The Impact of Improved Maize Germplasm on the Lives of the Extreme Poor: The Case of Tuxpeño-Derived Material in Mexico[1]

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Mauricio R. Bellon, International Maize and Wheat Improvement Center (CIMMYT), Apartado Postal 6-641, 06600 Mexico, D.F. Mexico, m.bellon@cgiar.org +52-55-804 2004
Michelle Adato, International Food Research Institute (IFPRI), 2033 K St. NW. Washington, DC 20006, USA, m.adato@cgiar.org
Javier Becerril, International Maize and Wheat Improvement Center (CIMMYT), Apartado Postal 6-641, 06600 Mexico, D.F. Mexico, j.becerril@cgiar.org +52-55-804 2004
Dubravka Mindek, Independent Consultant, dmindek@axtel.net

Abstract
This study documents how poor small-scale farmers in lowland tropical Mexico use improved maize germplasm and how their use contributes to their well being. It does this by assessing both the direct adoption of improved varieties as well as by examining the process of their "creolization." By exposing improved varieties to their conditions and management, continually selecting seed of these varieties for replanting, and in some cases promoting their hybridization with landraces, either by design or by accident, farmers produce what they recognize as "creolized" varieties. Our key hypothesis is that poor farmers benefit from improved germplasm through creolization. Creolization provides farmers with new options, as they deliberately modify an improved technology generated by the formal research system to suit their own circumstances and needs. Different methodologies such as participatory methods, ethnography, case studies, a household sample survey, and a collection and agronomic evaluation of maize samples were used. This study was carried out in two regions: the coast of Oaxaca and the Frailesca in the states of Oaxaca and Chiapas respectively, two of the poorest states in Mexico. These regions are contrasting—one subsistence-oriented and the other commercial, in both extreme poverty is pervasive. Maize continues to play a key role in the livelihoods of the poor in both regions. Modern varieties and particularly creolized varieties are widely planted in both regions. The results support the hypothesis. The implications of the findings are discussed.

Key words: impacts, maize, Mexico, poverty, small-scale farmers

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I. Introduction

Improved maize varieties have been available in Mexico for more than 40 years but diffusion of these varieties has been limited. Despite repeated government campaigns to encourage use of improved seed, today only about one-fourth of the total maize area in the country is planted to improved varieties; most of this area is located in the commercial production zones of central and northwestern Mexico (Morris and Lopez-Pereira 1999). The relatively low rate of diffusion may provide a misleading impression, however, of the true impacts of improved germplasm on the welfare of rural households. A growing body of evidence suggests that many small-scale subsistence-oriented farmers have taken up improved varieties and planted them alongside local varieties. Through exposing improved varieties to their conditions and management, continually selecting seed of these varieties for replanting, and in some cases promoting their hybridization with landraces, either by design or by accident, farmers produce what they recognize as "creolized" varieties (*variedades acriolladas*)[2] (Bellon and Risopoulos 2001). Improved varieties provide desirable traits or combinations of traits not found in landraces, but also may lack traits found in the landraces, hence choosing between one or the other presents trade-offs to farmers. Creolized varieties are intermediate between improved varieties and landraces. To farmers, particularly to the poor, creolized varieties then provide traits not supplied by landraces, while they entail less trade-offs than improved varieties.

Conventional germplasm impact studies usually focus on areas planted to improved varieties. To date, few attempts have been made to document the use of creolized varieties. The lack of studies in this area constitutes a major gap because if creolization is ignored, the benefits generated by formal plant breeding programs may be significantly underestimated. This study attempts to document how poor farmers in lowland tropical Mexico use improved maize germplasm both directly (by adopting improved varieties) and indirectly (by creating creolized varieties). In addition, the study attempts to determine how the use of improved germplasm contributes to the well being of poor small-scale farmers. Our key hypothesis is that poor farmers benefit from improved germplasm through creolization. Creolization provides farmers with new options, as they deliberately modify an improved technology generated by the formal research system to suit their own circumstances and needs.

The study involves three separate but related activities: (1) measuring diffusion, local adaptation, and use of improved maize germplasm; (2) understanding how adaptation choices are linked to livelihood strategies and vulnerability context of rural households; and (3) assessing the impacts of adoption on the welfare of rural households. The specific focus of the study is the Tuxpeño germplasm complex. Tuxpeño is one of approximately 250 maize landraces found in the New World. This maize race has been subjected to intensive breeding efforts, first by the Rockefeller Foundation and the Mexican Ministry of Agriculture and later by their successors, CIMMYT and Instituto Nacional de Investigaciones Forestales Agricolas y Pecuarias (INIFAP), respectively. This study was

[2] Wood and Lenné (1997) use the term "rustication" to describe the process through which materials produced by formal plant breeding programs change in the hands of farmers.

carried out in two regions: the coast of Oaxaca and the Frailesca in Chiapas. They are located in Oaxaca and Chiapas, two of the poorest states in Mexico.

