

The Changing Living Standard of Farmers in the Yaqui Valley:

Looking Beyond the

“Green Revolution”

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The World
Food Prize

About CIMMYT

CIMMYT is an internationally funded, nonprofit scientific research and training organization. Headquartered in Mexico, the Center works with agricultural research institutions worldwide to improve the productivity and sustainability of maize and wheat systems for poor farmers in developing countries. It is one of 16 similar centers supported by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR comprises over 50 partner countries, international and regional organizations, and private foundations. It is co-sponsored by the Food and Agriculture Organization (FAO) of the United Nations, the International Bank for Reconstruction and Development (World Bank), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP).

Financial support for CIMMYT's research agenda currently comes from many sources, including governments and agencies of Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Canada, China, Colombia, Denmark, France, Germany, India, Iran, Italy, Japan, the Republic of Korea, Mexico, the Netherlands, Norway, Pakistan, the Philippines, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, the United Kingdom, Uruguay, and the USA, along with (among others) Cornell University, the European Union, the Ford Foundation, Grains Research and Development Corporation, the Inter-American Development Bank, the International Development Research Centre, International Fund for Agricultural Development, Kellogg Foundation, Leverhulme Trust, Nippon Foundation, OPEC Fund for International Development, Rockefeller Foundation, Sasakawa Africa Association, Stanford University, Tropical Agriculture Research Center (Japan), UNDP, University of Wisconsin, and the World Bank.

Preface

The World Food Prize Youth Institute sponsors a seminar through which students are able to research a topic related to food security and present it for discussion at the annual conference. This year, The World Food Prize Foundation took the institute one step farther with the creation of an internship program. Selected interns pursue an eight-week program of study at a research institution employing a World Food Prize laureate. I was selected to study for the summer at The International Maize and Wheat Improvement Center (CIMMYT) near Mexico City. Even though CIMMYT does not employ a World Food Prize laureate, Dr. Norman E. Borlaug, 1970 Nobel Peace Prize laureate, helped to establish this institution and continues to act as a consultant for the programs.

My interest in international economics and politics led me to the Economics Program. Under the direction of Dr. Prabhu Pingali, Economics Program Director, I have studied the effects of the "Green Revolution" and the reform of Article 27 of the Mexican Constitution on the lives of Yaqui Valley farmers. During the internship, I traveled to the Yaqui Valley in Sonora, Mexico, to experience firsthand the living standard changes of wheat farmers. The following essay is an independent-study project that incorporates interviews and research on the topic.

(Photo: CIMMYT)



Dr. Norman Borlaug, 1970
Nobel Peace Prize laureate

The World Food Prize

The World Food Prize, considered to be the "Nobel Prize" for food, is awarded each October in Iowa to an outstanding individual who is designated as The World Food Prize laureate. The laureates are recognized for their contributions to human development by improving the quality, quantity, or availability of food in the world.

The Prize emphasizes the importance of a nutritious and sustainable food supply for all people. By honoring those who have worked successfully toward this goal, The World Food Prize calls attention to what can be accomplished in the future.

Dr. Norman Borlaug, a native of Cresco, Iowa, and winner of the 1970 Nobel Peace Prize for his work in world agriculture, envisioned a prize that would honor individuals who have made significant and measurable contributions to improving the world's food supply. Beyond recognizing these people for their personal accomplishments, he saw The Prize as a means of establishing role models who would inspire others. His vision was realized when The World Food Prize was created.

The World Food Prize is sponsored by businessman and philanthropist John Ruan, and is administered by The World Food Prize Foundation located in Des Moines, Iowa, USA.

The World Food Prize Youth Institute

The World Food Prize Youth Institute was introduced by The World Food Prize Foundation in 1994 to increase the awareness of The World Food Prize among Iowa youth. The Institute provides an educational opportunity for Iowa youth to interact with The World Food Prize laureates and other world leaders on critical issues relating to food security throughout the world. The Institute is further designed to attract and motivate dedicated young Iowans to consider careers in food, agriculture and natural resource disciplines.

Introduction

Over the years since Mexico achieved independence in 1821 there have been many economic and structural obstacles to overcome. The obstacles have included rising inflation, the fluctuating global markets, the oil crisis of 1986, and the latest devaluation of the peso in 1994. The Mexican government has been able to overcome many of these obstacles through the use of producer and consumer subsidies in the agricultural sector. The subsidies have increased dramatically since 1965 when the government placed a strong focus on the guaranteed price system. This system opened the door for numerous other programs to help both producers and consumers. Following Mexico's entrance into the General Agreement on Tariffs and Trade (GATT) in 1986 and the North American Free Trade Agreement (NAFTA) in 1994, the government changed its policies on agricultural practices. These policy changes have affected the lives of farmers in Mexico.

This essay will examine some of the living standard changes of seven wheat farmers who worked in the Yaqui Valley, Sonora, Mexico, during the time of the "Green Revolution" as well as the reform of Article 27 of the Mexican Constitution in 1992. The "Green Revolution" is a continuing process marked by different phases. During the beginning of the "Green Revolution" there were substantial increases in yields throughout the world. Today we are facing a new phase of the "Green Revolution" where yield curves have begun to level or even stagnate in many regions of the world. Thus, we must

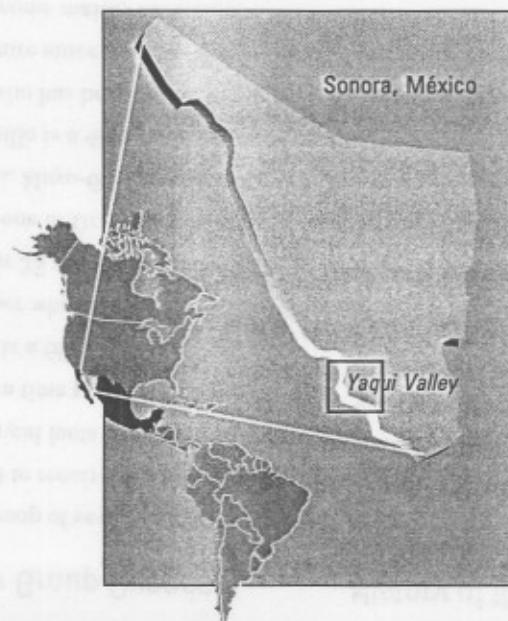
develop new methods different from those implemented in the past.

