

77. La IRRIGACION ha contribuido con su actual nivel de vida? **Y77**└─┘
1) Si 2) No

78. Por qué? _____ **Y78**└─┘
_____

79. En relación a su situación actual ¿como cree que va a vivir dentro de diez años? **Y79**└─┘
1. Va a vivir peor
2. Va a vivir igual
3. Va a vivir mejor
4. No sabe
5. No contestó

80. ¿Por qué cree que va a estar en esa situación?_____ **Y80**└─┘
_____

CARACTERISTICAS DE LA FAMILIA

| NOMBRE | Parentesco | Edad | Sexo | Alfabetismo | Escolaridad | Lugar Residencia | TRABAJO ASALARIADO | | | | | | | | | | ACTIVIDAD PROPIA | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Actividad Temporal | | | | | Actividad Permanente | | | | | | | | |
| | | | | | | | Ocupación | Lugar | No.de días | Salario diario | Ingreso * | Ocupación | Lugar | No.de días | Salario diario | Ingreso * | Ocupación | Lugar | No.de días | Ingreso * |
| | | | | | | | | | | | | | | | | | | | | |
| 1. | | | | | | | | | | | | | | | | | | | | |
| 2. | | | | | | | | | | | | | | | | | | | | |
| 3. | | | | | | | | | | | | | | | | | | | | |
| 4. | | | | | | | | | | | | | | | | | | | | |
| 5. | | | | | | | | | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | | | | | | | | | |
| 11. | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | |
| 13. | | | | | | | | | | | | | | | | | | | | |

PARENTESCO

1. Jefe de familia
2. Conyuge
3. Hijo o hija
4. Otros Parientes
5. Otros no parientes

SEXO

1. Hombre
2. Mujer

ALFABETISMO

1. Sabe leer
2. No sabe leer
0. Menor de seis años

LUGAR DE RESIDENCIA
LUGAR DE TRABAJO

1. Comunidad
2. Municipio
3. Estado
4. Estado Adyacente
5. Ciudad fronteriza
6. Estados Unidos
7. Ciudad de Mexico
8. Otra

OCUPACION ASALARIADA

1. Jornalero
2. Obrero ind
3. Empleado Público
4. Empleado privado
5. Albañil
6. Oficios
7. Artesano
8. Pensionado
9. Sirvienta
0. Otra

OCUPACION PROPIA

1. Comercio
2. Taller
3. Industria
4. Transporte
5. Costurera
6. Otro

*Ingreso anual

**EGRESOS E INGRESOS DE LA PRODUCCION AGRICOLA.**

| C O N C E P T O | PREDIO/CULTIV |
|---|---|
| DATOS GENERALES | |
| Cultivo | |
| Superficie (ha) | |
| Clase de tierra | |
| Tenencia | |
| Tipo de cultivo | |
| Ciclo agrícola | |
| 1. SUBTOTAL COSTO DE PREPARACION DEL TERRENO | |
| 1.1. LIMPIA DEL TERRENO | |
| 1.1.1. Jornales familiares | |
| 1.1.2. Jornales asalariados | |
| 1.1.3. Costo por jornal($) | |
| 1.2. NIVELACION DE TERRENO | |
| 1.2.1. Costo de yunta propia ($) | |
| 1.2.2. Costo de yunta rentada ($) | |
| 1.2.3. Costo tractor propio ($) | |
| 1.2.4. Costo tractor rentado ($) | |
| 1.3. SUBSOLEO | |
| 1.3.1. Costo tractor propio ($) | |
| 1.3.2. Costo tractor rentado ($) | |
| 1.4. PRIMER BARBECHO | |
| 1.4.1. Costo de yunta propia ($) | |
| 1.4.2. Costo de yunta rentada ($) | |
| 1.4.3. Costo tractor propio ($) | |
| 1.4.4. Costo tractor rentado ($) | |
| 1.5. SEGUNDO BARBECHO | |
| 1.5.1. Costo de yunta propia ($) | |
| 1.5.2. Costo de yunta rentada ($) | |
| 1.5.3. Costo tractor propio ($) | |
| 1.5.4. Costo tractor rentado ($) | |
| 1.6. PRIMERA RASTRA | |
| 1.6.1. Costo de yunta propia | |
| 1.6.2. Costo de yunta rentada | |
| 1.6.3. Costo tractor propio ($) | |
| 1.6.4. Costo tractor rentado ($) | |
| 1.7. SEGUNDA RASTRA | |
| 1.7.1. Costo de yunta propia | |
| 1.7.2. Costo de yunta rentada | |
| 1.7.3. Costo tractor propio ($) | |
| 1.7.4. Costo tractor rentado ($) | |
| 1.8. RIEGOS PRESIEMBRA O MUERTO | |
| 1.8.1. Costo del agua | |
| 1.8.2. Jornales familiares | |
| 1.8.3. Jornales asalariados | |
| 1.8.4. Costo por jornal ($) | |