The rest of the paper is divided into five sections. The next section describes the methods used in the study. The subsequent section presents a description of the two study regions. This section also presents characteristics of farmers who participated in this study, particularly in regards to poverty and their livelihood strategies. The third section defines the different types of germplasm studied and presents a history of their diffusion, including the origin of seed used and its management. The fourth and fifth sections present results of adoption of different germplasm types and their impacts on farmers' well-being respectively. The impacts are defined and analyzed in terms of the extent to which different types of germplasm supply farmers with traits they consider important and the trade-offs. The paper ends with the conclusion and implications.

II. Methods

Different methodologies were used. Twelve communities were selected in areas of medium, high and very high marginality, defined according to an index used by the Mexican government to target its poverty alleviation program (CONAPO-PROGRESA 2000), they also included communities with indigenous population. Site selection also included agroecological considerations since the study focused on a tropical maize germplasm, as well as information on government programs to diffuse seed of improved varieties. These included focus group discussions, both on technical issues and on livelihood strategies; household case studies in which anthropologists spend several months interacting with farmers in four of the villages included in the study; a representative sample survey of 325 farming households covering all 12 communities; a collection of all maize types grown in the communities and an agronomic evaluation of maize samples are used in this research[3].

III. The Study Area

The twelve communities were included in this study. They are located in two highly contrasting regions: the coast of Oaxaca and the Frailesca, Chiapas[4] (Figure 2). The communities were selected in a systematic way so as to sample the range of marginality levels, levels of improved germplasm diffusion and ethnicity present in both regions. We believe that these communities represent the range of conditions present in these two regions.

Communities in Chiapas have better access to government provided services and infrastructure even for similar marginality level than those in Oaxaca. Productive activities are more oriented to the market and the region has received strong support from state and national governments, particularly for agricultural development. This region

[3] For a complete description of the methodology see Bellon et al. 2003.
[4] For simplicity referred as Oaxaca and Chiapas respectively in the rest of this paper.

produces important maize surpluses that are exported to other parts of Mexico, however still agriculture is dominated by small-scale farmers that produce both for the market and for their own consumption. There is an important diary industry and farmers can add value to their maize by using it as animal feed. The use of inputs and improved seed has been promoted through several government projects throughout the years.

Figure 1. Map of the communities included in this study

In contrast, Oaxaca has been more isolated and has not received much government support for agricultural development. The state of Oaxaca imports substantial amounts of maize from other parts of Mexico and from outside. Although the coast of Oaxaca has better climate for maize and agricultural production than other regions of the state, it is not an important producer of this staple. Commercial agricultural activities are more biased towards extensive cattle ranching and maize production towards home consumption. Development has been more related to tourism, particularly in the southern part of the study area, where there are resorts such as Puerto Escondido, Puerto Angel, and Bahías de Huatulco.

a. Poverty

Poverty is pervasive in both regions, even in the more commercialized and developed Chiapas. Poverty rates were calculated with data on household consumption obtained from the survey. These data included both purchased and self-produced items to which local prices for similar goods and services were imputed[5]. Two poverty lines were constructed: extreme poverty and poverty[6]. Based on these lines three groups were defined: the extreme poor (expenditure below the extreme poverty line), the poor (expenditure between the extreme poverty and the poverty line) and the non poor (expenditure above the poverty line).

Most farming households are under the extreme poverty line in Oaxaca and Chiapas, 74.7% and 63.2% respectively. On a population basis, however the rates of extreme poverty increased substantially as Table 1 shows, indicating that extreme poor farming households have on average more members than the others. This table presents the FTG poverty measures (Foster et al. 1984) using the extreme poverty line as reference. The headcount index, the poverty gap, and the severity of poverty index show that there are more poor in Oaxaca with larger poverty gap and more extreme poverty than in Chiapas.

Table 1

[5] Per capita expenditure was calculated and adjusted to adult equivalents with the weights used by Skoufias et al. (1999). Furthermore, household expenditure in Oaxaca was adjusted to make it equivalent to purchasing power in Chiapas because prices for similar goods were higher in the former than in the latter .

[6] The poverty lines were developed according to the methodology of Guevara Sanginés et al. (2000). The extreme poverty line was defined as the expenditure necessary to purchase the COPLAMAR standard food basket plus 27% more for basic non food items (MX$ 415/capita month in 2001). The poverty line differed from the extreme poverty line in that it increased the amount of non food items to 125% of the cost of the food basket (MX$ 754.82/capita month in 2001).

Poverty has multiple dimensions of which consumption is only one. The qualitative work provided important insights into these other dimensions. Local indicators of poverty and wealth fall into several categories: material resources, culture, beliefs, and behavior. Resources are given the heaviest emphasis, with access to and uses of land being most significant, others include access to money, planting of other crops, e.g. coffee, performance of other activities besides agriculture, ownership of animals and implements, amount of family labor that can be mobilized, ability to speak Spanish, whether one receives remittances or not, and type of off-farm labor.