Over 25 years after the beginning of the "Green Revolution," the Mexican government recognized the need for reform in the agricultural sector. This reform came through the changes in Article 27. The main challenges and triumphs of the producers will be viewed alongside technical and statistical information from The International Maize and Wheat Improvement Center (CIMMYT) and the Mexican Agricultural Research Center of the Northwest (CIANO).

Yaqui Valley Background

The Yaqui Valley is located in northern Mexico in the state of Sonora (see map). This region is between N 26° 45', 27° 33' and W 109° 30', 110° 37' at an altitude of 40 m above sea level. Due to its arid climate, irrigation systems

have been of utmost importance. Dr. Borlaug began working for Mexico's Office of Special Studies in 1944. His research helped to expand the capabilities of the developing area. According to the Secretariat of Agriculture and Rural Development (SAGAR) and the Centro de Estadística Agropecuaria, in 1996 Sonora had a wheat production of 989,562 tons. This was 29.3% of the total wheat production in Mexico on 21.7% of the cultivated land. Over the last seven years Sonora has averaged 32.8% of the total wheat production in Mexico. In addition, the Yaqui Valley is the leading wheat producer in Sonora. These statistics have remained similar to those during the "Green Revolution." Since the Yaqui Valley has remained a major producer of wheat, it is fitting to listen to the stories of families who have cultivated the land since the beginning of the "Green Revolution."





(Photo: CIMMYT)

Harvest season in the Yaqui Valley

Survey Group Overview

A group of seven farmers were surveyed to receive their comments on historical facts and consequences of the two time periods. Balbanedo Cubedo is a 69-year-old private landowner who has been growing wheat for 35 years. He remembers back to one of Dr. Borlaug's first varieties, Mayo-60. Ernesto Beltrones Hermosillo is a 40-year-old private owner who has been active in agriculture since the late 1970s. His stories come mainly secondhand from his father's experiences. Daniel Montes is a 66-year-old *ejido* farmer (see box) who works on one of the plots of "communal land" (Smith 1989) distributed by the government to the peasantry. He has been in agriculture for 38 years. Ernesto Maldonado Valenzuela is a 52-year-old *ejido* leader of Ejido Atotonilco. Silvestre Valenzuela is a 49-year-old collective *ejido* member in Ejido Primero de Mayo. He works five hectares, the smallest number in the survey group. Federico Wallex is a 76-year-old private owner of 27 hectares. He has taken the greatest risks out of agriculture by renting-out his land. Jesus Castelo Roblez is a 76-year-old private owner of 36 hectares. He has been in agriculture for 60 years and is the father of seven children. The stories of these farmers will be presented collectively throughout the body of this essay.

History of the "Green Revolution"

It is fitting to begin with the person who is widely known as the "Father of the Green Revolution." Dr. Borlaug received his Ph.D. from the University of Minnesota before being selected as the head of the wheat program of Mexico's Office of Special Studies in 1944. President Manuel Avila Camacho promoted this office in 1941 which was funded partly by the Rockefeller Foundation (Alcantara 1976). When Dr. Borlaug began working in the Yaqui Valley, yields averaged 0.75 t/ha (CIMMYT data). Through the innovations in his varieties and greater use of inputs, average Yaqui Valley yields gradually rose to 1.386 t/ha in 1950 to 2.49 t/ha in 1960 (CIMMYT data). Dr. Borlaug's first varieties included Yaqui 48, 50 and 53; Chapingo 52 and 53; Mayo 48 and 54 (Alcantara 1976). With the introduction of semidwarf varieties in 1961, yields jumped to 3.857 t/ha by the end of the decade (CIMMYT data). Before the development of dwarfing varieties, the wheat plants were susceptible to falling over. This was due in part to the increase in fertilizer use which led to extra grain weight on weaker straw. New semidwarf varieties were able to increase the grain weight from 25 to 35% of the total weight in tall plants to 40 to 50% in semidwarf plants (CIMMYT 1992).

During the 1940s and 1950s India had experienced detrimental famines and national food security problems. When the government saw the increased possibility of another famine in the mid-1960s, they imported 18,000 tons of

What is an Ejido?

The basic definition of an ejido given by the *Harper Collins Spanish Dictionary* is a "communal land" (Smith 1989). This definition is elaborated when viewed in the context of the Mexican agricultural sector.

Since the peasant uprising in 1910, the Mexican government has been faced with numerous land tenure issues (see figure). These issues relate to the distribution of land to peasantry in rural areas. Through the success of the peasant uprising and pressure of the Zapatista-Villista coalition, the Agrarian Reform Decree was issued on January 6, 1915 (Thiesenhusen 1996). This decree was later referred to in 1917 in Article 27 of the Mexican Constitution.

In 1911, 15 million peasants, or 95% of the rural families, were landless (Thiesenhusen 1996). Up until 1934, there was little accomplished in Mexico on the part of agrarian reform. When President Lazaro Cardenas took office in 1934 he sought to bring about changes in the agrarian system of Mexico. Within the next six years, Cardenas redistributed 20 million hectares to 810,000 people (Thiesenhusen 1996). This vast distribution of land was in the form of ejidos. "The establishment of the ejido has long been thought to have formed the basis for Mexican political stability in the countryside" (Randall 1996, 7). "Cardenas stood firmly on the principle that the land belongs to those who work it...Cardenas clearly meant to throw the full power of his office behind a dramatic, large-scale land distribution" (Thiesenhusen 1996, 36).

