MAIZE IN NORTH VERACRUZ STATE, MEXICO -- FARMER PRACTICE AND RESEARCH OPPORTUNITIES

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ECONOMICS PROGRAM

CIMMYT

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I N D E X

PREFACE

In cooperation with researchers in many national agricultural research programs, CIMMYT has sought to develop procedures which help to focus agricultural research squarely on the needs of farmers. The process involves collaboration of biological scientists and economists to identify the groups of farmers for whom technologies are to be developed, determining their circumstances and problems, screening this information for research opportunities, and then implementing the resulting research program on experiment stations and on the fields of representative farmers.

CIMMYT's Economics Program has emphasized developing procedures for the first stage of this process, through to establishing research opportunities. The evolution of the procedures, now synthesized in a manual "Planning Technologies Appropriate to Farmers: Concepts and Procedures" has been strongly influenced by collaborative research with many national programs and with CIMMYT's wheat and maize training programs. Our efforts with national programs began in 1974 with Zaire's national maize program, then moved to work in Tunisia, Pakistan, and Egypt. The pace of work accelerated notably in 1976 with assignment of regional economists stimulating similar work in Kenya, Tanzania, Ecuador, Peru, Bolivia, Panama, El Salvador and India. Cooperation with still other national programs is now underway. We believe that the resulting procedures offer cost effective and robust guidelines to national programs.

We are now preparing reports that illustrate the implementation of these procedures in various national programs. While not all such work can be reported, we take this opportunity to thank all of those who have collaborated with us.

This report was developed from farm surveys conducted by Economics Visiting Scientists, in collaboration with CIMMYT's Economics Program and the Maize Training Program. Its purpose is to assess farmer circumstances and identify research opportunities in an area in Mexico in which the Maize Training Program conducts on-farm trials.

Donald Winkelmann
Director, Economics Program.

1.0) Background and Objectives

The following report summarizes the results of a farm survey conducted by CIMMYT Economics Visiting Scientists (1981 B) in North Veracruz State, Mexico. The objective of this survey was to obtain, rapidly but accurately, the information from farmers needed to plan a set of on-farm agronomic experiments for the chosen study area. The information collected from farmers can help researchers tailor agronomic experiments to the needs of representative farmers by helping take decisions on selection and level of experimental variables, level of non-experimental variables, site selection, etc.[1/]

The study area centered on the Municipio (township) of Tihuatlan, Veracruz, near the urban center of Poza Rica. It therefore falls into one of the humid tropical maize-growing areas of Mexico. (For a more complete description of the study area, see section 3.0).

2.0) Methodology

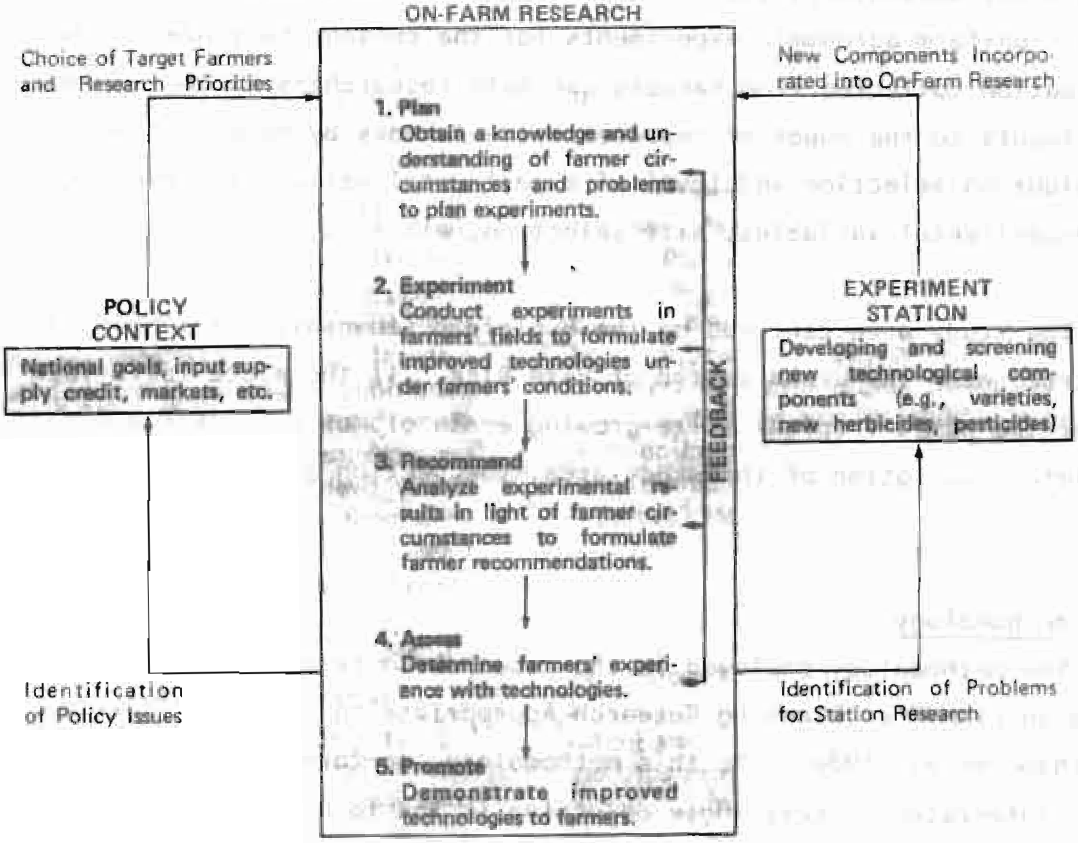
The methodology employed in the research to be reported below, was based on CIMMYT's "Planning Research Appropriate to Farmers" (Byerlee, Collinson *et al*, 1980). In this methodology, on-farm research is seen as an integrated process whose objective is the formulation of near-term recommendations for target groups of farmers (recommendation domains). The basic steps in this process include:

1) Planning research based on farmer circumstances
2) Conducting on-farm experiments under farmer conditions
3) Analyzing experimental results, to formulate farmer recommendations.
4) Subjecting these recommendations to assessment by farmers
5) Extending acceptable recommendations.