Another aspect of poverty is cultural: indigenous roots indicate poverty. These people live on the margins of the community with little land or money; illiteracy and lack of Spanish fluency keep people in poverty by limiting their ability to find work outside the area. Finally, poverty is also related to beliefs, practices and behavior. Wealthier families represent the best morals and practices: they are hard workers and frugal. They are also stuck-up, untrusting, and stingy. Informants described families of average wealth as hard workers, although they are held back by a lack of access to some vital resource. The poorest have great difficulties. They have no money and no one to help them. Additionally, they hurt themselves since they waste money from government programs on vices, and are perpetrators of domestic violence. Women cannot provide good homes here since they have to work. Similarly, their children cannot study for lack of money. In some communities, religious affiliation, in particular, Evangelical Protestants, as said to be wealthy because they do not drink and work hard.

Vulnerability is another dimension of poverty emphasized in the qualitative work. A number of factors make people vulnerable to poverty or to worsened conditions of their poverty: These include 1) p*opulation growth which provokes land pressure*; 2) *resource pressures:* cash for investment in agriculture, "tired," hilly and eroded land; 3) t*he local economic system, including restricted access of the poor to markets:* lack of stable wage work, little education level, illiteracy, and monolinguism hinder employment prospects; falling coffee prices, low maize prices. The institutional environment surrounding maize markets in Chiapas reveals and exacerbates social differences. Warehouses require a minimum quantity and quality, which the poorest farmers can not meet. They thus must sell it to intermediaries, better known as "coyotes." They are less demanding about the quality and quantity, but pay considerably less than the warehouses. In spite of this, the coyote is, if not well considered, represents at least a necessary evil because he pays cash up front, picks up the maize and does not charge transportation. Coyotes also provide loans for planting, and many farmers go in debt in order to plant. 4) *Shocks:* Rapid and severe climatic, human and animal health changes, and delays and excesses of rainfall, and strong winds adversely affect agriculture. Pests and diseases affect larger animals. 5) *Seasonal changes*: Mainly, people run out of maize, and they have to buy seed and invest in their fields precisely when they have the least money or food. The poor must leave their fields for work elsewhere during the planting season and as a consequence do not tend their fields, and lower their yields. Colds and flu make work more difficult. Finally, the religious festival season requires the poor to harvest maize too early, before the ears are ready, and sell the grain before the price reaches its maximum as noted above.

b. Role of maize in farmers' livelihoods

Households in these two regions have diversified livelihoods: they grow several crops, keep different types of animals and participate in diverse off- and non-farm activities. The crops include besides maize: beans, squash, fruit trees, coffee, tomatoes, red peppers, sesame seed, hibiscus, groundnuts and cacao. All households grow maize and this crop is an important component of farmers' livelihoods in both regions. There are, however, differences between them. More than three-quarters of farmers in Oaxaca grow maize for home consumption exclusively, while in Chiapas, almost all farmers grow maize both for the home and the market. Few farmers in both regions produce entirely for the market. More than half of farmers in Oaxaca did not produce enough to meet their maize needs in the last five years. Only about a third of farmers frequently sell maize and most sell less than half of their production. Maize is sold mainly to families in communities and to a much lesser extent, to local traders. On the other hand, farmers are very commercialized in Chiapas. More than 90% produced surpluses in the last five years, almost all sold maize and sold more than half of what they produced. They sold mainly to the government, private business and local traders, or a combination of them. Almost none sold to other families in the community.

The price of maize varies between regions. Maize is much more expensive (~60% on average) in Oaxaca than in Chiapas. There are also differences between the purchasing and selling prices within the two regions. While maize is more expensive in Oaxaca, there is almost no difference between the selling and purchasing price, while there are important differences in Chiapas, where buying maize is around 30% more expensive than selling it. Hence, it is significantly cheaper for a household in Chiapas to produce its own maize than to sell and buy it. This may explain, to a certain extent, why in a commercialized system such as the one in Chiapas, production for home consumption remains an important objective of maize production.

The qualitative work supports many of these findings. In Oaxaca, people mainly grow maize for personal consumption, and the poorest farmers depend on it for their food security. Although people in Chiapas are mostly interested in selling their crops, maize cultivation assures basic subsistence, and is particularly important for the poorer farmers. As one extreme poor farmer in Dolores explained "*It is necessary to take out the portion that is our food because there is no work and if we don't plant we will die of hunger*." Still, for many maize is most important as a source of money. Although they take out a portion of the food for their annual consumption, people who are better off sell maize in large quantities. Additionally, large producers in Chiapas have trucks, shipping contacts, and enough money to buy other products.

Maize also plays important non-economic roles in people's lives, though these sometimes also have economic effects. For example, maize plays a role in the cargo system (also known as *mayordomia),* a ritual cycle wherein people sponsor parties honoring a saint's feast day. This especially affects the extreme poor, who have to sell early in order to help pay for holiday expenses. An early harvest causes people to lose significant income. A few informants in the Oaxaca said that they planted maize because of traditions. They

also interpret the material benefits of corn in light of this. One man held, "*I cannot accept not planting, because ever since I was little this was the job of my father, so I couldn't find myself and can't keep from planting, because when there are tender ears, you go and harvest whenever you want and the amount you want, and if you go to buy it isn't the same*."

