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NAFTA AND MEXICO'S CORN PRODUCERS

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NAFTA and Mexico's Corn Producers

Summary

The fall in the producer price of corn that will accompany NAFTA has led to dire predictions of labor displacement in Mexican agriculture. We use a household survey of the ejido sector to show that a majority of corn producers are in fact not producing for the market and will consequently not be directly affected by a fall in the price of corn. For the net sellers, we explore the determinants of two solutions to a falling corn price: diversification toward high value crops and modernization of corn production. For both of these, results show the fundamental importance of reconstructing supportive institutions for marketing, credit, and technical assistance in replacement of the services formerly offered by government.

NAFTA and Mexico's Corn Producers

I. Mexico's corn production dilemma

Corn is a crop of extraordinary social importance in Mexico (Warman and Montañez, 1982). The expected impact of a sharp decline in the producer price of corn associated with trade liberalization under the North American Free Trade Agreement (NAFTA) has consequently been an issue of serious concern as this could lead to major social dislocations in Mexico and to increased illegal immigration to the United States (Lustig, Bosworth, and Lawrence, 1992). In this paper, we use a survey of farm households in the social sector to give a quantitative characterization of Mexican corn producers and their relation to the market. We then explore the potential impact of a decline in the price of corn on social sector corn producers and the determinants of success in following two escape routes to a falling corn price: diversification toward other crops and modernization of corn production.

Some 50% of Mexico's arable land is cultivated in corn: in 1992, there were 7.2 million hectares in corn for a total arable land of 14.7 million ha. In 1991, there were 2.4 million corn producers, representing 78% of Mexican farmers and some 12.5 million family members (SARH, 1991). Of the 2.4 million producers, 2.2 million had less than 5 ha planted in corn and the average corn area per producer is only 2.3 ha. Indeed, most corn producers are very small farmers, using primitive technology, achieving very low yields, and living in poverty. This is particularly the case for households in the social sector.

This sector was created by the land reform that followed the peasant-led revolution of 1910 and its legal status was defined in Article 27 of the 1917 constitution. The land reform returned to peasant communities, under the form of collective ownership, lands which had been appropriated by large haciendas. Land is used either individually in usufruct (now the overwhelming majority of cases) or collectively. By 1988, the social sector was composed of 28,056 ejidos and indigenous communities including 3.07 million ejidatarios and comuneros, accounting for 70% of Mexican farmers and some 15 million family members. The 1981

agricultural census indicates that 52% of Mexico's arable land and 50% of its irrigated area are in the ejido. This sector is, however, mainly endowed with rainfed land, much of which is of very poor quality, and the land is highly fragmented. Thus, only 16% of the ejido land is irrigated. Some 64% of the ejidatarios have farms of less than 5 ha which are in general insufficient to maintain a family, implying extensive participation by family members to the labor market and to seasonal migration. Only 9% have farms larger than 20 hectares constituting a small sector of commercial farms. Between these two groups, a critical sector of 37% farmers with an average farm size of 6.6 ha constitutes a family farm sector with a destiny that is very much uncertain under the current reforms.

Even more than in Mexican agriculture overall, corn is of primordial importance in the social sector. This sector produces 73% of national corn production. The 1990 SARH-CEPAL social sector survey which we use in this paper shows that, for the country as a whole, 80% of the ejidatarios and comuneros are corn producers and that corn occupied 44% of their land (SARH-CEPAL, 1992). On average, social sector producers cultivate 4 ha of corn where they obtain yields of 1 ton/ha under rainfed conditions and 2.1 ton/ha under irrigation.[1]

Implementation of NAFTA would sharply decrease the farm level price of corn which is currently supported by government procurement through CONASUPO (the National Corporation for Popular Staples). In 1991, the nominal rate of protection was 77% and the producer subsidy equivalent (PSE, measured in percent of the value of production) was 44%. This amounted to a PSE per ton of US$92 for white corn and 71 for yellow corn, compared to 28 in the United States and 21 in Canada (SARH, 1993). Consumer prices are, by contrast, held low and close to the border price. These food subsidies are, however, mainly available to urban consumers through access to CONASUPO stores. Only a few farmers, located close to such stores, are able to sell all their corn production at the high support price and subsequently buy their consumption needs at the low subsidized price. Most others buy on local markets at a price above the producer price.

NAFTA and trade liberalization are not the only reforms which are affecting Mexican farmers. Starting in the late 1980s, Mexico initiated bold reforms on many different fronts that have direct implications for the social sector and corn producers. These reforms include gradual privatization of land in the social sector as a consequence of derogation of Article 27 of the constitution; restructuration and descaling of the state apparatus including privatization of most parastatals in marketing, fertilizers, seeds, insurance, water management, and the provision of other inputs that were used to channel massive subsidies to agriculture; extensive reorganization of the financial sector with re-privatization of commercial banks, elimination of credit subsidies, and shift to PRONASOL (the National Solidarity Program) of all households with bad debts under a credit program based on social collateral; elimination of CONASUPO's monopoly over the marketing of basic foods except corn and beans, and strict targeting of the remaining corn and milk subsidies on the poor, although mainly urban; sharp contraction of public budgets for agricultural research and extension services, with private delivery or the charging of user fees expected to substitute for free public services; and gradual turnover of the management of water districts to water users associations with introduction of fees for water use.