| | |
|---|---|
| 1.9. SURCADO | |
| 1.9.1. Costo de yunta propia | |
| 1.9.2. Costo de yunta rentada | |
| 1.9.3. Costo tractor propio ($) | |
| 1.9.4. Costo tractor rentado ($) | |
| 2. SUBTOTAL COSTO DE ALMACIGO | |
| 2.1. Clase de semilla* | |
| 2.2. Cantidad de semilla propia (kg) | |
| 2.3. Valor de la semilla propia ($) | |
| 2.4. Cantidad de semilla comprada (kg) | |
| 2.5. Valor de la semilla comprada ($) | |
| 2.6. Tipo de insecticida usado** | |
| 2.7. Cantidad de insecticida (kg o Lt) | |
| 2.8. Precio de insecticida ($ por Kg o Lt) | |
| 2.9. Valor total del insecticida ($) | |
| 2.10. Tipo de fungicida usado*** | |
| 2.11. Cantidad de fungicida (Kg o Lt) | |
| 2.12. Precio del fungicida ($ por Kg o Lt) | |
| 2.13. Valor del fungicida ($) | |
| 2.14. Jornales familiares | |
| 2.15. Jornales asalariados | |
| 2.16. Costo por jornal ($) | |
| 2.17. Costo de materiales y equipo propio ($) | |
| 2.18. Costo de materiales y equipo rentado ($) | |
| 3. SUBTOTAL COSTO DE SIEMBRA Y TRASPLANTE | |
| 3.1. SEMILLA O PLANTA | |
| 3.1.1. Variedad de la semilla | |
| 3.1.2. Cantidad de semilla propia | |
| 3.1.3. Cantidad de semilla comprada | |
| 3.1.4. Costo de semilla propia ($) | |
| 3.1.5. Costo de semilla comprada | |
| 3.1.6. Cantidad de planta comprada | |
| 3.1.7. Costo de planta comprada | |
| 3.2. DISPOSICION DE SIEMBRA | |
| 3.2.1. Fecha de siembra | |
| 3.2.2. Densidad de siembra | |
| 3.2.3. Num. de semilla por mata | |
| 3.2.4. Distancia entre surcos | |
| 3.2.5. Distancia entre plantas | |
| 3.2.6 Ancho de melgas | |
| 3.3. COSTO DE LABORES DE SIEMBRA O TRASPLANTE | |
| 3.3.1. Jornales familiares | |
| 3.3.2. Jornales asalariados | |
| 3.3.3. Costo por jornal ($) | |
| 3.3.4. Costo de yunta propia | |
| 3.3.5. Costo de yunta rentada | |
| 3.3.6. Costo tractor propio ($) | |
| 3.3.7. Costo tractor rentado ($) | |
| 3.3.8. otros costos ($) | |
| 4. SUBTOTAL COSTO DE LABORES DE CULTIVO | |