Maize production is a risky endeavor for farmers. The case studies revealed that farmers see maize, though necessary for food security, as an extremely risky endeavor. There are many different sources of vulnerability in maize production. They include the climate (mainly rain, drought and wind), money invested—and hence profitability, availability of labor, lack of land, pests (both insects and mammals), and tired soils. Although there were differences between regions, in both climatic risks were considered the most important factor of vulnerability. Any factors or interventions that decrease climatic risks would have wide and very positive effect on the well being of all farmers in both regions.

IV. History of diffusion/dissemination/adaptation

a. Maize germplasm

We classified the maize varieties identified in the survey into five categories: hybrids, recycled hybrids, open- pollinated improved varieties (OPVs), creolized varieties, and landraces. The classification is based on: (a) the name provided by the farmer, (b) whether the farmer said that the seed came from a "bag," (c) the number of years seed was used, (d) information on its origin from the farmer and focus group discussions and (e) classification by a maize taxonomist of a collection of maize samples from all communities in the study. Table 2 presents the specific criteria used for each category. Obviously the classification is based on our judgment and hence there may be misclassifications. The criteria however, were applied systematically and we are confident that on average the classification is correct. This classification is the basis for the adoption and impact analyses presented below.

Table 2

A key finding of the case studies is that local categories of seed types are not the same as the ones defined above. People generally classify seeds that do not come in a new package as "*criollo*," regardless of whether they are recycled, creolized, or landraces according to formal definitions. In discussions of the case study findings, we use the local terms when referring to perspectives of the informants. In Oaxaca people distinguish between "*criollo*" and "variety" maize. The latter includes all those that come from agricultural secretariat programs. In Chiapas, informants distinguish between "*criollo*s" and seeds from a bag. Among bagged seeds, they distinguish between those from the secretariat and hybrids or commercial seeds from veterinarians. In neither region do people distinguish between old or "original" *criollo* seeds, i.e. landraces and those that were "*criollo*-ized" (*acriollado)* over time. Both types are called "criollos."

Furthermore, people do not necessarily define varieties so much as describe them in terms of their advantages and disadvantages. Only in Oaxaca did people sometimes refer to *criollo* as the original maize, i.e. a landrace. They do have positive associations with these varieties: "*It is good; it was the first one that began to help us*." People in Oaxaca generally have better knowledge about the characteristics of each variety, which is probably related to a longer tradition of maize cultivation.

Nonetheless, people have different confidence in different types of seed. Notably, people have more confidence in *criollo* seed (i.e. the combined local category), because they know it: "We consider it confidently because we already know it, we have planted it before, and we have no doubts about it." Recycling, i.e. selecting seed from a previous harvest and replanting, is considered to be creating creolized seed. Most people consider recycled or "*acriollado*" seeds to be *criollo* in a few years. Even in Chiapas large-scale producers expressed their preference for "*criollo* seed", despite the fact that they plant improved varieties. Key to classification as a *criollo* seed is that the seed has been "acclimatized" to local soils, i.e. seen as adapted to these soils. According to one farmer in Chiapas: "*at first it was like a hybrid and now, later, it is criollo... It likes the soil. It acclimated*." When asked whether this process was what makes a variety 'criollo,' another farmer said "*yes, that is exactly what makes it criollo. After some seasons it adapts and will produce any place. Because they planted it once and now it knows the land and since the land is good [it produces]."*

b. Sources of seed

Farmers in both Oaxaca and Chiapas distinguished between maize kernels as grain and maize kernels as seed, although from a biological perspective they are the same. In the case of recycled seed, maize kernels used as seed are usually subject to a rigorous selection process. In farmer-to-farmer seed transactions, kernels for seed and grain show important price differentials. For example, landrace seed costs MX$ 3.88/kg and MX$ 3.51/kg in Oaxaca and Chiapas respectively, while landrace grain costs MX$ 2.41 and MX$ 1.82, respectively. According to informants in the case studies, farmers can obtain seed in six manners: select it from their own harvest, obtain it through social networking (this includes buying and selling, and reciprocity from relatives, neighbors and friends), buying from the government through the *ejido* commissary, buying it from *campesino* organizations, buying (at a greatly reduced price) through political campaigns, buying it in veterinary clinics or seed stores.

The previous harvest and social networks were the most common sources in both regions, and prevalent among all social groups. Data from the survey supports these findings. During the rainy season of 2001, most farmers in Oaxaca planted seed from the previous harvest (61.4% of seed lots)[7]. In Chiapas this was much lower was still significant (39% of seed lots). The rest of the seed was acquired either from other farmers, the government or stores. In Oaxaca, the most common outside sources of seed are farmers' social networks—family, friends, and neighbors—the government and the store. In Chiapas, on

[7] A seed lot is defined as "…all kernels of a specific type of maize selected by a farmer and sown during a cropping season to reproduce that particular maize type" (Louette et al. 1997:24).

the other hand the government is the main source, followed by social networks and stores. These patterns again illustrate the contrasting nature of maize production in both regions, with the Oaxaca relying more on local sources of seed and Chiapas more on outside sources, particularly the government. Social capital plays a key role in accessing seed in Oaxaca, while this role is much weaker in Chiapas.