While the economic crisis that started in 1982 did not affect agriculture immediately as it did the rest of the economy, there was a sharp downturn in agricultural growth after 1986. The annual growth rate which had been 1.7% between 1982 and 1985 (while the rest of the economy grew at 0.2%), was negative 1.5% annually between 1985 and 1990 (while the rest of the economy was growing at 1.5%). This stagnation of agriculture was the consequence of a sharp decline in public investment in the sector (a 76% reduction between 1982 and 1989), falling prices, and rising costs associated with the removal of subsidies, particularly to interest rates. The real price of corn fell by 20% between 1987 and 1990. The producer subsidy equivalent (PSE) had declined by 25% since 1987 and remained at $99/ton for white corn due to the high nominal protection coefficient. In spite of this, the production of corn bounced back in 1990, the year of the survey used in this paper. With price

guarantees upheld only on corn and beans, corn at least offered income security to farmers, while prices of the major competing crops, wheat and sorghum, were declining proportionately. 1990 was a good year, with yields on rainfed land 16.4% above average for the previous five years and national corn production 23.5% above this average (Salinas de Gortari, 1991). With corn relatively attractive, in spite of an overall loss of profitability, production maintained the same level in 1991 and 1992.

The loss of profitability of corn had by 1990 already induced a series of adjustments among ejidatarios. Hewitt de Alcantara (1992) thus describes how many ejidatarios had extensified their corn production as credit availability reduced access to purchased inputs and engaged in greater participation to the labor market and seasonal migration. Appendini (1992) estimates that half of corn production originated in rainfed peasant farms and that half of this production was retained for home consumption.

Predictions of the impact on the Mexican farm population of a second corn shock, due to further price reductions associated with NAFTA, have in general been catastrophic. Calva (1991) thus asserted that 15 million people will be displaced from agriculture as a consequence of NAFTA and other policy changes.. Modeling approaches have also predicted large, if smaller, displacements.[2] Using computable general equilibrium models, Levy and van Wijnbergen (1992) and Robinson et al. (1991) consistently predict the displacement of 700 to 800,000 workers from agriculture as a consequence of a fall in the price of corn. With an economically active population (EAP) in agriculture of 5.3 million according to the 1990 Population Census (which includes landless agricultural workers), this would imply dislocation of some 15% of the EAP.

As we will show in this paper, these figures are in our opinion vastly exaggerated. Overestimation of the labor displacement effect of NAFTA can in part be explained by general unavailability of household-level information characterizing the degree of participation of Mexican corn producers to the market. Past studies have also paid insufficient attention to the possibility of using an array of policy instruments to help corn

producers either diversify into other crops benefited by trade liberalization or modernize their corn production and remain competitive.

II. Participation of ejido corn producers to the market

We use for this study a survey of social sector households conducted in 1990 by the Secretariat of Agriculture and Hydraulic Resources (SARH) and the National Institute for Statistics, Geography, and Information (INEGI). This survey covered 35,000 ejidatarios and comuneros, located in Mexico's 32 states and the Federal District, who engaged directly in agricultural production. We selected three states that capture some of the great diversity of Mexican agriculture: Michoacan with 1,224 observations of corn producing households, Sinaloa with 291 observations, and Veracruz with 1,453 observations.[3]

To classify these households between non-sellers and sellers of corn, we first reallocate from seller to nonseller a small number of households who sell corn even though their production is inferior to their domestic consumption. This is to avoid considering as sellers those households who take advantage of the food subsidy system by selling their corn at the farm support price to buy their consumption needs at the subsidized consumer price. Others, pressed by cash requirements, sell some or all of the corn they produce to subsequently purchase corn out of labor earnings. To screen out these households, we use data on corn consumption derived from a consumption survey of six villages in the Solis Valley of the State of Mexico where corn cultivation is the principal occupation of most household heads. In this study, average consumption of children under the age of 20 is 200 kg/year and that of adults 274 kg/year (Rose, 1992). Using family size and composition, we predicted a consumption level for each household and shifted to the non-seller category all seller households with production inferior to that threshold. This relocated 7.2% of the seller households into the non-seller category in Michoacan, 14.8% in Sinaloa, and 5.5% in Veracruz.

We present in Table 1 the average characteristics of the seller and non-seller households. The first observation is that the percentage of corn-producing households who do not sell corn is indeed very high: 51.5% in Michoacan, 64.3% in Sinaloa, and 41.1% in Veracruz. In principle, these households would not be directly affected by a fall in the sale price of corn. There may be indirect effects on their welfare if employment opportunities in the corn sector and rural wages fall (Levy and van Wijnbergen, 1992), but the net effect of NAFTA on employment, between falling demand for labor by commercial corn producers and employment creation in labor-intensive fruits and vegetables and in non-farm activities that will benefit from NAFTA is largely unknown, although expected to be small. However, it is likely that there will be a lag between loss of jobs in agriculture and expansion of production of labor intensive fruits and vegetables for exports. In predictions of labor displacement from Mexican agriculture by the existing models, employment creation in fruits and vegetables is secondary compared to direct loss of employment in corn production by subsistence farmers. However, these models fail to take into account the fact that there are significant market failures in corn and that consequently only a fraction of corn producers will be affected by a change in the sale price. As a result, their dire predictions of displacement of a vast majority of corn producers are vastly exaggerated. It does not mean, however, that the welfare impact on net sellers will not be serious, and we will subsequently explore adjustment opportunities available to them and the role of policy in helping them seize these opportunities.

Analyzing the differences in characteristics between sellers and nonsellers is revealing of the determinants of successful commercial corn production (Table 1).[4] Logically, physical asset endowments are fundamental differentiating features. Farm size is in the three states a major determinant of achieving seller status: in all cases, crop land measured in rainfed equivalent for corn production is larger among seller farms. Sellers have a larger share of land under irrigation, except in Veracruz, a tropical state where irrigation is

not important. Sellers also own more capital goods such as tractors and trucks. They have smaller families and thus lower needs to retain corn for home consumption.

Sellers follow production strategies that are more intensive in modern technology. They display a greater incidence of use of chemical fertilizers and trucks. And they belong more frequently to marketing and other producer organizations. The fact that they achieve higher yields can be a consequence both of their more intensive production strategies or of their location in better agroecological environments.