| | |
|---|---|
| 4.1. PRIMER CULTIVO | |
| 4.1.1. Jornales familiares | |
| 4.1.2. Jornales asalariados | |
| 4.1.3. Costo por jornal ($) | |
| 4.1.4. Costo de yunta propia | |
| 4.1.5. Costo de yunta rentada | |
| 4.1.6. Costo tractor propio ($) | |
| 4.1.7. Costo tractor rentado ($) | |
| 4.2. SEGUNDO CULTIVO | |
| 4.2.1. Jornales familiares | |
| 4.2.2. Jornales asalariados | |
| 4.2.3. Costo por jornal ($) | |
| 4.2.4. Costo de yunta propia | |
| 4.2.5. Costo de yunta rentada | |
| 4.2.6. Costo tractor propio ($) | |
| 4.2.7. Costo tractor rentado ($) | |
| 5. SUBTOTAL COSTO DE FERTILIZANTE QUIMICO | |
| 5.1. CLASE DEL PRIMER FERTILIZANTE QUIMICO | |
| 5.1.1. Precio por bulto o tonelada | |
| 5.1.2. Costo del primer fertilizante $ | |
| 5.1.3. Cantidad en la siembra(Kg) | |
| 5.1.4. Cantidad en la primera labor(Kg) | |
| 5.1.5. Cantidad en la segunda labor(Kg) | |
| 5.2. CLASE DEL SEGUNDO FERTILIZANTE | |
| 5.2.1. Precio por bulto o tonelada | |
| 5.2.2. Costo del segundo fertilizante | |
| 5.2.3. Cantidad en la siembra | |
| 5.2.4. Cantidad en la primera labor | |
| 5.2.5. Cantidad en la segunda labor | |
| 6. SUBTOTAL COSTO APLICACION DE FERTILIZANTE | |
| 6.1. Jornales familiares | |
| 6.2. Jornales asalariados | |
| 6.3. Costo por jornal ($) | |
| 6.4. Maquinaria propia | |
| 6.5. Maquinaria rentada | |
| 6.6. Transporte propio | |
| 6.7. Transporte rentado | |
| 7. SUBTOTAL ABONO ANIMAL U ORGANICO | |
| 7.1. CLASE DE ABONO | |
| 7.1.1. Cantidad de abono | |
| 7.1.2. Cantidad de abono | |
| 7.1.3. Valor de abono propio | |
| 7.1.4. Valor de abono comprado | |
| 7.2. COSTO DE APLICACION DE ABONO | |
| 7.2.1. Jornales familiares | |
| 7.2.2. Jornales asalariados | |
| 7.2.3. Costo por jornal ($) | |
| 7.2.4. Transporte propio | |
| 7.2.5. Transporte rentado | |
| 8. SUBTOTAL COSTO DE INSECTICIDAS Y FUNGICIDAS | |

| | |
|---|---|
| 8.1. PRIMER TIPO DE PESTICIDA | |
| 8.1.1. Cantidad de producto (kg o lt) | |
| 8.1.2. Numero de aplicaciones | |
| 8.1.3. Costo total del producto | |
| 8.2. SEGUNDO TIPO DE PESTICIDA | |
| 8.2.1. Cantidad de producto (kg o lt) | |
| 8.2.2. Numero de aplicaciones | |
| 8.2.3. Costo total del producto | |
| 8.3. COSTO DE APLICACION DE PESTICIDAS | |
| 8.3.1. Jornales familiares | |
| 8.3.2. Jornales asalariados | |
| 8.3.3. Costo por jornal ($) | |
| 8.3.4. Costo de bomba o tractor propia | |
| 8.3.5. Costo alquiler de bomba o tractor | |
| 8.3.6. Transporte de agua propio | |
| 8.3.7. Transporte de agua rentado | |
| 9. SUBTOTAL COSTO DE HERBICIDAS | |
| 9.1. COSTO PRODUCTO HERBICIDA | |
| 9.1.1. PRIMER TIPO DE HERBICIDA | |
| 9.1.1.1. Cantidad de producto (Kg o Lt) | |
| 9.1.1.2. Numero de aplicaciones | |
| 9.1.1.3. Costo total del producto | |
| 9.1.2. SEGUNDO TIPO DE HERBICIDA | |
| 9.1.2.1. Cantidad de producto (Kg o Lt) | |
| 9.1.2.2. Numero de aplicaciones | |
| 9.1.2.3. Costo total del producto | |
| 9.2. COSTO DE APLICACION DE HERBICIDAS | |
| 9.2.1. Jornales familiares | |
| 9.2.2. Jornales asalariados | |
| 9.2.3. Costo por jornal ($) | |
| 9.2.4. Costo de bomba o tractor propio | |
| 9.2.5. Costo alquiler de bomba o tractor | |
| 9.2.6. Transporte de agua propio | |
| 9.2.7. Transporte de agua rentado | |
| 10. SUBTOTAL COSTO DE RIEGO | |
| 10.1. COSTO DEL AGUA | |
| 10.1.1. Número de riegos | |
| 10.1.2. Costo del agua por riego | |
| 10.1.3. Costo de agua X miles de metros cúbicos | |
| 10.1.4. Costo por cuota anual | |
| 10.2. COSTO DE MANO DE OBRA PARA RIEGO | |
| 10.2.1. Jornales familiares | |
| 10.2.2. Jornales asalariados | |
| 10.2.3. Costo por jornal ($) | |
| 11. COSECHA DE FORRAJE VERDE | |
| 11.1. VALOR DE LA PRODUCCION DE FORRAJE VERDE | |
| 11.1.1. Producción total (tons) | |
| 11.1.2. Precio por tonelada($) | |
| 11.1.3. Valor del forraje verde | |