The memory of informants is not very precise regarding the particular history of introduction and adaptation of each variety, nor about the sequence of variety replacements. But they are aware that improved ones offered by different institutions have replaced the old criollo varieties.

Once inside a community, new seeds spread mainly by informal networks. People observe the fields of their neighbors and relatives and obtain successful varieties by buying or trading for them. Occasionally, they receive them as a gift. In the opinion of producers in Chiapas, good and guaranteed seeds are expensive, and sold by seed companies. They are usually unavailable to people because they are expensive. Even if they are considered the best, they are too expensive. In fact, people see poverty as defined in part by what kind of seeds one uses, as stated by a poor farmer: "*Poor people around here are the ones who plant ordinary varieties.*"

The government has played an important role in supporting maize cultivation, especially for less well-off farmers, through programs to promote access to seed, credit for purchase of inputs, and technical support. While a number of programs have existed, many problems have been encountered. This experience has influenced people's perceptions and attitudes toward the reliability of government support, and the quality of government seed. Significantly, experience with government seed and related programs have made people wary of using improved seed more generally.

The Agricultural Secretariat is the main government program and the main promoter of seeds in both regions is the. The agency manages two important programs: Alianza para el Campo and the Programa de Apoyos al Campo (Procampo). The former provides among other things subsidized seed from both public and private sectors, know as the *kilo por kilo* program. The latter provides farmers with a cash subsidy for the area planted to certain crops and maize is one of them. Farmers can use Procampo money to purchase seed and agricultural inputs—but that is a farmer's decision. These programs, but especially Procampo, are distrusted and many do not register all or any of their land because people feel that the programs aim to take land from them. In both regions, the *ejido* commissaries are the most important local institution that connects government programs and farmers. The *kilo por kilo* seed is channel through the *ejido* commissaries, which become an important source of seed. The majority of improved seeds used by *ejido* producers come through inexpensive technological packages." These packages have been and are the principal source of improved seeds for our case study households, although they are not the most popular. The quality of the seed often is poor. An agronomist working in the region explained that government seeds are poor because municipal governments limit themselves to providing cheap seeds that are poorly adapted to local soils. Another problem in both regions is that seeds arrive at the wrong time, e.g. when it

is too late to plant*: There is no faith in the government now, because they don't come through with what they promise…the support comes so late that nothing can be done."*

In communities in both regions, informants complain that government technical assistance is greatly needed but not does not come. Another complaint is that government authorities distribute seeds unfairly. In one community in Chiapas informants related this to the influence of political parties: "*The commissary gives the seed to his group of people and sells what is left over to the townspeople. He calls his people very secretly and writes their names on the list, especially those who belong to the PRI*." (*Partido Revolucionario Institucional*—until 2000 the dominant political party in Mexico, which is still strong at the local level.) Another way that seed is politicized is through political campaigns, where improved seeds are introduced in communities, and given as gifts to or at low price to supporters.

Complaints about politics are also heard regarding agricultural support services more broadly. In Chiapas, the poorest people complain that supports are mainly given to the people close to authorities. Another problem attributed to politics (though it may also relate to economics) is the frequent complaint that government programs stay in regional centers, with little reaching small towns. In Chiapas, some expensive seeds can be obtained by belonging to regional *campesino* groups. To belong to such a group can be difficult and expensive however, but it said that it can be worth the effort for those who are able to achieve it.

c. Seed management and flows

Recycled seed from one's own harvest or from other farmers is the most important source of seed, even in the more commercialized Chiapas. Beyond its value as a source of seed, seed recycling has important genetic consequences for the maize varieties that farmers plant. Varieties change under farmer selection. By selecting the plants and hence genes that are carried from one generation to the next, farmers play an important role in shaping the genetic structure of their varieties.

The case studies revealed seed recycling to be a widespread practice in both regions. When people are content with their harvests, they try to select and store seeds from it. Some informants consider it embarrassing to "waste" seed from their fields. There is also the notion that **"***it is better to choose my own seed grain, the one I like*" rather than buy bag seed that carries with it unknowns. Additionally, informants consider seed too expensive to buy every year. In fact, we did not find a single person who bought all his seed every year. Nonetheless, residents of Oaxaca were more likely to recycle selected seed than those in Chiapas and buy seed with less frequency from either government or informal networks. If the extreme poor plant maize from a bag, generally it means that the seed was free or cheap, and that they obtained it through one of the governmental programs.

Though all farmers recycle, poorer ones among the case study informants were more likely to do this than richer ones. However, some less poor informants prefer to plant

recycled improved seed that they obtained from the harvest of a neighbor who planted bag seed. Recycling provides access for the poor to improved varieties that they otherwise could not afford as original seed. The amount of years that farmers recycle varies between regions: 4-5 years among informants in the case study communities in Chiapas; in Oaxaca the period tended to be longer. After this process they do not distinguish the seed from those long in use. Farmers here consider that it is possible to '*criollo*ize' or adapt any seed and do not believe claims that replanting has negative consequences. Many farmers claim that getting recycled seed from neighbors is a way to improve their harvest.