1/ No unique set of on-farm experiments is expected to be planted, based on survey results. However these results are expected to be useful to CIMMYT's Maize Training Program, which uses the study area for fieldwork in production agronomy training.

This research process is presented in more detail in Figure 2.1. The current study was confined to the research planning stage.

FIGURE 2.1 OVERVIEW OF AN INTEGRATED RESEARCH PROGRAM



In the CIMMYT methodology, information on farmer circumstances can be used in the design of on-farm experiments, in at least five ways:

1) Identification of research opportunities (the identification of a relatively small number of variables that merit high-priority in on-farm trials because of their expected beneficial impact on income, risk or system interactions, for a given RD).

2) Pre-screening of experimental treatments (careful selection of those treatments which address important research opportunities, are likely to be profitable at reasonable levels of risk, and are expected to mesh well with such system characteristics as labor and machinery availability, cash flow and use).

3) Delineation of recommendation domains (RD's) (stratification of the farmers in a study area into homogeneous target groups).

4) Site selection (selection of experimental sites that are representative of the fields and farmers corresponding to a given RD).

5) Setting the level of non-experimental variables (setting agronomic practices which do not form part of the experimental program for a given RD, at levels representative of the current farmer practice for that RD).

The current study used a sequence of survey activities to ascertain farmer circumstances and address the above five issues. First, available secondary data were reviewed, including climate maps, rainfall data and census data (soils maps are not available for the study area).Then, a brief exploratory survey was conducted. During this exploratory survey, a non-random sample of farmers from the study area was "interviewed" by the researchers. Agricultural extension and credit agents were also interviewed. No questionnaire was used in these interviews, although a mental "check list" of topics to be covered was employed. The interviews were conducted as informal conversations. The results of the exploratory survey served to set up hypotheses on recommendation domains, the current farmer practice and research priorities. Specifically, the exploratory survey served to design a "formal survey" to test these hypotheses.

This formal survey was conducted in September, 1981. The draft questionnaire developed from exploratory survey results was extensively field-tested and adjusted.

A sample of 48 farmers was obtained through two-stage sampling, in which "ejidos" or villages served as primary sampling units. Only "ejidatarios" or beneficiarios of the land reform were included in the sample. The data were obtained by enumerators selected and trained for the occasion. Manual analysis was preceded by a thorough manual edit.

3.0) Agroclimatic Circumstances

The important agroclimatic factors in the study area (those factors that have a strong effect on farmer decision-making with respect to agricultural production technology) appear from the exploratory survey to be rainfall, soils, and topography.

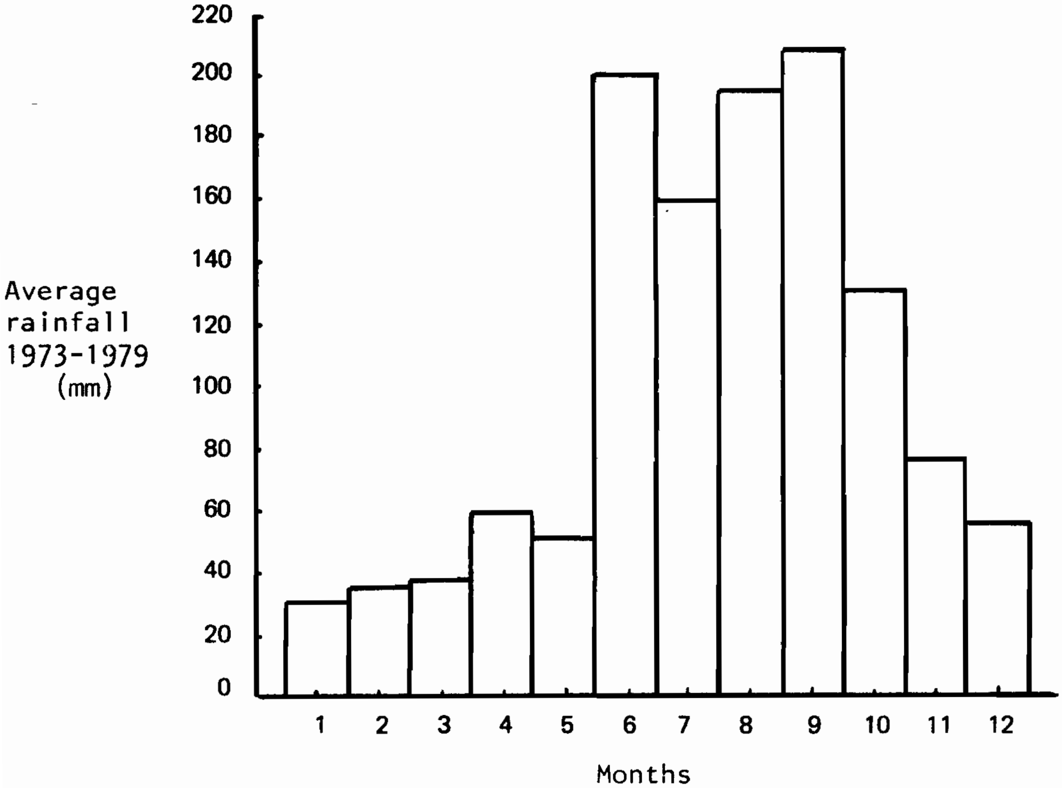
Rainfall is the only source of water for agricultural production in the study area. Water from the small rivers in the area is not used for irrigation. Historical data show that mean annual rainfall is in the 1200-1300 mm range, with considerable seasonal fluctuations (Figure 3.1). June, July, August and September are the heavy rainfall months, with a gradual decline in October, November and December. Rainfall, however, tends to be unpredictable and unreliable. Extended droughts during the "wet" months are not uncommon. Equally dangerous from the viewpoint of agricultural production are the periods of heavy rainfall which lead to water-logging of the area's heavy soils. Farmers perceived both drought and water-logging as serious weather-related problems in maize production (Table 3.2).