| | |
|---|---|
| 11.2. COSTO DE COSECHA DE FORRAJE VERDE | |
| 11.2.1. Jornales familiares | |
| 11.2.2. Jornales asalariados | |
| 11.2.3. Costo por jornal ($) | |
| 11.2.4. Transporte propio | |
| 11.2.5. Transporte rentado | |
| 12. COSECHA DE RASTROJO | |
| 12.1. VALOR DE LA PRODUCCION DE RASTROJO | |
| 12.1.1. Cantidad producida (Kg) | |
| 12.1.2. Precio ($/ton) | |
| 12.1.3. Valor de la producción de rastrojo | |
| 12.2. COSTO DE COSECHA DE RASTROJO | |
| 12.2.1. Jornales familiares | |
| 12.2.2. Jornales asalariados | |
| 12.2.3. Costo por jornal ($) | |
| 12.2.4. Maquinaria propia | |
| 12.2.5. Maquinaria rentada | |
| 12.2.6. Transporte propio | |
| 12.2.7. Transporte rentado | |
| 13. COSECHA DEL PRODUCTO PRINCIPAL | |
| 13.1. VALOR DE LA PRODUCCION | |
| 13.1.1. Numero de costales o cajas | |
| 13.1.2. Peso por costal o caja (Kg) | |
| 13.1.3. Producción total (Kg) | |
| 13.1.4. Precio ($/ton) | |
| 13.1.5. Valor de la producción ($) | |
| 13.2. COSTO DE COSECHA DE PRODUCTO | |
| 13.2.1. Epoca de cosecha | |
| 13.2.2. Maquinaria propia | |
| 13.2.3. Maquinaria rentada | |
| 13.2.4. Jornales familiares | |
| 13.2.5. Jornales asalariados | |
| 13.2.6. Costo por jornal ($) | |
| 13.2.7. Transporte propio | |
| 13.2.8. Transporte rentado | |
| 13.3. DESGRANE | |
| 13.3.1. Desgranadora propia | |
| 13.3.2. Desgranadora rentada | |
| 13.3.3. Jornales familiares | |
| 13.3.4. Jornales asalariados | |
| 13.4. EMPAQUE DEL PRODUCTO | |
| 13.4.1. Jornales familiares | |
| 13.4.2. Jornales asalariados | |
| 13.4.3. Costo por jornal ($) | |
| 13.4.4. Valor de la costalera y cajas ($) | |
| 14. PAGO DE INTERESES DE CREDITO | |
| 14.1. Monto total del préstamo | |
| 14.2. Interés prestado part. % mensual | |
| 14.3. Interés préstamo ofic. % Mensual | |
| 14.4. Plazo de préstamo meses | |

| | |
|---|---|
| 14.5. Pago total intereses | |
| 15. CONDONACIONES O INDEMNIZACIONES | |
| 15.1. Condonaciones del Banco | |
| 15.2. Condonaciones de contrato (Ingenio y otros) | |
| 15.3. Indemnizaciones de seguro agrícola | |
| 16. SUBSIDIOS | |
| 16.1. PROCAMPO | |
| 16.2. SANIDAD VEGETAL | |
| 16.3. CONASUPO | |
| 16.4. Otro subsidio | |
| 17. ASESORIA TECNICA | |
| 17.1. Costo de la asesoría técnica | |
| 17.2. Otros gastos para la asesoría (viáticos) | |
| 18. OTROS GASTOS | |
| 18.1. OTROS GASTOS DE MANO DE OBRA | |
| 18.1.1. Jornales familiares | |
| 18.1.2. Jornales asalariados | |
| 18.1.3. Costo por jornal | |
| 18.2. OTROS INSUMOS | |
| 18.2.1. Otros insumos propios | |
| 18.2.2. Otros insumos comprados | |
| 18.3. OTROS SERVICIOS | |
| 18.3.1. Otros servicios propios | |
| 18.3.2. Otros servicios comprados | |
| 19. RENTA DE LA TIERRA | |
| 19.1. Renta/ha de tierra de riego | |
| 19.2. Renta/ha de tierra de temporal | |
| | |