When asked why farmers preferred to recycle, one explained: "*Because we have always done it like this and, like I told you, we can't spend a lot on seed. Also, this way is safer because we have seen how the seed produces in the lands around here*." However, there is recognition that seeds also degenerate over the years: "*We change when the soil demands it, because sometimes the land just doesn't want the same seeds, because what happens sometimes is that the seed has degenerated.*. Because people observe other farmers' fields and see results, everybody buys and trades seed as well.

Another way farmers shape the genetic structure of their germplasm is by fostering gene flow among different varieties, something that has been documented in other parts of Mexico (Aguirre-Gómez 1999; Bellon and Berthaud 2001). In Oaxaca, farmers have mixed seed acquired from outside into 8.9% of their seed lots in the course of planting a seed lot, while this happened in 7.8% of seed lots in Chiapas. By mixing seed, we mean that a farmer added seed from a different variety or source to the seed lot that he planted. This means that when planted, the pollen of different seeds have a high chance of pollinating one another. Other evidence of potential gene flow are that farmers in Oaxaca said that in 2001 they gave seed to other farmers (exchange, sale, etc.) from 26.4% of their seed lots, while they received seed from other farmers for 29.7% of the seed lots they planted. This was much lower in Chiapas since farmers only gave seed to other farmers from 7.8% of their seed lots and they received seed for only 5.5% of their seed lots. In Chiapas, farmers seem to play a more limited role in shaping their germplasm than in Oaxaca, but they still play a role.

The case studies collected information on and observed systems of maize planting, to learn how creolization may occur. Many *ejido* farmers divide their crop in several parcels, which are located on different slopes and they plant each variety in different conditions. Most commonly, they will plant two varieties; however, some plant more. In Chiapas, those who have the highest production of commercial maize maintain their lands separate and planted exclusively with only one kind, avoiding the contamination of the ears. However, we also found informants who said that they planted more than one variety in the same plot, with little or no separation among them. This way of planting often presents a mixture of maize varieties that is not seen as a problem, as this maize is for household use and the deformed or stained ears are fed to the animals.

Regarding the deliberate crossing of maize varieties, it appears that most farmers have limited knowledge about the process. However, farmers are crossing maize, intentionally

or by accident. In Chiapas, they know that a maize crop is always purest in the center of a plot, and that one finds mixed grains of different varieties on the borders. They are not very knowledgeable about the characteristics of different kinds of maize. They know that the maize can be changed or contaminated when seeds are mixed through improper handling, but they do not do so intentionally. They do not know how to cross-fertilize maize plants. Even if the process of cross fertilization is not understood completely, some farmers recognize it and do it on purpose, while in other cases it happens unintentionally. Many just notice the cross because they observe a change in the color of the kernels or height of the plants as a consequence of having planted two varieties together.

V. Adoption

a. Extent of planting by maize type

The relative area planted and the proportion of farmers that plant each of the five types of maize germplasm varies between both regions (Table 3). Landraces dominate in Oaxaca**,** followed by creolized varieties**.** The importance of creolized varieties is very similar across poverty groups. Few farmers planted improved germplasm, especially hybrids, and those that planted improved varieties did so in a small area. The use of hybrids and recycled hybrids is most common between the non-poor. Furthermore, the use of landraces, even though they are dominant, is the lowest between the non-poor. In contrast, the use of improved germplasm and particularly hybrids are dominant in Chiapas. All farmers, particularly the non-poor, plant improved maize types. All poverty groups also plant creolized varieties and landraces. Creolized varieties are the most widely planted single maize type in relative area and proportion of farmers and are planted in roughly similar proportions by all poverty groups. In spite of the wide adoption of improved germplasm, landraces occupy more than a fifth of planted area and are planted by more than a fourth of farmers, particularly among the poor. The importance of landraces decreases with decreasing poverty level. In both regions (although at very different scales) there seems to be a trend of increasing use of hybrids and improved germplasm with decreasing poverty and a reversed trend for landraces. Creolized varieties seem, however, neutral to poverty level in both areas.

Table 3

VI. Impacts

A key hypothesis of this study is that farmers, particularly the poor, benefit from improved germplasm through creolization. While improved varieties provide desirable traits or combinations of traits not found in landraces, they may lack traits found in the landraces, hence choosing between one or the other presents trade-offs to farmers. Creolized varieties can provide traits not supplied by landraces, while they entail less trade-offs than improved varieties. Hence to look at the impact of these varieties on

farmers' well-being one has to examine the demand and supply of crop characteristics by different types of maize germplasm.