The "flooding" or water-logging problems noted above are due as much to the soils found in the study area, as to heavy rainfall. No soils maps are available, but agronomists have identified the predominant soils as heavy black vertisols.[1/]

Buckman and Brady (1969) describe a vertisol as follows: "This order of mineral soils is characterized by high content of swelling-type clays which in dry seasons cause the soils to develop deep, wide cracks... Their very fine texture and shrinking and swelling characteristics make them less suitable for crop production... They are sticky and plastic when wet and hard when dry. As they dry out following a rain, the period of time when they can be tilled is very short."

[1/] A Violic, personal communication.

FIGURE 3.1 AVERAGE MONTHLY RAINFALL, POZA RICA, VERACRUZ



Source: CIMMYT meteorological records, Poza Rica Experiment Station.

The terrain in the study area is characterized by rolling hills, with occasional flat plains. Soils on the slopes may be somewhat different than those on flat lands, but detailed data is lacking. Topography may also influence weather-related risk. The data in Table 3.2 suggest that flat fields are more likely to be waterlogged than sloped fields although the relation was not significant at the .20 level. Topography also appears to influence farmer decision-making with respect to tillage and weeding practices, as will be discussed in later sections.

TABLE 3.2 SERIOUS WEATHER PROBLEMS, BY CROP CYCLE AND TOPOGRAPHY 1/

PROBLEM	CROP CYCLE 2/			
	1981 WET		1980-1981 DRY	
	FLAT	SLOPE	FLAT	SLOPE
	%			
Drought	0	4	50	60
Waterlogging	72	54	31	15
Lodging	6	25	13	10
None	22	17	6	15

1/ % farmers reporting a given problem with respect to maize production

2/ Wet cycle = June or July planting
Dry cycle = December or January planting

4.0) Socioeconomic Circumstances

There are several socioeconomic factors that influence farmer decision-making in the study area. Of most interest are the following: land tenure, source of credit, and input markets.

4.1) Land Tenure

There are two major kinds of farmers in the study area of Tihuatlan: the private landowners, or "propietarios" and the beneficiaries of the land reform system, or "ejidatarios". This latter group is of greater interest as they produce almost all of the maize that is locally grown (1970 Census).

An ejidatario is a member of a land reform village or "ejido". He has the right to use the land and even pass it on to a son, but not to sell or rent it. Informal rental arrangements were detected in the exploratory survey, including both cash rentals and share-cropping. Lack of "ownership", however, does not appear to have inhibited long-run investment in agriculture: citrus production has recently become a major activity among ejidatarios.

4.2) Working Capital -- The Official Bank

Ejidatarios in the study area, in planting maize or beans, can either use their own funds or they can obtain financing through the official bank (BANRURAL). In the formal survey, 55% of respondents reported working with the bank. Funds obtained through the official bank are heavily subsidized and inputs are sold at a reduced price-- but working with the bank implies that the farmer must use the production technology required by the bank. The bank therefore, plays a central role in adoption of new technology for maize production. Recommendations developed through on-farm research may be directed at the BANRURAL as well as at individual farmers.

Many farmers were found in the exploratory survey that plant maize with the bank on some fields -- and self-finance further maize production on other fields. Curiously, farmers do not use the bank's recommended technology on their self-financed fields. This will be documented in detail in subsequent sections.

Access to some inputs and services -- notably chemical fertilizer and technical support -- are tied to the BANRURAL program. It appears to be quite difficult to obtain fertilizer, for example, other than through a bank loan.

A BANRURAL agricultural loan is relatively easy to obtain. In a given ejido, a group of farmers wishing to use the bank's services elect a representative or "socio delegado" who handles the paper work with the bank. Farmers using the bank's services in a given crop cycle, however, may not necessarily use them in the following cycle.

4.3) Input Markets

Four major input markets may be distinguished: labor, machinery services, fertilizer, and other purchased inputs (e.g. insecticide and herbicides).

There is a very active labor market in the study area. Most farmers (88%) use hired labor for peak season chores in maize production. Exploratory survey results indicate that few farmers can count on help from their sons because most of these find employment in urban areas or in the nearby petroleum fields. Other evidence points to a growing labor shortage: real wages for agricultural daily labor increased by roughly 40% between 1978 and 1981. The current wage is roughly MN $150 per day (equivalent to about 33 kg of maize).