Regarding household labor strategies, sellers are more dedicated to farming as the number of adults in the household working for a wage is smaller. Finally, they are located in regions with greater opportunities for lowering transactions costs in accessing markets: in these areas, there are more opportunities for sale to local merchants and more opportunities for sale under forward contracts.

These data reveal a sharp degree of social differentiation between sellers and non-sellers. Sellers control a high share of irrigated land in Michoacan and Sinaloa. When measured in land equivalent, sellers have in all three states nearly twice as much land as non-sellers. They plant in corn nearly four times as much rainfed land. Their shares of total corn production are 74% in Michoacan, 84% in Sinaloa, and 83% in Veracruz.

From a policy standpoint, it is important to determine more rigorously what makes an ejidatario be a seller or not. For this purpose, we turn to a probit analysis of the probability of being a seller as opposed to a non-seller. To do this rigorously, we need a theory to separate exogenous from endogenous variables. We do this by developing a model of household behavior that explains the decision to sell, buy, or be self-sufficient in terms of household-specific characteristics and market failures.

III. Decision-making regarding market participation

A household's decision to participate or not to the market for corn depends on the position of that household's supply and demand for corn relative to the price band created by

the gap between sale and purchase prices (de Janvry and Sadoulet, 1993). This price band originates in a set of transactions costs, some of which are specific to the region and others to the household itself. This is illustrated in Figure 1.

For a net seller, the decision price for both production and consumption choices is the effective sale price p. For this household:

Supply of corn	$q = q(p, z^q)$
Demand for corn	$c = c(p, z^d)$
Idiosyncratic price transmission	$p^s = p^s(z^p)$
Transactions costs	$TC = TC(z^t)$,

where $z^q, z^d, z^p,$ and z^t are exogenous shifters of supply, demand, sale price, and transactions costs, respectively. Hence, for net sellers, the household-level effective sale price is:

$$p = p^s(z^p) - TC(z^t).$$

The condition to be a net seller is thus:

$$q\left[p^s(z^p) - TC(z^t), z^q\right] - c\left[p^s(z^p) - TC(z^t), z^d\right] > 0$$

$$\text{or } I(z^q, z^d, z^p, z^t) > 0.$$

To classify households as sellers or non-sellers, we do a probit analysis of this function:

$$\text{Prob(netseller)} = \text{Prob}\left[I(z^q, z^d, z^p, z^t) > 0\right].$$

Candidate z-variables are given in Table 2.

Local conditions are defined by the average condition in the corresponding Regional Development Districts (DDR), which are administrative units that were designed for the purpose of achieving some homogeneity of agroecological conditions. Hence, regional conditions of sale are measured by the proportion of sellers in the region who sell to a local buyer, or with a forward contract. Regional availability of tractors is measured by the proportion of ejidatarios in the region who use a tractor.

The results are presented in Table 3. In these equations, irrigated and rainfed land, as well as price, were included even when not significant. All other variables from the above list of z-candidates were retained only if significantly different from zero in the probit equation. The goodness-of-fit is reasonably good, with between 65 and 83.5% probability of predicting correctly appurtenance to the corresponding group.

The areas in rainfed land (Michoacan and Veracruz) and irrigated land (Michoacan, Sinaloa, and Veracruz) are significant determinants of being a seller, with, as expected, the role of rainfed land of decreasing importance from Veracruz to Michoacan and to Sinaloa. Ownership of animals (and land in pasture) and family size both have significant negative impacts on the probability of being a seller. This is because they are demand shifters (z^d) that increase the retention of corn for home use. Family size thus plays a more important role in determining the probability of being a seller by increasing the home-consumption of corn than by providing access to cheap labor that could be used to increase corn production. Organizational assets are also important shifters of supply: they include membership to a credit organization and access to technical assistance and to insurance which are in restricted supply. In Sinaloa, those who are net sellers also live in regions which are better endowed ecologically. This is reflected by the positive effect of higher average yields of rainfed corn on selling. Higher yields of irrigated corn have a negative effect in Michoacan and Sinaloa, suggesting that better agroecological conditions on irrigated lands are used to diversify away from corn into higher value crops, an issue that we will explore later. Regional characteristics also affect transactions costs and hence the likelihood of being a seller. This shows through the role of greater opportunities to sell corn locally as well as greater opportunities to sell through forward contracts. Finally, the price received does not affect significantly the decision to be a seller. This price is defined as the observed sale price for those who sell corn and the average municipio sale price for those who are self-sufficient. This is expected because this price only affects demand, as it is expost relative to production decisions, while the guarantee price used for production decisions differs from the sale price

and is constant for all producers. This is the reason why we cannot estimate an elasticity of supply response from the available data. On the demand side, the price elasticity of corn is expectedly low, and price is consequently not a significant determinant of marketed surplus.

The relative importance of each variable in explaining the probability of being a seller of corn is measured by the percentage contribution of the variable to the total explanatory power of all variables together (Table 3). It is defined as:

$$100\beta_k(\bar{z}_{k,seller} - \bar{z}_{k,nonseller}) / \sum_k \beta_k(\bar{z}_{k,seller} - \bar{z}_{k,nonseller}),$$

where β_k are the estimated parameters. It measures how much difference in the potential marketed surplus--the I indicator defined above--is due to a specific factor, computed for the average predicted seller and non-seller. The results in Table 3 show that productive assets all together contribute to 40-50% of this difference. Differentiation in local conditions of sale is important in Veracruz, where the difference in availability of local purchase points contributes 51.4% of the difference between the average seller and non-seller and in Michoacan where it contributes 35%. Differentials in productive assets and local market conditions are thus the main determinants of participation to the market as a net seller.