The reforms continued for many years, with each successive President contributing to the agrarian reform. Laura Randall stated that the ejido is "traditionally a symbol of the government's concern for the poor" (7). With the initial start of reforms by Cardenas, between 1930 and 1940, the number of landless laborers declined by more than 50% (Thiesenhusen 1996).

In 1991, President Carlos Salinas de Gortari decided to stop the agrarian reforms (Thiesenhusen 1996). The next year, the Mexican government rewrote Article 27 to give the ejidatarios more rights to their land. This gave farmers more security in making improvements to the land and allowed them to use it as collateral if they followed the process to receive a title. The main change has allowed ejidatarios to sell or rent the land. Kristen Appendini wrote, "The 1992 reform of the land tenure law (Constitution Article 27) is the essence of the rural reforms because it is the utter expression of the dismantling of the agrarian institutions that dominated the countryside from the end of the Mexican Revolution" (65).

With the reform of Article 27, Programa para la Certificacion Derechos Ejidales y Titulacion de Solares Urbanos, PROCEDE, was established by the Mexican government to issue property titles for the ejidal lands. According to Dr. J. David Stanfield of the University of Wisconsin Land Tenure Center, as of 1995, there were approximately 29,800 ejidos in Mexico that covered 105 million hectares. He continued to write that this land was held by 3.5 million ejidatarios.

There have been numerous reforms in the agrarian system of Mexico in the last seventy years allowing more people to receive a portion of land. Although distribution of additional ejidal land has been stopped, development of the land will continue for years to come.



Source: *Reforming Mexico's Agrarian Reform*, J.D. Stanfield.



Dagoberto Flores, of the CIMMYT Economics Program, interviewing Yaqui Valley farmers

semidwarf wheat seeds (Shah 1998). With implementation of new technology and policy support, India was able to rapidly increase food production and evade the consequences of another famine. This success story is most notably referred to as the beginning of the "Green Revolution" in India.

In Mexico the implementation of new varieties was increasing annually. Because of the overwhelming popularity of Dr. Borlaug's innovations, the Office of Special Studies opened an information center to distribute the recommendations and facts about the new varieties (Alcantara 1976). This information was presented to farmers in the area for adoption into their practices. With the help of technicians, the groundbreaking technology was passed from researchers to producers for implementation. The changes and advantages of the "Green Revolution" kept increasing into the formation of permanent organizations to research wheat varieties. Due to these changes, the lives of the Yaqui Valley farmers were drastically changed for the better

by obtaining higher yields and net incomes. They were then able to look beyond their immediate family needs and market their crop to the national community.

The extension into the national community began to increase each year with greater yields. By the mid-1960s, the government was beginning to provide subsidies to farmers to increase the number of producers. This time period had a great influence on the family situations in the Yaqui Valley. Most of the farmers look back upon that period with great joy and respect for the work of Dr. Borlaug. Many attribute their success to his varieties.

Mexican Government Reform

There have been many policy changes in Mexico that have directly affected the farmers and therefore the economy during the last five to eight years. These changes include, but are not limited to, the entrance into NAFTA, the GATT Uruguay Round in 1994, and the World Trade Organization, WTO. With these changes in mind, the Mexican government rewrote Article 27 of the Constitution. This article relates to the ejido sector and the Agrarian Laws of 1915. In the past, the government saw only a few farmers holding most of the land. This observation led to the government taking some of the land from private owners and redistributing it to the peasantry in the form of ejidos. These lands were held in common among a group of people. This system

accomplished its goals during that time, but later came under great controversy. The process led to small, fractured plots contributing to low, inefficient production. Smaller farmers were unable to implement new technology, make capital investments, or improve their land because of the land size.

In 1992, Article 27 gave the ejidatarios rights over their land allowing them to sell or rent the property. Article 27, Section 15 states that the maximum amount of land any individual can hold is 100 irrigated hectares. This amount is increased to 2,500 ha for groups of people holding the land together. The ejidatarios, people who received land from the government in the past reforms, benefited from the changes in the Article. Now, they have the property rights to their own land.

Economic Policy on Agriculture

The living standard of the farmers was also affected by the policy changes reverberating from the reform of Article 27. Guaranteed prices were removed, many input distribution organizations were privatized, and irrigation systems were gradually handed-over to farmers. The government took a more *laissez faire* approach to microeconomic policy. These decisions were made to help prepare farmers for competing in international markets. Contrary to the government's expectations, there has been a decline in the agricultural living standard in the Yaqui Valley because of

lower product prices and inflated input costs. Dr. Prabhu Pingali, CIMMYT Economics Program Director, and Dr. Sanjaya Rajaram, CIMMYT Wheat Program Director, wrote that one of the changes expected in the wheat sector will be a "long term decline in real wheat prices coupled with rising costs of inputs, especially labor, land and water" (Pingali and Rajaram 1997).

To better understand this decline, the reasons for privatization and elimination of many guaranteed prices, one must consider Mexican agricultural policy. In 1986, Mexico joined GATT. This decision led to reductions in tariffs and the gradual elimination of many guaranteed prices. In the late-1980s, the government decided to phase-out guaranteed prices to encourage the development of high-quality goods that could be sold in the international market. This modernization strategy included a change in the market infrastructure by placing an emphasis on privatization. In 1992, after the government's last subsidy payment to the Mexican Fertilizer Company, Fertimex, of US\$294 million, the agency was privatized (OECD 1997). Privatization also included many banks and the national railway, Ferronales. These changes were extended when Mexico decided to join NAFTA; all tariffs will be eliminated by 2008. With numerous changes in the markets, input industries, and economic policy, the government decided it needed to fund the agricultural sector in some way to compete with the global market.