Peak labor periods are found in the months of June, July and August, with a lesser peak in the November to January periods. The June-August period corresponds to the harvest of dry cycle maize, and tillage, planting and weeding of wet cycle maize. (Table 4.1)

Custom machinery hire is widespread throughout the Tihuatlan study area, especially for land preparation for annual crops. For example of these farmers using tractors for tillage in the 1981 "wet" maize cycle, over 90% used hired tractor services. No farmers reported that tractor hire was difficult to obtain, but field observation leads one to believe that many farmers used tractor services at inappropriate times. Wet plowing of the heavy vertisol soils was observed to leave behind huge blocks of soil. This may indicate that the current stock of tractors is insufficient to perform tillage operations during the short periods of favorable physical soil conditions.

TABLE 4.1 PEAK LABOR MONTHS[1/]

MONTH	PERCENTAGE[2/]
MAY	16
JUNE	43
JULY	32
AUGUST	16
SEPTEMBER	11
OCTOBER	0
NOVEMBER	12
DECEMBER	16
JANUARY	16
FEBRUARY	0
MARCH	0
APRIL	0
ALL YEAR	9

1/ Percentage mentioning a given month as a busy one with respect to agricultural work.

2/ Percentage sums to more than 100 due to multiple answers.

The market for fertilizer is tightly controlled. Fertilizer is not freely available through commercial channels, but rather through a limited number of franchized dealers. The only major source of fertilizer at a reasonable distance for farmers in the study area is

BANRURAL, the official bank. The bank clearly has a strong preference for credit users. In short, a farmer who wishes to use fertilizer on his maize but does not wish to use bank services will have problems in finding the fertilizer.

Such other purchased inputs as seed, insecticide and herbicides have a much freer market structure. They are widely distributed through private channels, and frequently are found at the village level.

5.0) The Farming System

5.1) Land Use and Crop Rotations

Maize is not by any means the only agricultural activity undertaken by farmers in the study area. With respect to land use, it is not even the most important. Pasture occupies roughly half the land controlled by the ejidatario farmers, with fruit orchards and annual crops (including maize) accounting for most of the rest. (Table 5.1)

TABLE 5.1 LAND USE

USE	PERCENTAGE OF FARMERS 1/	AVERAGE HA 2/	AVERAGE HA 3/	PERCENTAGE OF FARM
Fruit orchard	58	5.7	3.3	22
Pasture	70	9.6	6.7	46
Annual crops	100	3.8	3.8	26
Fallow/forest	37	2.6	0.9	6
TOTAL			14.7	100

1/ Percentage farmers who use land for this purpose (ejidatarios only)

2/ Only farmers who use land for this purpose

3/ All farmers

Pasture land is used by ejidatario farmers primarily for small dairy operations. These activities provide a constant income and appear to have no major peaks in labor or cash requirements. Fruit orchards similarly have no detectable labor peak demand periods (harvesting is performed by the purchaser), although income is received at infrequent intervals.

On the average, ejidatario farmers only reserve about 25% of their land for the production of annual crops, out of an average farm size of almost 15 ha per farmer. Small farmers, however (less than 10 ha farm size), use almost 70% of their land in the production of annual crops. (Table 5.2). Larger ejidatario farmers (10-20 ha farm size) produce roughly the same number of hectares of annual crops as small farmers, but a lower percentage of their farm area is in these crops.

TABLE 5.2 LAND USE, BY FARM SIZE

CATEGORY	PERCENTAGE OF FARM IN:			
	ANNUAL CROPS	FRUIT ORCHARDS	PASTURE	OTHER
All Farmers	26	22	46	6
Farm size < 10 ha	69	9	5	16
Farm size > 10 ha	22	25	49	4

Within annual crop land, the most important crop is maize. The preferred rotation is two crops of maize per year on the same field. Occasional crops of beans, squash (for oilseed), and chiles are also grown. (Table 5.3). Although the preferred rotation is continuous maize, farmers can choose from a wide variety of potential crop rotations, given the customary planting and harvesting dates of each alternative annual crop. These dates are shown in Table 5.4.

TABLE 5.3 CROP ROTATIONS

ROTATION[1/]	PERCENTAGE OF FARMERS
Maize-Maize-Maize	79
Maize-Squash-Maize	8
Maize-Maize-Beans	3
Other	11

1/ In the rotation description, the first crop is the crop in the ground in a selected field at the time of the survey. The two previous crops are then listed.

TABLE 5.4 TIMING OF CULTURAL PRACTICES, BY CROP

ACTIVITY	OPERATION	M O N T H											
		WET CYCLE						DRY CYCLE					
		MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR
MAIZE	a) Land Prep.	X	X					X	X				
	b) Planting		X	X					X	X			
	c) Weeding			X	X					X	X		
	d) Harvesting	X	X				X	X	X				X
BEANS	a) Planting					X							
	b) Harvesting								X				
SQUASH	a) Planting											X	
	b) Harvesting			X	X								
CHILE	a) Planting							X					
	b) Harvesting												X

In the exploratory survey, farmers indicated that the area in annual crops has been reduced significantly in the last few years, due to profit and risk factors. Maize, for example, is seen as both less profitable and riskier than citrus production.[1/] Sources of risk in annual crop production, as determined in the exploratory survey, are summarized in Table 5.5.