IV. Determinants of diversification

If the price of corn is expected to fall, one of the strategies available to sellers of corn is to diversify away from corn production. To explore this possibility, we construct an indicator of diversification away from traditional field crops. Traditional field crops include corn, beans, barley, oats, chickpeas, and nopal. Diversified crops include nontraditional field crops (sesame, alfalfa, rice, sugar, saffron, lima beans, kenaf, lentils, linseed, potatoes, sorghum, and wheat) and a long list of fruits and vegetables. We define diversified households are those planting more than 25% of their land in these crops.

We first construct a new typology of households that distinguishes five categories allowing us to isolate diversified households among both non-sellers and sellers of corn. Non-sellers of corn include three categories of households: traditional producers who do not

sell because they have an important effective demand for corn as a feed for animal production; those who do not sell but have diversified cropping patterns, suggesting that corn production is for them a marginal activity but that they may be heavily vested in other crops; and those traditional producers who are non-sellers and have neither important animal activities nor diversified cropping patterns. The three categories of non-sellers of corn are defined as follows:

Category 1. Traditional non-sellers: corn production is less than 1.25 times their predicted household human consumption requirements.

Category 2. Traditional non-sellers with livestock: corn production is greater than 1.25 times their human consumption requirements, and yet do not sell.

Category 3. Non-sellers with diversified crops: more than 25% of their land is in nontraditional crops.

Sellers of corn similarly include both traditional corn producers and households that have diversified cropping patterns. We thus distinguish two groups among sellers:

Category 4. Traditional sellers of corn.

Category 5. Sellers with diversified cropping patterns.

This typology, reported in Table 4, isolates a large group of minifundists whose agricultural activity is concentrated in traditional crops, and yet do not sell corn (Category 1). They represent 20.8% of all households in Michoacan, 25.4% in Sinaloa, and 14.7% in Veracruz, on 10 to 20% of the land.[5] For these households, crop production is minimal and only used for home consumption; nonagricultural activities generate an important complementary cash income. Another group of similar size (Category 2) is made up of ejidatarios who produce mainly traditional crops, but are also vested in livestock production. This leaves about 60% of the households in Michoacan and Sinaloa and 74% in Veracruz vested in crop production with an orientation to the market. This includes producers confined to traditional crops and selling corn (Category 4), and producers who have been able to diversify their production for sale on the market (Categories 3 and 5), whether sellers

of corn or not. The households that will be most vulnerable to harm from NAFTA are those belonging to the group of traditional producers oriented to the market (Category 4). They represent 27.8% of all producers in Sinaloa, 39.8% in Michoacan, and 42.9% in Veracruz. They occupy 44 to 56% of the crop land (in equivalent rainfed), and produce 60 to 77% of corn production in the three states. This group needs the most attention and support to help it react to the declining profitability of corn. We will explore two escape routes for them, diversification towards other crops and modernization in corn production.

It is notable that many traditional corn producers who do not sell corn use modern purchased inputs, if generally with a lower frequency than sellers. In Michoacan, a particularly high percentage of producers of all categories (between 87.7 and 94.9%) use chemical fertilizers. This in spite of the fact that very few producers have access to credit, particularly among non-sellers. In Sinaloa and Veracruz, non-sellers use fertilizers less frequently than the other categories, reaching 16.8 and 24.8%. This stresses the fact that modern technology is important for traditional non-sellers as well as for sellers, and that these non-sellers do incur expenses for acquiring these inputs through earnings derived from participation to the labor market and remittances.

The fact that some of those who are diversified have remained involved in corn production for home consumption (12.2% of corn producers in Michoacan) or for sales (8.7% of producers) reflects the relatively high attractiveness of corn under the regime of price support. Yet, they already use more than 26% of their land equivalent for diversified production, showing that they have access to the technology, information, institutional support, and marketing channels that are necessary to switch away from corn. Indeed, in terms of average characteristics, diversified non-sellers of corn differ significantly from traditional non-sellers in many attributes. They have not only more land and capital assets, but also use more credit and belong to more producers' organizations. An important question is to find what are the critical determinants which have allowed them to diversify, in contrast with those who have remained dedicated almost exclusively to traditional production for the

market. This is what we do in the next probit analysis, where we contrast the diversified producers (seller and non-seller of corn) to the traditional net sellers of corn.

The results are reported in Table 5. Area in irrigated land has a positive impact on diversification in Michoacan and Veracruz, while rainfed land is important for diversification in Sinaloa. As we have defined it, diversification embraces two relatively different types of activities, production of nontraditional field crops and fruits and vegetables. Fruits and vegetables are themselves quite diversified, including perennial tree crops as well as seasonal vegetables. This explains why rainfed land is important in Sinaloa, where all diversification is in non-traditional field crops, while irrigated land dominates in the other two states. A striking common factor in all three states is the critical role of marketing conditions. Conditions of sale characterized by the availability of local purchase points and contract sales explain 16% of the differentiation between diversified and traditional farmers in Veracruz, 40% in Michoacan, and 69% in Sinaloa. The other important determinants of diversification are access to credit (in Veracruz), membership to organization (in Sinaloa and Veracruz), and ownership or regional availability of trucks, mechanical equipment, and tractors (in Michoacan and Veracruz).

While diversification into high value crops that will be favored by NAFTA opens an option to some producers, corn will likely remain an important crop in Mexico, but only where yields are sufficiently high. We consequently explore, in what follows, the determinants of higher levels of yields in corn production.