INVENTARIO GANADERO ESPECIES MENORES

| ESPECIE | Animales a la fecha | | | | | COMPRADOS | | | CONSUMO FAMILIAR | | | VENDIDOS | | | MUERTOS | | | EXISTENCIAS HACE UN AÑO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. anim | Raza | Precio por animal | (A) Valor | Nac. en el año | No. | Precio por animal | (B) Valor | No. | Precio por animal | (C) Valor | No. | Precio por animal | (D) Valor | No. | Precio por animal | (E) Valor | No. | Precio por animal | (F) Valor |
| PORCINOS | | | | | | | | | | | | | | | | | | | | |
| Sementales | | | | | | | | | | | | | | | | | | | | |
| Vientres | | | | | | | | | | | | | | | | | | | | |
| Engorda | | | | | | | | | | | | | | | | | | | | |
| Lechones | | | | | | | | | | | | | | | | | | | | |
| Subtotal Porcinos | | | | G1 | | | | G2 | | | G3 | | | G4 | | | G5 | | | G6 |
| OVICAPRINOS | | | | | | | | | | | | | | | | | | | | |
| Sementales | | | | | | | | | | | | | | | | | | | | |
| Adultos | | | | | | | | | | | | | | | | | | | | |
| Crias | | | | | | | | | | | | | | | | | | | | |
| Subtotal Ovicaprinos | | | | G7 | | | | G8 | | | G9 | | | G10 | | | G11 | | | G12 |
| AVES | | | | | | | | | | | | | | | | | | | | |
| Guajolotes | | | | | | | | | | | | | | | | | | | | |
| Gallinas | | | | | | | | | | | | | | | | | | | | |
| Patos | | | | | | | | | | | | | | | | | | | | |
| Subtotal Aves | | | | G13 | | | | G14 | | | G15 | | | G16 | | | G17 | | | G18 |
| OTRAS ESPECIES | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| Subtotal Otras esp. | | | | G19 | | | | G20 | | | G21 | | | G22 | | | G23 | | | G24 |
| TOTAL GANADO MENOR | | | | G25 | | | | G26 | | | G27 | | | G28 | | | G29 | | | G30 |

COSTOS DE PRODUCCION PARA GANADERIA MENOR

| | PORCINOS | OVICAPRINO | AVES | OTRAS ESP |
|---|---|---|---|---|
| 1. INSUMOS | | | | |
| 1.1. Medicinas y vacunas | | | | |
| 1.2. Alimentos balanceados | | | | |
| 1.3. Forraje verde propio | | | | |
| 1.4. Forraje verde comprado | | | | |
| 1.5. Rastrojo y paja propio | | | | |
| 1.6. Rastrojo y paja comprado | | | | |
| 1.7. Otros insumos propios | | | | |
| 1.8. Otros insumos comprados | | | | |
| SUB-TOTAL INSUMOS | | | | |
| 2. SERVICIOS | | | | |
| 2.1. Consulta veterinaria | | | | |
| 2.2. Flete o transporte propio | | | | |
| 2.3. Flete o transporte rentado | | | | |
| 2.4. Pago de renta de almacen | | | | |
| 2.5. Pago de seguro ganadero | | | | |
| 2.6. Intereses de prestamos | | | | |
| 2.7. Inseminación artificial | | | | |
| 2.8. Alquiler de sementales | | | | |
| 2.9. Otros servicios propios | | | | |
| 2.10. Otros servicios rentados | | | | |
| SUB-TOTAL SERVICIOS | | | | |
| 3. COSTOS DE REPARACION | | | | |
| 3.1. Reparación de corrales | | | | |
| 3.2. Reparación de vehículos | | | | |
| 3.3. Reparación de implementos | | | | |
| 3.4. Otros gastos de reparación | | | | |
| SUB-TOTAL REPARACION | | | | |
| 4. COSTOS DE MANO DE OBRA | | | | |
| 4.1. Mano de obra familiar | | | | |
| 4.2. Mano de obra asalariada | | | | |
| SUBTOTAL MANO DE OBRA | | | | |
| 5. RENTA DE POTREROS | | | | |
| 5.1. Uso de potreros propios | | | | |
| 5.2. Renta de potreros | | | | |
| SUBTOTAL POTREROS | | | | |
| 6. OTROS GASTOS | | | | |
| 6.1. Impuestos | | | | |
| 6.2. Cuotas de asociaciones | | | | |
| 6.3. Otros | | | | |
| SUB-TOTAL OTROS GASTOS | | | | |
| TOTAL COSTOS DE PRODUCCION DE GANADO MENOR | | | | |