Rising inflation and fluctuating prices gave the Mexican government good reason to start the Program of Direct Payments to the Countryside, PROCAMPO, a form of funding which was paid directly to farmers based on their land area. These direct payments took the place of the previous system of subsidizing the purchasing price of the crop. The farmer had to be cultivating one of nine crops to receive the direct payment. These crops were maize, beans, wheat, sorghum, rice, soybeans, safflower, cotton, and barley. In 1994, PROCAMPO helped 3 million farmers at a cost of US\$1.4 billion. In 1995, the payment per hectare was reduced, so the expenditure was reduced, in turn, to US\$900 million (OECD 1997).

There were many reasons for the change in policy from price subsidy to direct payment. The clearest reason is the decrease in administration. It is much easier for the government to keep records of the amount of land farmers own in comparison to fluctuating yields from year-to-year. This reduces the cost the government must withstand in supporting the program. In both programs larger farmers usually benefit more than smaller farmers. In the past system, farmers with larger holdings seemed to receive more subsidies because they could implement the technology, improve the land, and therefore obtain greater yields. This new system again gives larger farmers more subsidies because of their property size.

It is interesting to see how the seven farmers interviewed for this study view the policy changes. Montes said the guaranteed price was a great support during the "Green Revolution." Cubedo said the government gave more support in seed and equipment during the "Green Revolution." He believes the guaranteed price was a good way to get the people to plant. Now, Cubedo sees an uncertainty in planting certain crops. He said that you do not know the price you will receive until the end of the cycle. This decision can become difficult with the numerous climatic changes. E. Valenzuela is disappointed in the PROCAMPO policy because he does not feel he is receiving a fair price. He said the price of inputs is increasing while the price of the product has stabilized. He thinks there are many problems with the new government policies.

This trend of decreasing subsidies can be seen in the lives of the farmers. During the "Green Revolution" farmers were content with improving their techniques and increasing their yield. The support of the government was a great benefit for those involved in agriculture. Now, the lives of the people have changed drastically. The government has reduced the price supports at a time when the people could use the money the most. In 1986, there was only a 25% difference in the average wage of agricultural workers and the average wage of all employees in Mexico. In 1992, the average difference was 85% (OECD 1997). This is one clear sign of the relative

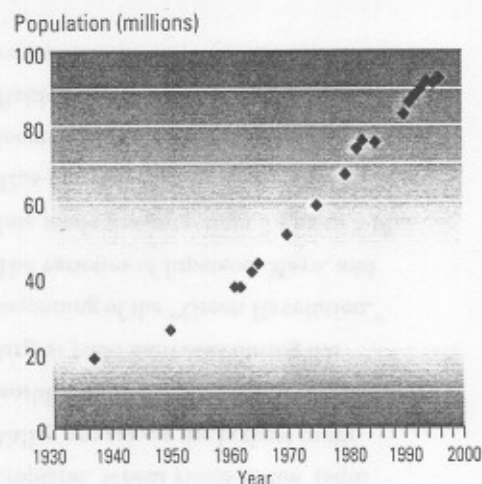


Figure 1. Mexico: population trends. Source: FAO Production Yearbook.

decrease in income for the average farmer. This can be, in part, attributed to the rising population of Mexico (Figure 1). During the time period surrounding the "Green Revolution," the population grew at an average annual rate of 3%. Between 1980 and 1990, the annual population growth rate decreased to 2.3% (OECD 1997). During this time period the population growth rate of 2.3% has been higher than the economic growth rate. During the "Green Revolution," the growth in the economy was much higher, contributing to the ability to feed the growing population.

Comparison of CIMMYT and CIANO

A few organizations have been formed to help increase food security in Mexico and productivity of the farmers, and allow them to obtain better standards of living. Two of the main organizations stationed in Mexico with this goal in mind are CIMMYT and CIANO. M.C. Jose de Jesus Martinez Santana of the CIANO Wheat Program stated that CIANO spends only 20% of its time on breeding. This is compared to CIMMYT's larger dedication to breeding. Santana believes that there are many other aspects related to agriculture that must be researched. He said, "Variety plays an important role, but there are some other components." CIANO researches soil preparation, seeding method, seed rate, variety

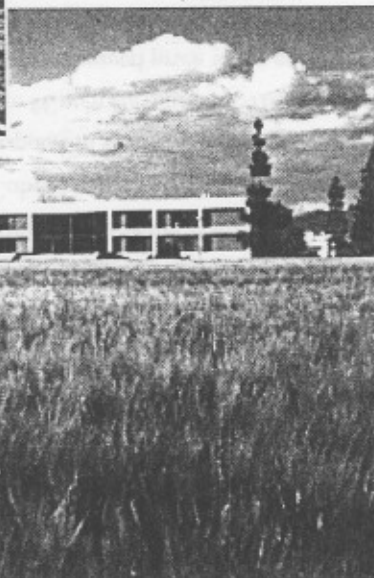
(breeding), irrigation, fertilization, weed control, insect control, and disease control (Figure 2).

CIANO is able to effectively research crop management because it is site-specific to northwest Mexico. Their goal is to improve the productivity of farmers in that region. CIANO is an organization of the Mexican government, therefore their research and development is conducted at the national level. CIMMYT, on the other hand, employs a few agronomists to study these areas, but the main focus has been and remains on breeding. CIMMYT's mandate is also different from CIANO's, in that CIMMYT works for sustainable food solutions internationally. Breeding conducted by CIMMYT can be implemented in various parts of the world and is not only focused on one region.

CIANO headquarters
in Sonora, Mexico
(Photo: CIMMYT)



CIMMYT headquarters
in El Batan, Mexico
(Photo: CIMMYT)



Living Standard Changes of Yaqui Valley Farmers

There are a few factors that are easily compared to see the changes in the standard of living experienced by farmers. One factor is yield of the cropland. Wheat yields in the Yaqui Valley are among the highest in the world (Figure 3). Roblez saw one of the largest yield increases during the beginning of the "Green Revolution." The varieties of Jupateco, Mayo, and Inia made the jump from 3 t/ha to 5 t/ha. This increase greatly affected his income from the 36 hectares he owns. Roblez had some valid points about the recommended varieties. He said there is

a difference in the seeds from one store to another so it affects the CIANO recommendation. Although he said this, he continued by saying there has never been a year when he lost money. Due to his success in farming, he has been able to send all seven of his children to the universities. Cubedo was able to increase his yields by 0.5 t/ha by implementing the new varieties during the revolution. He said he has a very favorable opinion of the "Green Revolution." He believes it occurred because of the recommended varieties.