TABLE 5.5 SOURCES OF RISK FOR ANNUAL CROPS[1/]

CROP	DROUGHT	WATERLOGGING	INSECTS	DISEASES	VARIABLES PRICES
Maize	Yes[2/]	Yes[3/]	No	No	No
Beans	Yes	No	Yes	Yes	No
Squash	Yes	No	No	No	Yes
Chile	Yes	No	Yes	Yes	Yes

1/ Source: Exploratory Survey

2/ Dry cycle

3/ Wet cycle

The reduction in annual crop area implies that maize is being increasingly used for home consumption and not for cash sales. In the formal survey, for example, only 50% of the farmers reported selling any maize at all. No significant relation was detected between farm size and the sales of maize. About 40% of small ejidatario farmers (1-9 ha) sell some maize, versus 53% for large ejidatario farmers (10-20 ha).

1/ Recent increases in government subsidies on inputs for maize production combined with large increases in the floor price for maize may have led, after this study was finished, to an increased area in maize.

5.2) Labor Hire and Off-Farm Income

It was pointed out in section 4.3 that ejidatario farmers in the study area rely to a great degree on scarce hired labor in maize production, especially in the peak labor demand months of June, July, December and January. Fewer farmers indicated off-farm work as a source of income. Only 7% reported having permanent off-farm employment, while 17% reported working occasionally as a hired daily laborer. Farm size, however, relates strongly to labor hire practices. As many small farmers as large farmers hire temporary labor but only small farmers work for others. (Table 5.6).

TABLE 5.6 LABOR HIRE PRACTICES, BY FARM SIZE

VARIABLE	FARM SIZE	
	SMALL (1-9 ha)	LARGE (10-20 ha)
% hire labor	82	90
% occasionally work for others	55	0
% permanent off-farm work	9	6

6.0) Current Practices in Maize Production

In the following section, the current management of the maize crop will be described and analyzed practice by practice, including tillage, weed control, insect control, and harvest.

6.1) Tillage

Tillage for maize production in the Tihuatlan study area is largely mechanized, with 60% of farmers plowing, harrowing and furrowing with a tractor. Most of the rest of the farmers prepare their land by hand, with a hoe. Of these farmers using tractors, the majority (90%) use a rented tractor. About 25% of the farmers reported difficulties in obtaining the services of a hired tractor the rental price of which is currently between $1500 and $2000 M. N.[1] per hectare (mean price = MN $1725/ha; modal price = MN $1500/ha). This includes a plowing and one harrowing. Farmers occasionaly pay for a second harrowing at $400 -$600/ha MN.

Tillage practices are strongly influenced by topography and by credit source. Tractors are more commonly used on flat fields than sloped ones. Similarly, tractors are more commonly used on fields where maize production is financed by the official bank. (Table 6.1). This is expected, as the official bank's recommended maize production technology includes tractor tillage. Indeed, almost all farmers who used tractor tillage on <u>sloped</u> fields were found to be working with the bank.

TABLE 6.1 TILLAGE SYSTEMS BY TOPOGRAPHY AND SOURCE OF CREDIT

Tillage System	Flat		Sloped		TOTAL
	Bank 1/	Free 2/	Bank 1/	Free 2/	
	%		%		%
Plow, harrow & furrow with tractor	100	80	55	15	60
Plow & furrow with horse	0	0	9	31	9
Manual (hoe)	0	20	27	46	26
Other	0	0	9	8	5
Total	100	100	100	100	100
% of Total	33	12	26	30	100

1/ Credit from BANRURAL.

2/ Credit from other source, or own capital ("free" is a direct translation)

1/ Equivalent to between 333 and 444 kg of maize.

Farm size does not appear to influence tillage methods. Small farmers, for example, were not found to use more manual land preparation, nor did large farmers appear to prefer tractors (Table 6.2). Recall that farm size does not appear to affect area in maize.

TABLE 6.2 TILLAGE SYSTEMS, BY FARM SIZE

TILLAGE SYSTEM	SMALL (1-9 ha)	LARGE (10-20 ha)	TOTAL
		%	
Plow, harrow and furrow with tractor	75	55	60
Plow and furrow with horse	8	10	9
Manual (hoe)	17	29	26
Other	0	6	5
TOTAL	100	100	100

The farmer's tillage practice does not usually produce an even seedbed. Although the soils that are being tilled are very heavy, tillage is usually restricted to a plowing and one harrowing, which leaves many large clods in the field. Given that hand planting is employed, and that few herbicides are used for weed control, the problem is probably not serious.

If mechanized planting or chemical weed control were to be introduced, however, the current tillage system may be an obstacle to adoption. An even seedbed is needed to achieve a good stand with mechanized planting. Similarly, an even seedbed can significantly reduce the herbicide dose required to obtain good weed control, when compared to an uneven seedbed. For example, if 1 kg/ha Gesaprim 50 is needed on a perfectly even surface to control weeds, 2-3 kg/ha Gesaprim 50 may be needed to control weeds in a field full of a large clods, given the larger effective surface area to be covered by the herbicide.

6.2) Planting

Ejidatario farmers in the Tihuatlan study area all plant their maize by hand, using a long planting stick. On sloped land, where land preparation is performed with a hoe, no furrows are normally used. On flatter fields tillage consists of a plowing, a harrowing and a furrowing, and planting is performed in the bottom of the furrows. Planted density depends on the variety chosen.

Most farmers use the local variety, although some use the Tuxpeñito open-pollinated variety. Those farmers using this commercial variety also use a higher seed rate (Table 6.3).