V. Modernization of corn production

There appears to be a large productivity gap in corn production. Yields are very low, even under irrigation. Average yields in 1991 were 1.6 tons/ha under rainfed and 3.2 tons/ha under irrigation (Table 6). Comparison of yields under different technologies in rainfed areas show that use of fertilizer almost doubles yields from 0.8 tons/ha to 1.5 tons/ha, and that use of improved seeds further increases yields by 85%. An issue of concern is that 27% of all

producers have, and 21% of the corn area is still cultivated with, traditional technology and very low yields. Fertilizer is used in almost all production under irrigation, but improved seeds are planted on less than half of the land. Obviously, these technical choices and yields are not independent of land quality, and the highest yields obtained in rainfed areas must correspond to well-endowed agroecological regions. However, there is also an enormous heterogeneity in yields under similar conditions, suggesting large technological gaps among producers.

Estimations of yield equations are reported in Table 7. The potential determinants explored are, as in the previous econometric estimations, productive, human capital, and organizational assets. We also allow for a differential yield for producers that are actively invested in a different production strategy (in livestock production or in diversified crops, as these categories were defined above) in contrast to traditional producers. Finally, we explore whether some determinants of yield differ between sellers and non-sellers of corn. Since the characteristic of being a seller or not is obviously endogenous and jointly determined with yield, correction for potential selectivity bias is done whenever a variable differentiates sellers and non-sellers.

These estimations reveal an interesting pattern in the relationship between area and yield. There is a clear inverse relationship between cropped area and yield for non-sellers. This relationship is, however, strongly tempered for the sellers, remaining negative in Veracruz but becoming null or positive in Michoacan. A possible hypothesis for this U-shaped curve is that it is due to differential transactions costs associated with participation in the product market. Understanding the underlying cause of this curve would require a detailed study of the inputs used and the transactions costs incurred in their acquisition.

Both productive assets (crop land; truck and tractor ownership) and human capital assets (family size and years of study) have positive influences on yield. The number of adults working for a wage is an endogenous variable which we instrumentalized with the household assets. The predicted value of this variable has a negative effect on yield. This

reflects the loss of family workers and higher labor costs as substitute labor needs to be recruited and supervised. Interestingly, migration abroad has a positive impact on yield. The debate on the role of migration on agricultural productivity has emphasized two potential contradictory effects: a negative effect from the absence of the most active workers in the household, and a positive effect from the availability of cash remittances, which could be used for investing in agriculture or for purchasing inputs, providing a source of liquidity which is particularly important in the current context of sharp constraints on access to credit. The limited evidence presented here seems to indicate a dominance of the positive effect of migration on land productivity

Access to marketing organizations, technical assistance, and credit for the sellers all foster yield. Access to credit has a negative impact on rainfed yields of non-sellers in Michoacan. A logical interpretation is that non-sellers need reimburse credit with the sale of family labor or with other incomes, which reduces the availability of family labor and other productive resources for corn. Finally, as can be seen from the producer categories in Table 7, producers who are participating to the corn market as net sellers have yields which are 0.30 to 0.44 ton/ha higher than traditional non-sellers. Those who are actively engaged in agricultural production, be it in livestock or in diversified crops, also have yields which are higher by 0.25 to 0.53 ton/ha.

VI. Conclusion

Analysis of the relationship of ejido corn producers to the market shows a great degree of structural heterogeneity among these households. The expected fall in the price of corn associated with NAFTA will consequently be felt highly differentially across household types. Taking into account this structural heterogeneity is thus fundamental to predict the expected impact of NAFTA, identify the groups of households that will need targeted assistance, and design solutions that correspond to their needs and possibilities.

The households most at risk are the non-diversified corn sellers who depend heavily on the price of corn for their welfare. These households represent 39.8% of the corn producers in Michoacan, 27.8% in Sinaloa, and 42.9% in Veracruz. They control 49%, 56.4%, and 43.9% of the total land equivalent in these three states, respectively. This group constitutes a minority among corn producers, but is of critical importance for both the efficiency of Mexican agriculture (due to the importance of the land which it controls) and for the welfare of the rural population (due to the significant share of the farm population which it represents). Designing mechanisms for these households to adjust to the NAFTA environment is thus critical.

We analyzed two adjustment paths which these households could pursue. One is diversification away from corn production toward nontraditional field crops and fruits and vegetables; the other is modernization of corn production to reach higher yields and, it is hoped, achieve competitiveness under the new price conditions.

We found that success in achieving both crop diversification and higher corn yields is enhanced by farm size and by the availability of family labor which is increased by family size and reduced by the number of adults working for a wage. For corn yields, the role of family labor is seen not only directly, but also through falling yields with area in corn that reflect rising labor costs with increasing reliance on hired labor. In all cases, ownership and/or regional access to machinery is important. Higher yields are increased by human capital and by the liquidity effect of adult migration

For both diversification and modernization of corn production, the availability of supporting institutions is critical. This is seen by the role of access to credit and of membership to producers' organizations, particularly for credit and marketing. For diversification, availability of local buyers and contract sales are important. For modernization, access to technical assistance is important. These are institutional factors that help relax constraints on access to factors of production, reduce transactions costs in trading

on markets, and create productivity gains. Access of current traditional corn sellers to these services is thus fundamental to their economic survival as farm producers.

The profound macroeconomic and agricultural reforms pursued by the Mexican government during the last eight years have deeply redefined the relationship between state and peasants. Economic liberalization and removal of direct controls over the ejido sector have substantially broadened the range of initiatives which these households can pursue. In particular, they have gained greater freedom in deciding on resource allocation, on choice of technology and crops, on local management of water, on accessing individually the product and factor markets and sources of credit, and on contracting with merchants and agroindustry. At the same time, redefinition of the role of the state has implied reduced access to a number of essential services for the ejido sector such as credit, technical assistance, insurance, marketing, delivery of inputs, and extension services that were formerly delivered by government. The result is creation of an institutional vacuum which is only partially being filled by the private sector but this mainly for access by the larger commercial farms; or by targeted welfare interventions of the state (PRONASOL) but this mainly for the most marginal rural households. Much of the ejido sector falls between these two extremes and is thus left largely devoid of institutional support, precisely at a time when it needs full access to these services to modernize corn production and diversify cropping patterns toward higher value crops. Our results show that modernization and diversification indeed crucially depend on access to these institutional services. Promotion of producers' organizations for the self-delivery of these services and to lower transactions costs in accessing markets and public services is a fundamental element of a solution. More generally, selective reconstruction of the institutional services formerly delivered by the state to ejidatarios should be a priority item for organized producers, NGOs, the private sector, and, in a supportive and regulatory role, the Mexican government if the economic viability of this important sector of family farms is to be preserved.