Dr. Rajaram has recognized the leveling effect of the varieties' yields in the Yaqui Valley. He said the average yield should be 6.5 t/ha in the Valley. This past year, Yaqui Valley farmers came the closest with an average of 5.7 t/ha. According to Dr. Rajaram, the CIMMYT Wheat Program is currently working to develop a "super wheat" variety that could produce 10-11 t/ha on experimental stations and 8-10 t/ha on farms. He said there are many variables that affect the production in the Yaqui Valley. The variables include the amount of water in the dam for irrigation, the climate, and the size of the farms.

Indicators of the Standard of Living

One important determinant of farmers' standard of living is net returns per hectare farmed. Net returns show the profitability of wheat production in a specific area. The CIMMYT Economics Program has compiled production and yield data over the last 17 years to aid in computation of net returns to wheat

production in the Yaqui Valley. Figure 4 shows a decrease in average net returns of farmers in the Yaqui Valley over the period from 1987 to 1994. In the years leading up to and immediately following the reforms, the profitability of wheat farming was rapidly falling. This decline seems to have reversed, as the last survey data shows a turnaround. Although returns began to rise in 1995, farmers have still not been able to achieve the same net returns they received in the 1980s. The gradual rise may have resulted from implementation of Article 27 reforms; some low-productivity, inefficient farms have been eliminated to have an increase in high-productivity, high-yield farmland.

Farm size has contributed to many aspects of farmer income. There are two main distinctions between the farm types. Some are private, while others are ejidos. In 1991, the average private farm at the national level was 55 ha. The average ejido was 12 ha. Eight hundred and twenty-three thousand ejido farms had two or fewer hectares (OECD 1997). Due to this fragmentation in land, many farmers do not have adequate resources. Because of the lack of resources they cannot implement all of the recommendations of researchers. S. Valenzuela has five hectares of land and six people in his family. He said that he would need at least 20 hectares to live a decent life. Due to these circumstances he has had to supplement his income with another job. His small amount of land is attributed to the reorganization of his

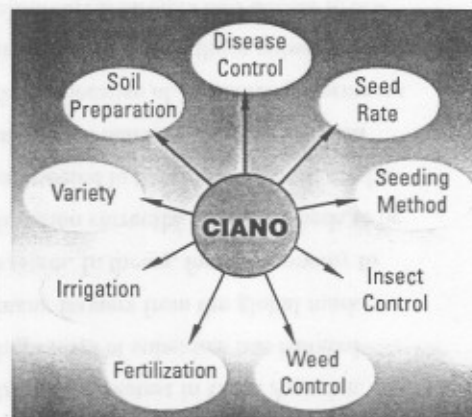


Figure 2. CIANO research.
Source: M.C. José de Jesús Martínez S., CIANO

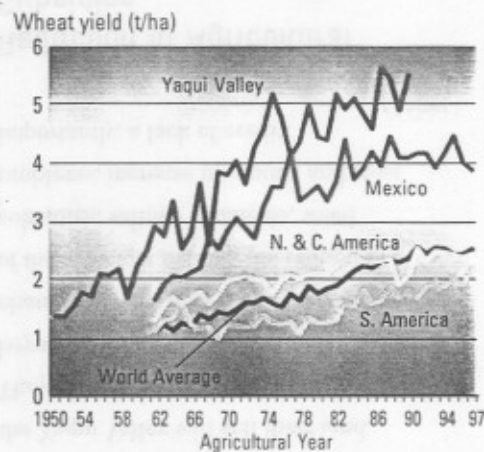


Figure 3. Comparison of world wheat yields to the Yaqui Valley.
Source: FAO Production Yearbook, CIMMYT.

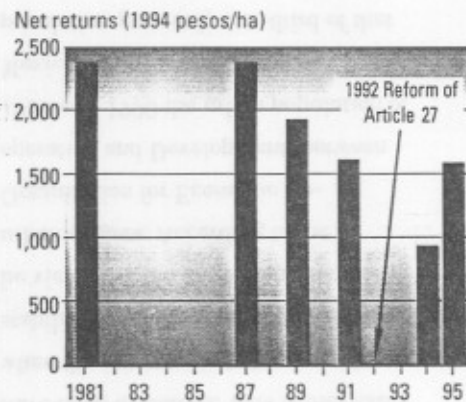


Figure 4. Net returns to wheat production, Yaqui Valley, Mexico, 1981-95.
Source: CIMMYT, Banco de México.
Note: Blank years reflect insufficient data.

ejido in 1989. The ejido was created in 1975 and organized collectively. Since the leaders weren't spending the money correctly, they split into sectors of two or more people.

Renting farmland has become a growing trend in the Yaqui Valley. Wallex is a private owner with 27 hectares. He thinks the rising costs of inputs and the decrease in product prices makes it impossible to farm the land except perhaps on a very large scale. The rate he uses for rent of his land is M\$2,800 per hectare per year. He believes this is much lower than the average. Santana believes that a farmer needs 40-60 hectares to live a good life. He said 60 ha made more money in 1970 than 300 ha now. He said, "The poor can't compete with the rich farmers." In his opinion it is better for farmers with seven hectares to rent the land. This relates to the concept of economics of scale in agriculture. On average, the production costs on small farms are much higher than the cost on larger farms. There is an inverse relationship present between the production cost and amount of land. This concept leads to the consolidation of land to be more suitable for competition. Larger farmers are able to improve land, invest in capital resources, implement new technology, and therefore increase productivity. In order for the economy of the country as a whole to increase, the smaller, inefficient farms need to be eliminated. This allows for an increase in productivity on a much larger scale.