TABLE 6.3 PLANTING PRACTICES

VARIABLE	ESTIMATE
Variety:	
-- % planted local variety	63
-- % planted Tuxpeñito	28
-- % planted other	9
Average seed quantity:	
-- kg/ha seed -- local variety	12
-- kg/ha seed -- Tuxpeñito	18
Planting date:	
-- % planted in May or June	30
-- % planted in July	38
-- % planted in August or September	32
Source of seed:	
-- % planted own seed	70
-- % obtained seed from bank	28

In response to an open-coded question, farmers reported that different advantages and disadvantages correspond to the two different varieties. Farmers praised the good yields in storability of the local variety but are concerned by its tendency to lodge. Tuxpeñito lodges less due to its small plant size, but is susceptible to weevil attack in storage. (Table 6.4). The question of storability, of course gains in importance to farmers as maize shifts from a cash crop to a consumption crop.

TABLE 6.4 ADVANTAGES AND DISADVANTAGES OF MAIZE VARIETIES[1/]

VARIABLE	VARIETY LOCAL	TUXPEÑITO
	Percent of Farmers	
Advantages:		
-- Yields well	50	17
-- Resists lodging	0	58
-- Early maturing	0	25
-- Stores well	20	0
-- Drought tolerant	16	0
Disadvantages:		
-- Lodges	47	0
-- Insects in storage	10	75

1/ Percentage of farmers using a given variety who mentioned a given advantage or disadvantage of that variety in response to an open-ended question.

The Tuxpeñito variety tends to be grown on flat fields by farmers working with official bank financing. (Table 6.5). Small farmers also tend to use Tuxpeñito, probably because a greater proportion of their financing comes from the bank. It is interesting to note that almost all farmers <u>not</u> working with the bank (and who therefore could take responsibility for variety selection) used the local variety.

TABLE 6.5 MAIZE VARIETY BY TOPOGRAPHY, FARM SIZE, AND SOURCE OF FINANCING

VARIABLE	PERCENTAGE OF FARMERS PLANTING: LOCAL	TUXPEÑITO
Topography:		
-- Flat fields	44	56
-- Sloped fields	94	6
Farm Size:		
-- Small (1-9 ha)	45	55
-- Large (10-20 ha)	76	24
Source of Financing:		
-- Bank	45	55
-- Other	94	6

Farmers reported a remarkably wide range in planting dates. Some farmers planted as early as May while others delayed planting until September. The major reason for delay in planting appeared to be water-logged fields caused by unusually heavy rains in June and early July. Since fewer sloped fields were waterlogged, fewer sloped fields were planted late. (Table 6.6). There is no evidence, however, to indicate that fields planted in August are less productive than fields planted in June or July.

TABLE 6.6 DATE OF PLANTING, BY TOPOGRAPHY

DATE OF PLANTING	FLAT	SLOPED	TOTAL
		%	
May - June	10	46	30
July	40	36	38
August - September	50	18	32
TOTAL	100	100	100

There seems to be little room for the mechanization of maize planting at the current time. Mechanization would require more thorough tillage, which would increase production costs by MN $400 - 500[1] per additional harrowing. It would at the same time save very little labor; currently, farmers only use 2-3 man-days per ha in planting, costing MN $ 150 per man-day. Finally, it should be recalled that maize area is declining and that few farmers have more than a few ha reserved for annual crops.

There does, however, appear to a need for improved maize varieties. It is clear that farmers would like to have access to a high yielding, early-maturing variety of white maize that is resistant to lodging -- and that also is storable (i.e. weevil resistant) under farmer conditions.[2] If it appears unlikely that such a variety be developed, research on storage techniques for the Tuxpeñito variety (or other forthcoming modern varieties) could be useful.

6.3) Fertilization

Most ejidatario farmers in the study area do not fertilize their maize. Of the 36% of farmers who do fertilize, most of these use only urea (46-0-0) and the rest use only DAP (18-46-0). The most common method of application is to place the fertilizer in the furrow near each plant, immediately before either cultivation or hilling-up (15-45 days after planting). The average dose of N applied by fertilizer users is 45 kg/ha (Table 6.7).

The use of fertilizer does not appear to be related to either topography or farm size. That is, farmers on flat land do not show a higher tendency to fertilize than farmers on sloped lands, nor do fewer small farmers apply fertilizer than large farmers. However, the use of fertilizer is related to source of financing. Farmers working with the bank tend to fertilize, but farmers not working with the bank rarely do

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1/ Equivalent to between 90 and 110 kg of maize.

2/ More work needs to be done to ascertain what characteristics are needed for weevil resistance - husk cover, grain type, etc.

so. This is to be expected, because the bank is for all practical purposes the only source of fertilizer in the study area.[1/] (Table 6.8).

TABLE 6.7 FERTILIZATION PRACTICES -- FERTILIZER USERS

VARIABLE	ESTIMATE[1/]
% Fertilizer	36
-- % use urea	30
-- % use 18-46-0	6
% Obtain fertilizer from bank	82
% Use only one application	100
Application method:	
-- % broadcast	12
-- % place in furrow near plant	88
Timing of fertilization:	
-- % at planting	6
-- % at first weeding	47
-- % at hilling-up	47
Average N dose (kg/ha)	45

1/ Users only, except for "% fertilizer"

[1/] It was expected that an even larger proportion of farmers working with the bank would use fertilizer because this forms part of the bank's required technology. In follow-up interviews, some farmers indicated that bank fertilizer arrived too late for application to current cycle of maize.