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1 This compares to a U.S. national average yield of 6.12 ton/ha in 1990/91. Mexico's national average yield that same year was 1.97 ton/ha (USDA, 1993).

2 For a survey of labor market issues related to NAFTA, see Hinojosa and Robinson (1992).

3 These states were not chosen for their preeminence in corn production, but because they are typical of three of the most important agroecological environments: Michoacan is in a high plateau temperate zone, Veracruz in a humid tropical zone, and Sinaloa in an arid zone.

4 We refer to both ejidatarios and comuneros as "ejidatarios" since there are no important differences between the two for our standpoint here.

5 For simplicity, Table 4 only reports data for Michoacan. Selected information on the other states is reported in the text.

Figure 1. Transactions costs and market participation

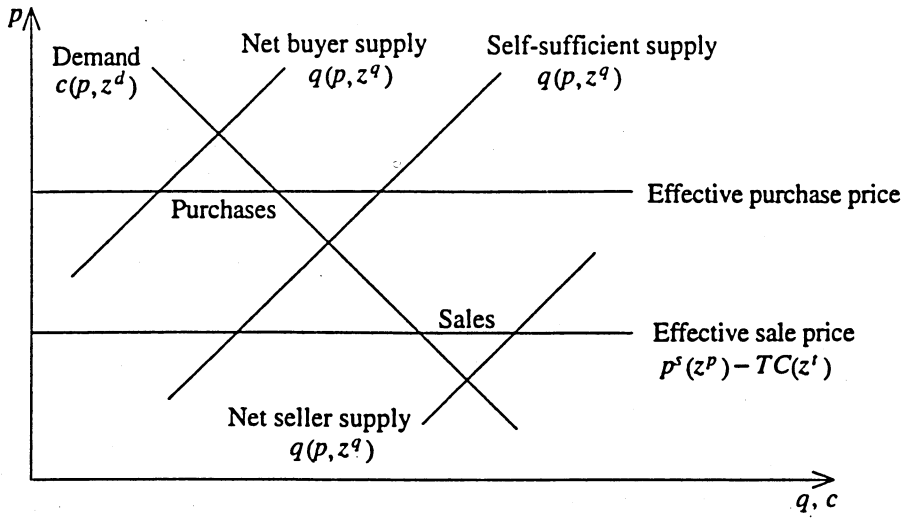

Table 1. Typology of ejido corn producers: non-sellers versus sellers

		Michoacan		Sinaloa		Veracruz	
	Units	Non-sellers	Sellers	Non-sellers	Sellers	Non-sellers	Sellers
Number of households	No	630	594	187	104	597	856
Household assets							
Total land	ha	6.2	7.8 *	6.9	8.9 *	8.4	12.4 *
% irrigated	%	10.8	18.6 *	6.3	31.8 *	1.0	.8
Crop land equivalent	ha°	5.2	8.7 *	4.3	16.4 *	5.6	7.3 *
Cattle	No	4.4	4.3	4.1	2.6	4.3	4.8
Truck ownership	%	10.1	10.9	2.1	16.2 *	3.5	8.9 *
Tractor ownership	%	10.0	20.4 *	.2	2.8	3.1	6.1 *
Family size	No	6.4	5.3 *	6.7	4.7 *	6.1	5.7 *
Production strategy							
Area in corn rainfed	ha	2.1	3.1 *	2.3	3.1 *	1.9	4.4 *
Area in corn irrigated	ha	.2	1.2 *	.1	1.8 *	.0	.0
Corn yield rainfed	t/ha	1.0	1.4 *	.6	.9 *	1.1	1.4 *
Corn yield irrigated	t/ha	1.2	2.0 *	2.8	3.9	2.2	1.9
Use chemical fertilizer	%	88.9	92.1 *	25.8	69.0 *	45.0	56.3 *
Use truck	%	17.2	26.6 *	9.2	43.2 *	26.2	38.2 *
Use of credit	%	5.9	8.7	10.2	39.7 *	20.4	21.5
Use of credit last 5 years	%	41.7	44.4	40.5	62.6 *	33.8	38.4
Marketing organization	%	6.1	12.2 *	1.7	7.8 *	6.5	16.6 *
Number of organizations	No	.8	1.0 *	.4	.6	.7	.9 *
Regional characteristics (DDR)							
Local sale	%	28.0	32.6 *	11.3	14.9 *	26.8	35.4 *
Sale on contract	%	1.7	2.1 *	1.6	2.4 *	2.8	3.1 *
Income strategy							
No of adults working for wage	No	.39	.25 *	.84	.56 *	.28	.09
No of adults migrating	No	.10	.05 *	.01	.01	.00	
Social differentiation							
Share of number of producers	%	51.5	48.5	64.3	35.7	41.1	58.9
Share of total land used	%	45.5	54.5	58.2	41.8	32.2	67.8
Share of total land equivalent	%	38.7	61.3	32.0	68.0	34.8	65.2
Share of irrigated corn area	%	41.9	58.1	56.6	43.4	23.1	76.9
Share of rainfed corn area	%	17.1	82.9	12.9	87.1	23.2	76.8
Share of total corn production	%	26.5	73.5	16.3	83.7	16.6	83.4

° Land equivalent is measured in rainfed corn-producing land.