The survey included a section on farmers' evaluation of maize varieties. This evaluation was done for 19 crop traits or characteristics identified as significant in focus group discussions. The evaluation comprised two parts. The first consisted of an assessment of the "demand" of characteristics by farmers. Male and female farmers rated each trait as very important, important or not important in terms of their relevance for choosing a maize variety to grow. The second consisted of an assessment of the "supply" of these traits by each variety they grew. Male and female farmers rated each variety in terms of its performance for each of the 19 traits as very good, good, poor or very poor. The varieties rated did not always refer to varieties grown, particularly in the case of women, but to varieties known. Also there were instances in which varieties currently grown were not rated because the farmer did not feel that he/she knew enough about their performance. Later we grouped ratings of varieties by maize types according to the definitions presented in section IIIa.

a. Demand of characteristics

Even though a large number of characteristics were rated, almost all males and females in both Oaxaca and Chiapas rated them as either very important or important. Table 4 presents the percentage of farmers who rated each characteristic as very important by gender for both regions. Almost all characteristics were rated as very important by 50% or more of the farmers in both regions. This suggests that focus groups were very accurate at identifying pertinent crop characteristics and that these farmers value multiple traits. To test whether any of these traits are particularly important to the poor, non parametric correlations between the expenditure of the household and the ratings of importance were run for each trait. A significant negative correlation indicates that as expenditure decreases importance increases, i.e. the trait is more important to the poor. Table 7 reports the statistically significant correlations as well.

Table 4

The characteristics that were rated as very important by the highest number of male farmers in Oaxaca are yield by weight, yield of dough to make tortillas, ease of shelling, and resistance to lodging. Yield by weight is a key trait for breeding. Yield of dough to make tortillas is a trait that is seldom taken into consideration by breeders. Lodging is one of the key sources of risk and vulnerability in maize production. As pointed out earlier, farmers in Oaxaca are still heavily oriented to subsistence farming so yield of dough to make tortillas and ease of shelling are understandably key characteristics. The correlations showed that as poverty decreases duration (growing cycle), good for "elote" (corn on the cob) and good pasture become more important. There were no traits that seem to be particularly important for poor male farmers. For females the traits that were rated by the highest number are resistance to lodging, yield of dough to make tortillas, atole quality, tolerance for excess water and *nixtamal* (the dough used to make tortillas) quality. Clearly, consumption characteristics seem more relevant for females than males

as would have been expected since females are in charge of maize processing and preparation. The correlations show that three traits are significantly more important for poor female farmers: tolerance to drought, susceptibility to rot, and resistance to pests. Clearly these traits are related with vulnerability factors and that seem to be more important for females than for males.

The characteristics that were rated as very important by the highest number of male farmers in Chiapas are very similar to those for males in Oaxaca: yield by weight, yield of dough to make tortillas, resistance to lodging, tolerance to drought, and yield by volume. Only the importance of one trait is associated with the poor: good for pasture. For females the traits that were rated by the highest number are also similar to those for females in Oaxaca. Similarly, consumption characteristics are more relevant for females than for males. This shows that even with the high level of commercialization—although marketability is considered more important than in Oaxaca—subsistence production is still relevant for females. Only the importance of resistance to lodging is associated with the poor, again a vulnerability factor.

b. Supply of characteristics

To examine systematically the farmers' perceptions of the performance of the varieties available with respect to the characteristics they demand, we ran ordinal regressions (Agresti 1996; Coe 2002) to test whether there were systematic relationships between farmers' ratings and the five maize categories defined in section IIIa[8]. The regressions were run for all 19 traits identified in Table 4. The results[9] are presented in Tables 5 and 6 by gender for the Oaxaca and Chiapas respectively. For simplicity these tables only present the characteristics where there were statistically significant differences. The table should be interpreted as follows: the category presented in the row was rated as superior to the category in the column for the characteristics described in the cell that results from their intersection. For example, in Table 9 for male farmers, creolized varieties were rated as superior to improved varieties for yield by weight, while improved varieties were not rated as superior to creolized varieties for any characteristic (the cell is void). By comparing the characteristics described in cells that result from inverting the categories in the rows and the columns one can identify the trade-offs between two types of maize categories. For example, in Table 9 for male farmers, the trade-offs between landraces and improved varieties are ear rot, ease of shelling, good for nixtamal and good for pasture versus resistance to lodging.

Tables 5 and 6

[8] In fact these categories were further grouped for the regressions due to low number of cases. In the case of Oaxaca, hybrids, recycled hybrids, and improved OPVs are in one category called "improved" since there were relatively few cases of each category. In Chiapas, recycled hybrids and OPVs were grouped for the same reason.

[9] The result of an ordinal regression in this context is the ratio of the odds that farmers rated a maize category as superior compared to another category.

Table 5 shows that for males in Oaxaca, there were statistically significant differences for only seven of the 19 traits rated. There is no overall superior maize type; all types have advantages and disadvantages with respect to each other. Most advantages (traits rated as superior) were associated with landraces, however both improved and creolized varieties were superior with respect to resistance to lodging—a key vulnerability factor in the area. While landraces are considered as superior, improved varieties and creolized provide a trait lacking by them—resistance to lodging, furthermore creolized varieties although inferior for good for elote, are superior for yield by weight with regards to both improved varieties and landraces. Clearly these maize types show some trade-offs between key traits. These results support the hypothesis that creolized varieties provide traits not provided by landraces and have with less trade-offs than improved varieties. Furthermore, creolized seed is much cheaper, for example hybrid seed cost on average MX$ 17.44/kg compared to MX$ 5.33/kg for seed of creolized varieties, while seed of landraces costs MX$3.88/kg. This coincides with the results of the qualitative study where farmers said that while they considered that seed of improved varieties were very expensive, they would "make the sacrifice" and buy them if improved varieties were truly superior, which they did not consider to be the case. Furthermore, the price differentials between seed of creolized varieties and landraces also illustrate that farmers perceive advantages in the former compared to the latter since they are willing to pay a premium.