TABLE 6.8 FERTILIZER USE BY TOPOGRAPHY, FARM SIZE AND SOURCE OF FINANCING

VARIABLE	PERCENTAGE OF FARMERS WHO FERTILIZE
	%
All farmers	36
Topography:	
-- flat fields	35
-- sloped fields	36
Farm Size:	
-- small (1-9 ha)	36
-- large (10-20 ha)	35
Source of financing:	
-- bank	52
-- other	12

Those farmers who did not apply fertilizer indicated several reasons for this decision. The major reasons were that: this cycle's weather was unfavorable for fertilization (50%), insufficient capital (31%) and that fertilizer does not increase yields (19%).

Fertilizer does not have to increase yields very much in order to be profitable, given current price relations. A farmer increasing his fertilizer dose from 0 to 45 kg/ha of N in the form of urea only incurs an expense of about MN $ 400 per ha for the purchase and transport of urea. Adding an application cost ($ 150) and cost of capital (50% minimum rate of return required to induce investment), the total cost that must be recovered increases to MN $ 825 per ha. This is equivalent to roughly 200 kg/ha of maize, or roughly 4 kg of maize per kg of N. That is, an average yield increase of only 200 kg/ha is sufficient to make profitable the use of 45 kg/ha of N in the form of urea.

In a good year, (i.e., with good weather), agronomists expect maize yields to increase by considerably more than 200 kg/ha. In bad years (drought, waterlogging), however, maize yield response to fertilizer can be cut to zero. Given the high probability of bad years occuring (Table 3.2), fertilizer use may only be just profitable on the average and may particularly difficult for risk averters. (Recall, however, that fertilizer use is not related to farm size, a commonly-used measure of risk-taking capacity.)

In summary, survey results indicate that there are two likely reasons for low fertilizer use rates: weather-related risk, and difficulties in obtaining fertilizer. Technological innovations that reduce the effects of drought or water-logging on maize yields (e.g. zero tillage with mulch, drainage) should also raise the average productivity of fertilizer and make its use more attractive. Nonetheless, fertilizer use is not likely to become more widespread until fertilizer supplies are made more accessible to farmers, especially farmers who decide not to work with the official bank,

6.4) Weed Control

Weeds are a serious problem in the Tihuatlan study area. Farmers consider weeds to be a problem and field trips revealed numerous plots in which weeds can be expected to reduce yields considerably. Weeds are mostly broad leaves and annual grasses.

Most farmers control weeds by hoeing their field once or twice. Some farmers, however, use horse cultivation, at times in combination with hoeing or "hilling-up". (Table 6.9). Hilling-up refers to a pass between the rows with a horse-drawn plow, which heaps up earth around the base of the maize plants. Cultivation is done at roughly 20 days after planting, while hilling-up is done at roughly 45 days. Few farmers use herbicides.

TABLE 6.9 WEED CONTROL PRACTICES

VARIABLE	ESTIMATE
% farmers consider weeds a serious problem	77
Weed control system:	
-- % only hoe	53
-- % cultivate, hoe and hill-up	14
-- % cultivate and hoe	11
-- % cultivate and hill-up	8
-- % other	16
% use herbicide	6

The weed control practice used by farmers depends somewhat on the tillage practice employed. Farmers that tend to prepare land with a hoe also tend to weed with a hoe. The hoe is, however, also used by a number of farmers that use tractor tillage (Table 6.10).

TABLE 6.10 WEED CONTROL SYSTEM BY TILLAGE SYSTEM

WEED CONTROL SYSTEM	TILLAGE SYSTEM TRACTOR PLOW HARROW AND FURROW	ONLY HOE
	%	
Only hoe	42	80
Cultivation	58	20
TOTAL	100	100

Exploratory survey results indicate that farmers use 8-12 man-days per ha in hand weeding, per weeding, with only one weeding being more common than two. The cost of weeding, then, varies between MN $ 1200 and 1800 per ha. Much of this labor is hired labor, as weeding is performed during a period of peak demand for labor. As was noted in a previous section, labor is increasingly scarce in the study area. This is reflected in a 40% increase in the real wage paid to agricultural laborers, in three years.

The weed control practice selected by farmers is somewhat influenced by topography, with farmers planting maize on sloped fields showing a slightly higher preference for the hoe. (Table 6.11).

TABLE 6.11 WEED CONTROL SYSTEMS BY TOPOGRAPHY, FARM SIZE AND SOURCE OF FINANCING

VARIABLE	% ONLY HOE	% CULTIVATE 1/
Topography:		
-- flat fields	38	62
-- sloped fields	67	33
Farm Size:		
-- small (1-9 ha)	33	67
-- large (10-20 ha)	61	39
Source of Financing:		
-- bank	55	45
-- other	57	43

1/ Any weed control system in which cultivation is included.

Given increasingly scarce labor, chemical weed control may offer substantial benefits to local farmers. Estimating four man-days per ha needed for hauling water and herbicide application, and a dose of 2 kg/ha of Gesaprim 50, the cost of weed control could be cut to roughly MN $1000/ha. Furthermore, the quality of weed control may improve; chemical weed control is likely to lead to a cleaner field during the early stages of plant growth and may therefore increase yields. However, the selection and dose of herbicides should be determined by appropriate experiments on farmers' fields.

Intercropping and rotations should not present complications in the adoption of chemical weed control. The most common rotation is maize-maize, and intercropping of annual crops is almost nonexistent.

The farmers' tillage practice, however, may affect the profitability of chemical weed control. Tractor tillage in the study area leaves large, unbroken clods which, among other things, increases the dose of pre-emergent herbicide needed to control weeds. If the cost of <u>herbicide purchase</u> were to exceed MN $ 1000/ha (eg. 4 kg/ha Gesaprim 50), chemical weed control would show no cost advantage over hoeing with hired labor.