Because of these policy changes to increase the economic growth, people have been displaced. This is inevitable when the initiative is to increase the stability of the economy. The result can be viewed by the large migration to the urban centers. According to the Organization for Economic Cooperation and Development, between 1950 and 1990 the urban population of Mexico grew fivefold. The rural population grew only one-third of that amount.

E. Valenzuela has had experience as the leader of his ejido. He forecasts that in ten years over 100 farmers in the Yaqui Valley will sell their land. They all continue to say that factors beyond their control have hurt their chances of making a good living. Some of these factors include the reduction in subsidies, salinity problems, weed problems, increase in inputs, and most importantly, a lack of credit.

Reduction in Agricultural Subsidies

Over the years, government support to agriculture in Mexico has been the greatest in Latin America. The high level of subsidies has isolated many farmers from the global market system. In theory, for the economy to function correctly, the farm needs to be connected to the product, land, credit, and input markets. This connection failed because of excessive government intervention. Once these subsidies were eliminated, farmers had access to few markets. In addition, the ejido land did not officially have a value because prior

to 1992 it was unable to be sold or rented. There have been many problems associated with eliminating subsidies, and therefore allowing the farmers to participate in the international market environment.

One particularly large obstacle for farmers during the "Post-Green Revolution" era has been receiving credit from the banks. Before the reform of Article 27, the farmers were hurt by rising interest rates, loans on default, and many other problems relating to the distribution of credit. During this time period it was difficult for the ejidatarios to receive credit. They did not own the land, so they could not use it for collateral. E. Valenzuela said it is hard for the farmers to obtain credit because of past bad loans. He said many of the bad loans were because of the drop in the price of cotton and freezes, which have affected watermelon and vegetable crops. He believes one of the greatest problems was when the farmers wasted money on other areas not related to farming. Hermosillo said that during the "Post-Green Revolution" era there have been many more requirements to receiving financial aid. Mainly, the farmer needs to show he is putting the money into the land. Montes received credit from Bancrícola during the revolution. He contradicted some of the other farmers by saying the policies have remained relatively the same because one still must give the bank collateral. According to Montes, before the revolution credit was given only to private property owners. In the "Post-

Green Revolution" era, ejidatarios could receive credit if they met the requirements. Wallex has followed the growing trend of renting the land because then he does not have to worry about the credit.

Since the monetary policy of the Mexican government was tightened, it has become more difficult to obtain loans. Roblez has not had any problems obtaining loans because he has used a private bank instead of the government bank, Banrural. S. Valenzuela has experienced the more difficult side of receiving loans. He said there is limited credit, more requirements, and the farmer needs to show he has a sufficient number of workers. He only has five hectares, so he is having trouble obtaining credit for the inputs. In addition to these problems, the agricultural sector has been burdened by the late time of issuing the loans. When the loans were issued late, some farmers were unable to apply the recommendations of CIANO.

In 1990, the Solidarity Fund for Production began providing interest-free loans, which did not require insurance or collateral. These loans were only available to farmers with no more than 3 hectares of rainfed, low-productivity land. Between 1990 and 1995, the fund provided US\$1.2 billion in agricultural loans. Only 47% of the loans were recovered (OECD 1997). The other 53% were not recovered most often because of natural disasters or poor production not due to the fault of the farmer. "When farmers are able to demonstrate that they tried to produce

but failed, the loan is forgiven" (OECD 1997, 86). Due to the change in the Mexican monetary policy after the decrease in the value of the peso in 1994, there have been changes in the banking industry. It is interesting to note that none of the farmers interviewed mentioned the Solidarity Fund. This could be related to the fact that the smallest farm in the survey was five hectares. Even though these changes have benefited some in the agro-industry, there are still many who cannot obtain credit. These are the people the government needs to start to focus upon to increase the productivity of the country. It is only after one speaks with someone in the same situation as S. Valenzuela that he/she can truly understand that many farmers are still in need of government support.

One of the greatest contributors to the increase in production and decrease in income is fertilizer, whose distribution has recently been opened to the market system. Many of the farmers said that in the last few years, fertilizer prices have risen dramatically. When coupled with the increase in use, the farmers have to absorb a large cost increase. Cubedo followed the fertilizer recommendations during the beginning of the "Green Revolution." Before the revolution he applied 120 kg/ha of N. In the "Post-Green Revolution" era he applied 240 kg/ha. This increase in fertilizer produced yield increases. Net income problems began when the cost of fertilizer increased, product costs decreased, and yields stabilized. Roblez was very cautious during the

"Green Revolution" to be sure not to damage the land. Before the revolution he applied 50-60 units of ammonium nitrate/ha. He was using new wheat varieties, but the yield had stabilized. Then he followed the recommendation to apply 120-130 units/ha and the yield increased 2 t/ha. Now he admits to applying an abundance of fertilizer to be sure the yields remain high. This belief in using large amounts of fertilizers has been one of the largest problems facing CIANO. The continuation of applying more fertilizer than necessary has both dramatically hurt the incomes by raising production costs and adversely affected the environment. Santana estimates that in 1960 the total production cost of the wheat harvest was 25%. In 1980, this increased to about 30%. Today, he estimates the production cost to be almost 50%. CIANO is working with the farmers to implement their recommendations of less fertilizer, seed, and water.

The cost and consumption of fertilizer has affected the income of the farmers in the Yaqui Valley. A study conducted by Dr. Ivan Ortiz-Monasterio, CIMMYT Agronomist, for Stanford University and the University of California at Berkeley concluded plants recover only 30-40% of nitrogen applied during that cycle. This has cost the farmers in the larger quantities they are applying. He said that in 1992 the greatest cost of production was land preparation. This year the greatest cost

has been fertilizer. Santana said that CIANO recommendations have pushed for 30% less use of fertilizers. This action should help to reduce the production cost.