INVENTARIO GANADERO ESPECIES MAYORES

| ESPECIE | Animales a la fecha | | | | | COMPRADOS | | | CONSUMO FAMILIAR | | | VENDIDOS | | | MUERTOS | | | EXISTENCIAS HACE UN AÑO | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. anim | Raza criollo fino Cruza | Precio por animal | (A) Valor | Nac. en el año | No. | Precio por animal | (B) Valor | No. | Precio por animal | (C) Valor | No. | Precio por animal | (D) Valor | No. | Precio por animal | (E) Valor | No. | Precio por animal | (F) Valor |
| BOVINOS | | | | | | | | | | | | | | | | | | | | |
| Sementales | | | | | | | | | | | | | | | | | | | | |
| Vientres | | | | | | | | | | | | | | | | | | | | |
| Secas | | | | | | | | | | | | | | | | | | | | |
| Novillos | | | | | | | | | | | | | | | | | | | | |
| Becerros | | | | | | | | | | | | | | | | | | | | |
| Subtotal Bovinos | | | | G31 | | | | G32 | | | G33 | | | G34 | | | G35 | | | G36 |
| ANIMALES DE TRABAJO | | | | | | | | | | | | | | | | | | | | |
| Bueyes | | | | | | | | | | | | | | | | | | | | |
| Mulas | | | | | | | | | | | | | | | | | | | | |
| Caballos | | | | | | | | | | | | | | | | | | | | |
| Burros | | | | | | | | | | | | | | | | | | | | |
| Subtotal animales de trabajo | | | | G37 | | | | G38 | | | G39 | | | G40 | | | G41 | | | G42 |
| TOTAL ESPECIES MAYORES | | | | G43 | | | | G44 | | | G45 | | | G46 | | | G47 | | | G48 |
| GRAN TOTAL GANADERIA | | | | G49 | | | | G50 | | | G51 | | | G52 | | | G53 | | | G54 |

COSTOS DE PRODUCCION PARA GANADERIA MAYOR

| | BOVINOS | ANIMAL/TRABAJO |
|---|---|---|
| 1. INSUMOS | | |
| 1.1. Medicinas y vacunas | | |
| 1.2. Alimentos balanceados | | |
| 1.3. Forraje verde propio | | |
| 1.4. Forraje verde comprado | | |
| 1.5. Rastrojo y paja propio | | |
| 1.6. Rastrojo y paja comprado | | |
| 1.7. Otros insumos propios | | |
| 1.8. Otros insumos comprados | | |
| SUB-TOTAL INSUMOS | | |
| 2. SERVICIOS | | |
| 2.1. Consulta veterinaria | | |
| 2.2. Flete o transporte propio | | |
| 2.3. Flete o transporte rentado | | |
| 2.4. Uso de potreros propios | | |
| 2.4. Pago de renta de potreros | | |
| 2.5. Pago de seguro ganadero | | |
| 2.6. Intereses de prestamos | | |
| 2.7. Inseminación artificial | | |
| 2.8. Alquiler de sementales | | |
| 2.9. Otros servicios propios | | |
| 2.10. Otros servicios rentados | | |
| SUB-TOTAL SERVICIOS | | |
| 3. COSTOS DE REPARACION | | |
| 3.1. Reparación de corrales | | |
| 3.2. Reparación de vehículos | | |
| 3.3. Reparación de implementos | | |
| 3.4. Otros gastos de reparación | | |
| SUB-TOTAL REPARACION | | |
| 4. COSTOS DE MANO DE OBRA | | |
| 4.1. Mano de obra familiar | | |
| 4.2. Mano de obra asalariada | | |
| SUBTOTAL MANO DE OBRA | | |
| 5. RENTA DE POTREROS | | |
| 5.1. Uso de potrero propio | | |
| 5.2. Renta de potrero | | |
| SUBTOTAL POTREROS | | |
| 6. OTROS GASTOS | | |
| 6.1. Impuestos | | |
| 6.2. Cuotas de asociaciones | | |
| 6.3. Otros | | |
| SUB-TOTAL OTROS GASTOS | | |
| TOTAL COSTOS DE PRODUCCION DE GANADO MAYOR | | |

PRODUCCION DE PRODUCTOS Y SUBPRODUCTOS DE LA GANADERIA

| | CANTIDAD | PRECIO PROMEDIO | VALOR TOTAL |
|---|---|---|---|
| LECHE | SPG1 | 2 | 3 |
| HUEVO | 4 | 5 | 6 |
| CARNE | 7 | 8 | 9 |
| MIEL | 10 | 11 | 12 |
| ESTIERCOL | 13 | 14 | 15 |
| OTROS | 16 | 17 | 18 |