A possible solution to this difficulty is chemical zero tillage. If herbicides were used for both land preparation and weed control, large clods would not be formed and herbicide doses could be kept to a minimum. Furthermore, the resulting mulch cover could have highly favorable effects on moisture conservation and erosion control. Recall that droughts are perceived by farmers as an important problem in maize production. This practice could probably be implemented through the use of relatively inexpensive herbicides, given the absence of perenniel grasses in farmer's fields.[1/]

1/ CIMMYT agronomists have had, in fact, considerable success in developing a cost-reducing, yield-increasing, risk-reducing practice of chemical zero tillage suited to the study area.

6.5) Insect Control

Insect pests and their control were not studied in the formal survey. Exploratory survey results indicate that insects rarely lead to serious maize yield losses in the study area. Farmers already use an inexpensive and effective control when insect infestations do occur, although they have chosen a relatively toxic insecticide. Insects that are commonly present are leaphoppers in the early stages of plant growth, and armyworms somewhat later. Farmers apply 1/4 to 1/2 lt/ha Folidol (50% Methyl parathion) once or twice on infested fields. These insects may be present in both the dry and wet maize cycles.

6.6) Maize Harvest, Sales and Storage

Ejidatario farmers in the Tihuatlan study area harvest their maize by hand, largely with hired labor. Given the small size of most maize fields, it is unlikely that harvesting will be mechanized in the near future. Farmers normally leave the maize in the field until dry enough for storage, as there are no drying facilities in the area. Given the atmospheric humidity usually present, field drying can take quite a while.

About half of farmers sold no maize at all. The proportion holds for large as well as small farmers. Of those who do sell some maize, most sell less than half of their harvest. Those sales are normally conducted immediately after harvest. (Table 6.12). As noted in section 5.0, maize is now more a consumption crop than a cash crop.

No questions were included in the formal survey on maize storage problems. The exploratory survey, however, indicated that weevils are the major storage problem, particularly with respect to the modern variety, "Tuxpeñito". Maize is typically stored unshelled with the husk intact. Few farmers complain of rat damage or maize spoiled due to moisture.

TABLE 6.12 MAIZE SALES

VARIABLE	ESTIMATE
Maize Sales:	
-- % sell whole harvest	5
-- % sell more than half the harvest	12
-- % sell less than half the harvest	31
-- % do not sell	52
Timing of Sales:	
-- % sell immediately after harvest	28
-- % sell one month after harvest	15
-- % sell even later	5
-- % do not sell	52
Median sales price ($/kg)	4.5

7.0) Conclusions

7.1) Recommendation Domains

Before a list of research opportunities and priorities can be drawn up, a tentative decision must be made on the delineation of recommendation domains (RD's). An RD is a group of farmers with similar circumstances and problems, and who are expected to find the same new technology similarly useful.

Three potential criteria for RD delineation were analyzed in sections 6.1 to 6.6. These are: Topography (sloped fields vs flat fields), farm size (1-9 ha versus 10-20 ha), and source of financing (bank versus self-financed). The latter criterion, however, is not a very satisfactory base for planning agricultural research: are researchers to plant one set of trials for bank users and another set for non-users? This becomes ridiculous as current users can easily be non-users next cycle, and vice-versa.[1/]

Of the two remaining criteria, topography appears to have more impact on farmer practices and circumstances than does farm size. (Table 7.1). Therefore, the topography criterion is proposed as a basis of grouping the first set of on-farm experiments. The possibility of adjustment at some future date, of course, remains open.

TABLE 7.1 EFFECT OF TOPOGRAPHY AND FARM SIZE AND FARMER CIRCUMSTANCES AND PRACTICES

VARIABLE	EFFECT OF: TOPOGRAPHY	FARM SIZE
Source of risk - maize	Some	None
Off-farm income	None	Some
Land Use	None	Great
Crop rotation	None	None
Maize Production:		
-- Tillage	Great	None
-- Variety	Great	Some
-- Planting Date	Some	None
-- Fertilizer Use	None	None
-- Weed Control	Some	Some
-- Sales	None	None

1/ If use of official bank credit were to have a major impact on input prices or cost of capital, two recommendations (one for bank users and another for non-users) might emerge from a single set of on-farm trials. The question then becomes why all farmers don't work with the bank.

7.2) Research Opportunities and Priorities

For a program of on-farm experiments (for the purpose of formulating new technologies useful to representative farmers) the following are proposed, on the basis of the survey results presented in the previous section, as high-priority research topics:

1) Chemical weed control: on flat fields, the basis of comparison should be horse cultivation with hoeing along the row, and hilling-up. On sloped fields, the base for comparison should be hoeing only (maximum two hoeings). Herbicides should be selected to control broadleaf weeds and annual grasses.

2) Zero tillage (herbicides): on flat fields, the base for comparison should be tractor plowing, harrowing (once) and furrowing. On sloped fields, the basis of comparison may be tractor tillage (moderate slopes only) or hoeing.

3) Fertilization: the official bank may welcome guidance in the selection and doses of fertilizer for these customers. Flat and sloped fields are likely to have different average responses to fertilizer. The response to earlier applications of fertilizer could also be checked.

4) Storage: Research on weevil control could be very helpful.

5) Varieties: As a longer-run project, selection by breeders of new varieties to fit farmer preferences would be most useful. Farmers would like a high-yielding, short-statured, white maize with low susceptibility to weevils in storage.