New Initiatives

Breeding new varieties has taken an important role in CIMMYT's research to increase wheat production. Varieties have been developed to withstand the diseases of the Yaqui Valley, while maintaining high yields. The CIMMYT Economics Program has compiled data on the wheat varieties most widely used in the Yaqui Valley. Many of the farmers in the survey stated that Jupateco was the main variety that produced high yields. In the 1975-1976 growing season, 60.5% of the wheat farmers in the Yaqui Valley reported planting Jupateco. This

number increased to 71% during the following growing season (D. Flores, CIMMYT). Hermosillo said he planted Jupateco and received yields of 5 t/ha. Roblez said that once he applied the correct amount of fertilizer, the new varieties, including Jupateco, increased their yield to 5 t/ha. He said his yields have remained constant and with new varieties he is confident the yields will increase. In the 1997-1998 growing season, 73.8% of the total area of wheat in the Yaqui Valley was planted with Altar, a variety released in 1984 (D. Flores, CIMMYT).

This year was an exceptional year for the farmers in the Yaqui Valley. S. Valenzuela and Montes both reported yields of 8 t/ha. There is a reluctance to speculate what the next season's yields will average because of the current water problems in the Yaqui Valley. Dr. Rajaram stated that 1974 was the last time the dam had the low levels of water the farmers are currently seeing.

Low water levels in the dam near the Yaqui Valley contribute to agricultural concerns



He reiterated that farmers could still have yields of 5 t/ha with only two irrigations.

The CIMMYT Wheat Program is currently researching the possibility of higher yield varieties that could be implemented in the Yaqui Valley. Dr. Pingali and Dr. Rajaram wrote, "Three distinct but inter-related strategies are being pursued for achieving a dramatic shift in the wheat yield frontier: changes in plant architecture; exploitation of heterosis (hybrid wheat); and wider genetic resource utilization" (Pingali and Rajaram 1997). They continued to write, "Significant progress has been made on all three areas and the prospects for a substantial shift in the yield frontier within the next decade are high."

Economic Consequences of Reduction in Organic Material

Soil research at CIANO has provided valuable information into the reasons for decreasing organic material and increasing use of inputs. Dr. Javier Uvalle, CIANO Head Soil Scientist, stated that agricultural technology has had a damaging effect on the quality of the land in the Yaqui Valley. Between 1950 and 1954, the organic material content of the soil was 2%. This amount was in equilibrium with the ecosystem. Fifty years later he said the soil has lost 50% of its organic material. Some of the factors that have contributed to this loss include: 1) burning of residuals, 2)

furrows wash away the organic material, 3) intensive rotation of crops, 4) soil alkalinity, 5) salinity, 6) compacted soil.

Today, farmers apply more fertilizer and use more water to compensate for salinity problems that cause an increase in osmotic pressure. This increased pressure inhibits the transfer of water and nutrients to the plant. The compacted soil has also led to many problems in nutrient and water transfer for farmers. According to Dr. Uvalle, before the "Green Revolution" water passed through the soil at a rate of 4 cm/hr. Now, water is moving at a rate 100 times slower. The high alkalinity has also made it more difficult for the fertilizer to function. Even though all of these problems have developed during the "Post-Green Revolution" era, Dr. Uvalle still believes the revolution was

a great event for the farmers. He stated that there are a few ways to alleviate this problem (Table 1). Farmers must recover the organic material by stopping the residual burning and clear the canals of the weeds so their seeds are not deposited in the fields. These actions would be a large step for the farmers in trying to recover the organic material in the land. The drawback is the risk of it costing them part of their income. Since organic material has been reduced, it is inevitably going to cost farmers more money to apply additional fertilizers and water.

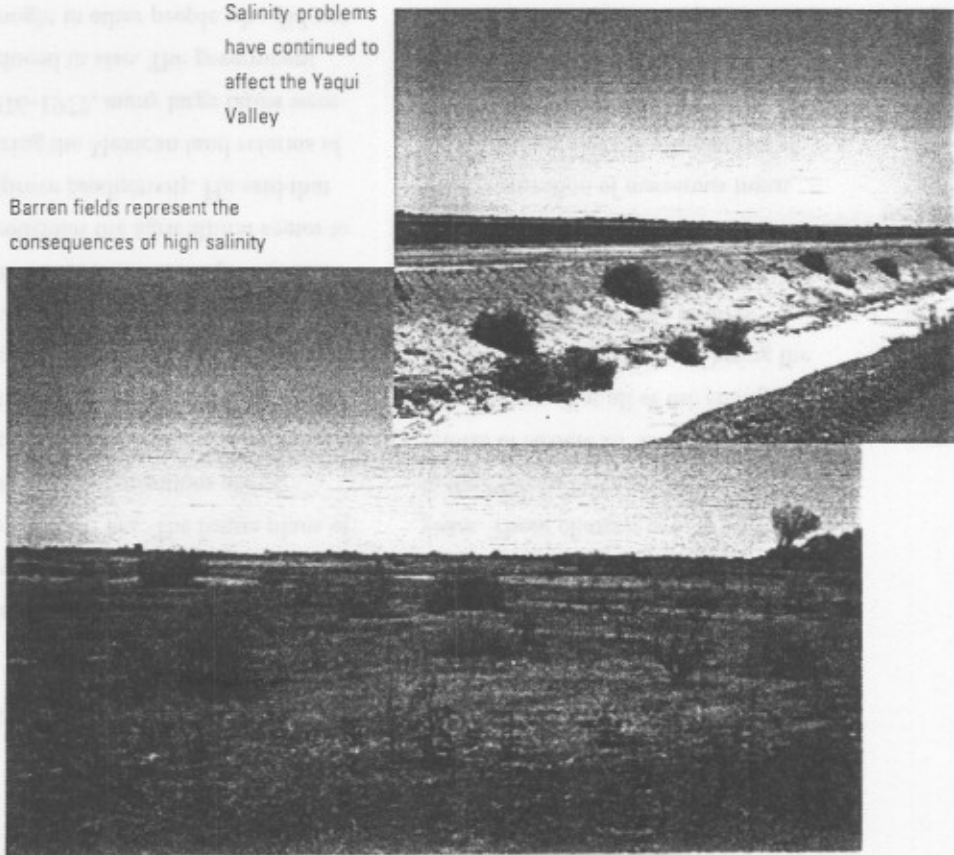
Table 1. Factors to improve soil content

1. Stop the residual burning
2. Conservation tillage
3. Clear the irrigation canals of weeds

Source: CIANO.