* Values for sellers and non-sellers are significantly different at 90% confidence level.

Table 2. Exogenous Determinants of Seller Status

Supply shifters zq	Demand shifters zd	Price transmission shifters zp	Transactions costs shifters zt
Productive assets: Total farm area Irrigated area Rainfed area Cropland (in rainfed corn-equivalent) Ownership of capital goods: Truck Tractor Human capital assets: Family size Average age Education household head Organizational assets: Access to credit this year Access to credit last five years Access to technical assistance Access to insurance Member credit organization Member marketing organization Number of organizations to which member Local conditions: Average yield irrigated Average yield rainfed Availability of tractors	Human consumption: Family size Share of adults Number of adults working for a wage Number of adults migrating Animal consumption: Number of animals owned Area in pastures	Sales price Conditions of sale: Forward contract Local sale Sale to CONASUPO	Truck ownership Education Local conditions of sale: Availability of marketing organizations Availability of local buyers Availability of forward contracts

Table 3. Probit Analysis of Corn Producers by State: Sellers versus Non-sellers

Endogenous variable: probability of being a net seller of corn versus a non-seller

		Michoacan			Sinaloa			Veracruz		
Variables	Units	Coefficient	t-ratio	Contribution of factor* (% of total)	Coefficient	t-ratio	Contribution of factor* (% of total)	Coefficient	t-ratio	Contribution of factor* (% of total)
Constant term		-.55	-1.1		-.99	-.5		-.80	-5.0	
Productive assets (zq)										
Irrigated land	ha	.20	9.3	27.6	.31	5.5	28.8	.15	3.0	.1
Rainfed land	ha	.09	7.7	16.2	.01	.4	.3	.15	10.2	24.3
Land in pasture	ha	-.03	-2.7	1.2						
Land in perennials	ha	-.14	-5.0	4.9	-.19	-2.7	1.5	-.17	-9.9	15.8
Animals	No	-.01	-2.4	.0	-.04	-2.6	3.3	-.01	-2.3	-2.1
Truck ownership (zq and zt)	0,1				1.66	3.8	14.0	.49	3.1	4.3
Human capital assets (zd)										
Family size	No	-.07	-5.7	13.4	-.19	-5.2	20.5	-.06	-4.6	3.7
Organizational assets (individual) (zq)										
Member credit organization	0,1	.36	4.2	2.6						
Receives tech assistance	0,1				1.58	5.0	8.4			
Receives insurance	0,1							.22	2.2	2.1
Regional conditions of production by DDR (zq)										
Average rainfed yield	t/ha				3.99	4.7	20.4			
Average irrigated yield	t/ha	-.67	-5.6	-.7	-.31	-3.6	-3.0			
Regional conditions of sale by DDR										
Sale to local buyer (zt)	%	.03	8.5	35.0				.03	10.8	51.4
Sale on contract (zt)	%				.10	1.6	5.2			
Price (1,000 pesos) (zp)	p/kg	.01	1.4	-.2	-.01	-.3	.6	.05	.7	.3
Goodness of fit		Predicted non-seller	Predicted seller		Predicted non-seller	Predicted seller		Predicted non-seller	Predicted seller	
Observed non-seller°	No	408	180		172	17		358	236	
Observed seller°	No	198	427		34	67		193	662	
%correct	%	67.3	70.3		83.5	79.8		65.0	73.7	

* Computed as: parameter*difference in average value of the variable for predicted sellers and nonsellers, in percentage of total.

° "Observed" numbers correspond to weighted counts, and hence are different from the number of actual observation given in Table 1.

Table 4. Typology of ejido corn producers: traditional and diversified

		Michoacan				
		Non-sellers			Sellers	
	Units	Traditional	Traditional w/ livestock	Diversified	Traditional	Diversified
Number of households	No	254	227	149	487	107
Household assets						
Total land	ha	3.6	8.1 *	7.6 *	7.8	7.9
% irrigated	%	4.7	3.5	24.5 *	13.9	38.5 *
Crop land equivalent	ha°	3.2	5.6 *	7.8 *	8.5	9.9
Cattle	No	2.2	7.0 *	4.8 *	4.3	3.9
Truck ownership	%	16.4	3.8 *	8.1 *	8.5	20.7 *
Tractor ownership	%	7.3	4.8	19.5 *	19.5	23.9
Family size	No	7.5	4.7 *	6.8	5.2	5.4
Production strategy						
Area in corn rainfed	ha	1.6	3.2 *	1.9	3.5	2.0 *
Area in corn irrigated	ha	.1	.3 *	.3 *	1.3	1.6
Corn yield rainfed	t/ha	.8	1.1 *	1.1 *	1.3	1.6 *
Corn yield irrigated	t/ha	1.0	1.2	1.2	2.0	2.0
Animal corn consumption	ton	.1	1.3 *	.5 *	.7	.5
Use chemical fertilizer	%	87.7	87.7	91.8	91.5	94.9
Use truck	%	17.7	5.9 *	28.9 *	22.1	44.5 *
Use of credit	%	2.2	7.4 *	9.5 *	9.5	5.4
Use of credit last 5 years	%	41.2	44.8	38.9	42.8	50.9
Marketing organization	%	5.6	2.9	10.4	11.4	15.6
Number of organizations	No	.6	.8 *	1.1 *	.9	1.1
Social differentiation						
Share of number of producers	%	20.8	18.5	12.2	39.8	8.7
Share of total land used	%	10.7	21.6	13.3	44.5	9.9
Share of total land equivalent	%	9.5	15.0	13.9	49.0	12.6
Share of irrigated corn area	%	12.4	21.9	8.3	50.9	6.5
Share of rainfed corn area	%	3.4	6.7	5.2	66.5	18.1
Share of total corn production	%	5.3	15.9	5.7	60.2	12.9

° Crop land equivalent is measured in rainfed corn-producing land.