## OTROS INGRESOS

OTROS INGRESOS POR VENTA, RENTA Y OTROS
(Ingresos ventas únicas, no confundir con las ventas de actividades permanentes de la tabla de características de la familia)

| | |
|---|---|
| 1. INGRESOS POR VENTA | |
| 1.1. Venta de productos | |
| 1.2. Venta de servicios | |
| 1.3. Otras ventas únicas | |
| 2. INGRESOS POR RENTA | |
| 2.1 Renta de Maquinaria | |
| 2.2. Renta de otros instrumentos de producción | |
| 2.3. Renta de casas o inmuebles | |
| 2.4. Renta de tierra | |
| 2.5. Renta de potreros | |
| 2.6. Otra renta | |
| 3. OTROS INGRESOS | |
| 3.1. Regalos de hijos no dependientes | |
| 3.2. Regalos de parientes | |
| 3.3. Otros | |

**ANEXO PARA MIEMBROS DE ORGANIZACION DE USUARIOS QUE MANEJAN INFRAESTRUCTURA DE RIEGO**

A.1. De quien fue la iniciativa de fundar la asociación de usuarios? **AN1** ⌊__⌋
1) De uno de los actuales dirigentes de la asociación
2) De los funcionarios de la CNA
3) De los de la CNC
4) De un grupo de usuarios
5) De otro _____

A.2. Usted se unió a la organización de forma voluntaria? **AN2** ⌊__⌋
1) Si 2) No

A.3. Usted está de acuerdo con que los usuarios de la irrigación se hagan cargo de la infraestructura de riego? **AN3** ⌊__⌋
1) Completamente en desacuerdo
2) Un poco de acuerdo
3) Muy de acuerdo
4) Completamente de acuerdo

A.4. Por qué _____ **AN4** ⌊__⌋
_____

A.5. Los miembros de la asociación de usuarios recibieron alguna capacitación para hacerse cargo del manejo y distribución del agua de riego? **AN5** ⌊__⌋
1) Si 2) No

A.6. En caso de SI ¿Como considera usted que fue la capacitación? **AN6** ⌊__⌋
1) Muy deficiente
2) En algunos aspectos deficiente
3) Buena en muchos aspectos
4) Excelente

A.7. ¿Usted considera que la asociación de usuarios ha podido manejar adecuadamente la infraestructura? **AN7** ⌊__⌋
1) Muy deficientemente
2) Bien en unos aspectos y mal en otros
3) Bien con mínimos problemas
4) Muy adecuadamente

A.8. ¿El gobierno le ayuda de alguna manera a la organización de usuarios?
1) En nada **AN8-1** ⌊__⌋
2) Con dinero **AN8-2** ⌊__⌋
3) Con asesoría **AN8-3** ⌊__⌋
4) Resolviendo conflictos **AN8-4** ⌊__⌋
5) Otra _____ **AN8-5** ⌊__⌋

A.9. Usted esta a gusto con su participación en la asociación de usuarios? **AN9** ⌊__⌋
1) Completamente inconforme
2) Un poco inconforme
3) A gusto
4) Muy a gusto

A.10. ¿Se considera usted dueño de la infraestructura de riego
1) Si 2) No **AN10** ⌊__⌋

A.11. En caso de SI, ¿Esto lo motiva a trabajar mas? **AN11** ⌊__⌋
1) Si 2) No

A.12. ¿Usted participa en las decisiones de la organización de manera efectiva? **AN12** ⌊__⌋
1) Nunca
2) Algunas veces
3) Casi siempre
4) Siempre

A.13. Todos miembros cumplen con sus obligaciones? **AN13** ___

1) Ningún miembro
2) Unos pocos
3) Casi todos
4) Todos

A.14. En caso de que alguien no cumpla con sus obligaciones de socio ¿Cuales son las sanciones que se impone a los infractores? **AN14** ___

1) No se les hace nada
2) Se les da una multa en dinero
3) Se les quita el agua
4) Se les excluye de la asociación
5) Se les reporta a la CNA
6) Tienen que pagar con trabajo después
7) Se les hace una llamada publica de atención
8) Otra _____

A.15. Quien resuelve los conflictos entre los miembros de la organización?

1) Los dirigentes **AN15-1** ___
2) La CNA **AN15-2** ___
3) La reforma agraria **AN15-3** ___
4) La CNC **AN15-4** ___
5) El mismo grupo **AN15-5** ___
6) Entre quienes tienen el problema **AN15-6** ___
7) Nadie **AN15-7** ___
8) Otro _____ **AN15-8** ___

A.16. Usted esta de acuerdo en como los dirigentes de la organización la han manejado? **AN16** ___

1) Completamente en desacuerdo
2) Un poco de acuerdo
3) Muy de acuerdo
4) Completamente de acuerdo

A.17. ¿Cuales son los 3 principales problemas de la organización de usuarios para manejar la infraestructura de riego?