Salinity problems have continued to affect the Yaqui Valley

Barren fields represent the consequences of high salinity



In order to reduce fertilizer and water use, many farmers have looked to organic material to improve the soil. Montes decided to apply organic fertilizer to 20 hectares three years ago. He said he was surprised to see the yield increase by 0.6 t/ha. This is a process that many of the farmers would like to adopt, but the price is too high. According to Dr. Uvalle, a yield of 5 t/ha requires 200 kg of N. Four hundred kg of urea or 40 t of chicken manure can achieve this amount. The chicken manure costs M\$2,000/ha and the urea costs M\$800/ha. The farmers in the Yaqui Valley also don't have the right equipment to apply the manure effectively. Dr. Rajaram stated, "They [the farmers] always think the higher yields will give them more profit." He said the production costs must also be considered. This is the focus of some of the research for both CIMMYT and CIANO.

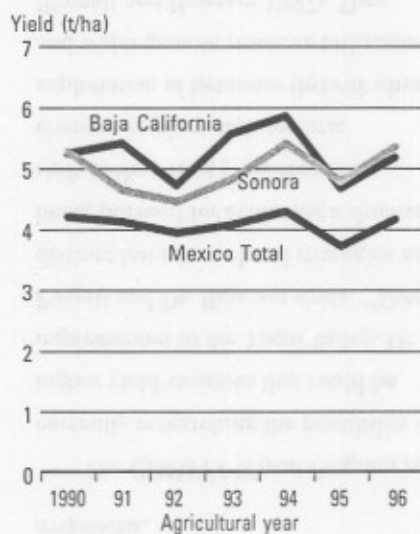


Figure 5. Comparison of wheat yields. Source: Centro de Estadística Agropecuaria, SAGAR.

Future Endeavors

There have been numerous changes in CIMMYT and CIANO operations during the "Post-Green Revolution" era. The future plans of these two organizations are of significant importance to reducing the production cost and allowing farmers to again earn more money from their land. Dr. Rajaram believes education and extension should be implemented throughout the agricultural sector to improve productivity. He said that during the Mexican land reforms of 1976-1977, many large farms were reduced in size. The government brought in other people who did not know the fundamentals of farming. This posed great difficulty in working with the farmers on new techniques.

According to Dr. Rajaram, one of the greatest losses in revenue is the late planting of crops. Many farmers in the Yaqui Valley wait until December, when the crops should be planted in November. The longer growing season can help increase the yields of the crops. This has been seen in Baja California where the same varieties are used as the Yaqui Valley, but with a longer growing season (Figure 5).

Conclusion

The living standard of wheat farmers in the Yaqui Valley has undergone changes in the past forty years. These changes are, in part, due to the "Green Revolution" and the reform of Article 27 of the Mexican Constitution. Not all of the changes have benefited producers. During the "Green Revolution" the farmers recognized the great increases in the yields. During the past seven years, the privatization of numerous input organizations and the elimination of many guaranteed prices have negatively affected the farmers. Santana's comments have paraphrased the current situation; "Farmers are losing the style of life."

The decrease in the standard of living can most certainly be attributed in part to the opening of markets after years of government control. There were few established land or commodity prices in the past, so this became one of the system's failures. The government should have reformed the sector at alternating intervals to allow the farmers to adjust to the changes at a gradual pace. When all of the markets were opened at the same time, many farmers could not recover from the losses. In addition to these problems associated mainly with the smaller farmers, the overall economy

of Mexico will benefit by replacing inefficient, subsidy-absorbing farmland with high-productivity farms. Unfortunately, one of the inevitable consequences of the policy reform was farmer displacement. The new reform has led to an increase in larger farms that the Agrarian Laws tried to reduce. It is interesting to note how the policy change has certainly adversely affected most of my survey group because I focused on the smaller farmers who lived through the middle of the "Green Revolution." The answers to some of the questions would have been different if I had interviewed some of the wealthier farmers in the Yaqui Valley.

The farmers in the survey group were a great inspiration to continue the work of CIANO and CIMMYT. They look forward to the recommendations and continue to farm the land to the best of their abilities. When speaking with a farmer who owns five hectares or a farmer who owns over 50 hectares, there is always one thematic element in the conversation. The farmers are grateful for the help of CIMMYT in improving their ability to farm the land of the Yaqui Valley.

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Afterword

Traveling to northern Mexico in the region of the Yaqui Valley was a great experience. It was fascinating to witness firsthand the lifestyles of people I have researched. The most enjoyment came from speaking with farmers who have lived and worked on the land for more than 30 years. Having the opportunity to speak with them about the changes they have seen was the main influence on this paper. Solely reading about the area and studying the published material does not give a person the true sense of the experience. Listening to the proud farmers share their stories was the best part of the internship. My favorable opinion of the hard work and dedication of the farmers will be the main insight I will remember and hope to see again.

This experience in Mexico has drastically changed my perception of developmental and agricultural economics. I witnessed firsthand the beneficial results of CIMMYT's contributions to the living standards of Yaqui Valley farmers. Although my research has focused on Mexico, my interactions with the multinational population at CIMMYT has allowed me to recognize its global impact. Having the opportunity to study here has given me an expanded knowledge of this important topic and a greater interest in this profession. I would like to extend a "thank you" to the farmers of the Yaqui Valley and to the researchers at CIANO and CIMMYT for their time during the interview process.