* Values are significantly different at 90% confidence level for traditional with livestock versus traditional non-sellers; diversified non-sellers versus traditional non-sellers; and diversified versus traditional sellers.

Table 5. Probit Analysis of Corn Producers by State: Diversified Versus Traditional

Endogenous variable: probability of being diversified (either seller or non-seller of corn) versus traditional corn seller

		Michoacan			Sinaloa			Veracruz		
Variables	Units	Coefficient	t-ratio	Contribution of factor* (% of total)	Coefficient	t-ratio	Contribution of factor* (% of total)	Coefficient	t-ratio	Contribution of factor* (% of total)
Constant term		-.41	-1.1		-2.02	-2.6		-.67	-3.6	
Productive assets										
Irrigated land	ha	.13	6.4	39.8	-.02	-.3	1.6	.15	1.9	4.0
Rainfed land	ha	-.00	-.2	.5	.08	2.7	9.2	.00	.1	.0
Equipment ownership	0,1	.76	3.0	11.9						
Truck ownership	0,1				.84	1.8	1.2			
Human capital assets and off-farm incomes										
Family size	No	.04	2.4	8.0	.17	3.9	20.7	.06	3.9	5.2
Organizational assets (individual)										
Number of organizations	No				.45	2.4	10.3			
Member credit organization	0,1							.29	3.3	5.3
Use credit	0,1							.72	7.3	47.7
Conditions of sale (regional characteristics)										
Sale to local buyer										
Traditional crops	%	-.029	-4.9	24.2	-.075	-5.1	26.5	-.019	-6.7	15.5
Nontraditional field crops	%	.009	2.9	14.6	.037	4.5	43.8			
Fruit and vegetables	%	.007	2.5	-1.4	.107	5.3	-13.4			
Sale on contract										
Traditional crops	%	-.054	-2.3	2.4						
Fruit and vegetables	%									
Availability of tractor	%							.013	6.5	22.2
Goodness of fit		Predicted traditional	Predicted diversified		Predicted traditional	Predicted diversified		Predicted traditional	Predicted diversified	
Observed traditional°	No	412	57		57	18		551	88	
Observed diversified°	No	150	122		12	84		223	208	
% correct	%	73.3	68.2		82.6	82.4		71.2	70.3	

* Computed as: parameter*difference in average value of the variable for predicted sellers and nonsellers, in percentage of total.

° "Observed" numbers correspond to weighted counts, and hence are different from the number of actual observations given in Table 4.

Table 6. Corn Yields under Alternative Technologies, 1991

Technology	Rainfed				Irrigated			Total
	Regular seeds & no fertilizer	Regular seeds & fertilizer	Improved seeds & fertilizer	Total	Regular seeds & fertilizer	Improved seeds & fertilizer	Total	
Number of producers (%)	27.0	49.9	9.3	86.2	10.0	3.8	13.7	2.4 million
Area (%)	21.1	48.8	17.2	87.1	7.0	5.9	12.9	6.2 million ha
Production (%)	9.5	40.9	26.5	76.9	9.0	14.0	23.0	11.2 million ton
Average yield (ton/ha)	0.8	1.5	2.8	1.6	2.3	4.3	3.2	1.8 ton/ha
State average yield								
Michoacan	1.0	1.6	3.0	1.9			3.2	
Sinaloa	0.5			0.5			4.6	
Veracruz	1.2	2.1	1.4	1.8			2.3	

Source: SARH, Direccion General de Estadistica, Encuesta Nacional sobre Rentabilidad y Productividad, Maiz, 1991

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Table 7. Corn yield equations by state, rainfed and irrigated
Endogenous variable: corn yield in ton/ha

		Michoacan				Sinaloa		Veracruz	
		Rainfed corn		Irrigated corn		Rainfed corn		Rainfed corn	
Variables	Units	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Constant term		-.31	-2.4	.30	.8	-.06	-.4	-.09	-.9
Area in corn (rainfed or irrigated)	ha					-.07	-4.6		
- non seller	ha	-.058	-3.7	-.02	-.2			-.14	-7.8
- seller	ha	-.002	-.2	.50	1.7			-.05	-5.7
Productive assets									
Crop land equivalent									
- non seller	ha*	.020	3.6						
- seller	ha*	-.003	-.1						
Truck ownership	0,1	.14	2.0						
Tractor ownership	0,1	.21	3.4	.60	4.0			.21	2.6
Human capital assets and off-farm incomes									
Family size	No							.02	3.3
Maximum years of study	No	.04	5.6			.01	2.0		
No of adults working for a wage (predicted)	No	-.30	-5.5						
Number of adults migrating abroad	No	.39	4.2						
Organizational assets (individual)									
Member of marketing organization	0,1			.82	3.5				
Used credit this year	0,1								
- non seller	0,1	-.27	-2.3						
- seller	0,1	.27	2.7						
Receives technical assistance	0,1							.16	3.9
Regional conditions by DDR									
Average rainfed yield	t/ha	.90	8.6			1.10	4.6	.91	10.7
Average irrigated yield	t/ha			.68	3.9				
Corn producer categories									
Livestock producers	0,1	.53	8.1			.32	3.4	.40	6.1
Diversified	0,1	.34	6.2					.25	6.4
Seller	0,1	.30	2.4			.44	4.2	.30	3.0
Mills ratio (seller vs nonseller)		.19	2.4	.45	3.8	-.20	-.3	.03	.5
Goodness of fit									
Adjusted R-square		.30		.24		.23		.27	
Number of observations		947		222		250		1345	

*Land equivalent is measured in rainfed corn-producing land.