1. _____ **AN17-1** ___
2. _____ **AN17-2** ___
3. _____ **AN17-3** ___

# APPENDIX B

**Demographic Characteristic of the Ejidatario-Farmer Families in 1987 at the Panuco River Irrigation Project**

| STRATA / CHARACTERISTICS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | TOTAL AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| FAMILY SIZE | 7.5 | 5.4 | 5.3 | 4.4 | 5.1 | 5.6 | 5.2 | 4.8 | 4.0 | 5.1 |
| DEPENDENT CHILDREN* | 5.5 | 3.6 | 3.2 | 2.7 | 2.9 | 3.6 | 3.2 | 2.5 | 2.0 | 3.1 |
| PERCENTAGE OF MEN | 40.0 | 57.4 | 60.3 | 60.0 | 58.3 | 57.1 | 50.0 | 63.2 | 58.3 | 57.4 |
| PERCENTAGE OF WOMEN | 60.0 | 42.6 | 39.7 | 40.0 | 41.7 | 42.9 | 50.0 | 36.8 | 41.7 | 42.7 |
| AGE | 16.9 | 22.9 | 21.3 | 21.3 | 23.6 | 23.2 | 27.0 | 22.8 | 37.4 | 23.1 |
| PERCENTAGE OF LITERACY (15 years and older) | 100.0 | 94.7 | 91.4 | 95.0 | 95.7 | 80.0 | 93.8 | 100.0 | 100.0 | 93.8 |
| YEARS IN SCHOOL (15 years and older) | 5.1 | 5.2 | 4.6 | 4.2 | 5.7 | 3.9 | 5.8 | 5.0 | 4.7 | 4.9 |
| AGE OF HOUSEHOLD HEADS | 38.5 | 41.0 | 40.2 | 40.6 | 44.7 | 50.4 | 52.8 | 47.8 | 56.7 | 44.3 |
| PERCENTAGE OF LITERACY OF HOUSEHOLD HEADS | 100.0 | 90.0 | 91.7 | 100.0 | 85.7 | 80.0 | 100.0 | 100.0 | 100.0 | 93.0 |
| YEARS IN SCHOOL OF HOUSEHOLD HEAD | 5.0 | 2.5 | 4.5 | 3.1 | 3.6 | 2.4 | 4.6 | 3.5 | 2.3 | 3.5 |

# APPENDIX C

**Demographic Characteristic of the Ejidatario-Farmer Families in 1995 at the Panuco River Irrigation Project**

| STRATA<br>CHARACTERISTICS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | TOTAL AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| FAMILY SIZE | 5.0 | 4.6 | 7.2 | 5.1 | 5.6 | 4.8 | 4.8 | 5.5 | 4.7 | 5.5 |
| DEPENDENT CHILDREN | 3.5 | 2.4 | 3.9 | 3.1 | 3.4 | 2.8 | 2.4 | 3.3 | 2.0 | 3.1 |
| PERCENTAGE OF MEN | 40.0 | 67.4 | 60.5 | 58.7 | 61.5 | 70.8 | 58.3 | 54.6 | 57.1 | 60.8 |
| PERCENTAGE OF WOMEN | 60.0 | 32.6 | 39.5 | 41.3 | 38.5 | 29.2 | 41.7 | 45.5 | 42.9 | 39.2 |
| AGE | 24.0 | 27.8 | 24.5 | 27.3 | 26.4 | 28.8 | 34.8 | 26.0 | 37.6 | 27.4 |
| PERCENTAGE OF LITERACY (15 years and older) | 83.3 | 90.9 | 96.4 | 91.2 | 95.7 | 81.2 | 90.5 | 100.0 | 100.0 | 92.9 |
| YEARS IN SCHOOL (15 years and older) | 4.5 | 5.6 | 5.5 | 5.5 | 5.2 | 3.8 | 7.3 | 5.7 | 5.7 | 5.5 |
| AGE OF HOUSEHOLD HEADS | 43.5 | 48.9 | 49.8 | 48.9 | 52.0 | 57.4 | 60.2 | 44.0 | 53.7 | 50.9 |
| PERCENTAGE OF LITERACY OF HOUSEHOLD HEADS | 100.0 | 90.0 | 91.7 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 96.5 |
| YEARS IN SCHOOL OF THE HOUSEHOLD HEAD | 5.5 | 3.3 | 3.7 | 2.8 | 3.1 | 1.6 | 5.2 | 7.0 | 6.3 | 3.8 |

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