For females there were statistically significant differences for only four of the traits rated. Females have a much more positive outlook of improved varieties compared to males. Improved varieties were rated as superior to landraces and to a lesser extent creolized varieties for many more traits. Landraces were rated as superior only for ease of shelling. Surprisingly, there were no differences for any consumption characteristics—unlike the case with males—and females rated improved varieties superior to yield reliability (yields something even in a bad year). One would have expected landraces or even creolized varieties to be superior in this respect since they have been grown longer in these areas and may have been better adapted and more stable to year-to-year variability. Males did not consider differences among maize types in this respect.

Table 6 shows that for males in Chiapas, there were statistically significant differences for only six of the 19 traits rated. As in the case of Oaxaca, there is no overall superior maize type; all types have advantages and disadvantages with respect to each other. Hybrids were rated as superior for many traits compared to landraces and creolized varieties. Both landraces and creolized varieties were rated superior for the same two characteristics, susceptibility to ear rot and good storage. Relative to hybrids, creolized varieties however, entail less trade-offs when compared to landraces, and still provide a key trait—resistance to lodging—that landraces do not have. The outlook of males regarding hybrids is also quite positive. Unlike Oaxaca, where most advantages are associated with landraces, in Chiapas they are with hybrids, hence in terms of trade-offs, the role of creolized varieties is reversed. The results support the hypothesis that creolized varieties provide traits not provided by hybrids and with less trade-offs than landraces. The cost of seed from creolized varieties is more expensive on average than that of landraces (MX$ 6.33/kg vs. MX$ 3.51/kg respectively), but much cheaper than hybrid seed (MX$ 20.25/kg). In any case, as in the case of Oaxaca, the price differentials

between seed of creolized varieties and landraces also illustrate that farmers perceive advantages in the former compared to the latter since they are willing to pay a premium.

For females there were statistically significant differences for only five of the traits rated. Females have a very negative outlook of hybrids. They did not rate hybrids as superior for any trait, but inferior for several ranging from tolerance to drought to quality of tortilla dough. Surprisingly they did not rate hybrids nor creolized varieties as superior for resistance to lodging, a trait for which all other have in both regions. Creolized varieties are also considered superior to hybrids for several traits, but not the other way around. Creolized varieties and landraces have distinct advantages and disadvantages. The former are superior for storage but inferior for tolerance to drought compared to the latter and vice versa.

c. Case study perspectives on impacts on poverty and well-being

The case studies reveal a number of ways in which creolized maize contributes to the well-being of poor farmers in the study regions. Unlike the survey results, the case studies did not emerge with as many accounts of direct benefits from improved maize 'from the bag,' though certainly commercial production using improved maize was observed among some farmers in Chiapas. The scarcity of positive feedback may reflect the fact that even where improved maize was providing important economic benefits, there were still problems, and people tend to express these when given a chance to talk about their experience. Nevertheless, the benefits of creolized maize, where improved maize has changed over time, emerged strongly in both Oaxaca and Chiapas, and across all farmers.

The main way in which creolized maize improves well-being seems to be through a reduction of vulnerability. Poor farmers in both regions depend on maize for their survival. Thus, the introduction of germplasm that improves yields and reduces vulnerability to crop losses reduces vulnerability to food insecurity. By reducing expenses needed for inputs, as well as reducing the cost of the seed itself, creolization also releases cash for other basic household expenses, as well as reducing vulnerability to price and currency fluctuations. Farmers expressed that creolized seed combines the benefits of resistance and acclimation to local conditions, with traits of improved seeds such as yield, height, and wind resistance. Finally, the case studies support the survey findings that find that creolized varieties provide people with traits that they want, and reduce trade-offs.

It is also worth noting that associated with the perceptions of recycling and 'acclimation,' there is a perception of security provided to farmers by 'knowing' the seed, which was expressed repeatedly as being particularly important. Farmers need to see it perform before trying it, even if it means using a second generation. Recycled seeds are also advantageous because they are less expensive, even if the yield is reduced (often they do not see it as reduced or not bothered by it). Farmers may not use the word "creolization" or "criolized", but that is what they are referring to when they described their practices of seed selection/recycling/making 'criollos' or acclimation, which also may entail crossing

of varieties. Furthermore, there is evidence that some farmers are purposely crossing varieties to get traits that they want.

That the introduction of new germplasm has improved people's well-being is illustrated by the words of an informant from Nopala: "*It has given us results. Since we bought that seed many things began to improve for the people, because before we had to buy lots of maize around here… but now we buy less. And, last year I was even selling maize; this year we harvested less, but for September we will have new maize*." Still, adopting different varieties does not seem to significantly change people's life strategies. Rather, the risks involved with maize cultivation of any kind drive these strategies. It is not possible for poor people in either of the two regions to meet their vital necessities (which depend more and more on cash earnings) with the income obtained--if any--from growing maize. They also need to make investments beforehand to grow maize, which for the most of the poor and average poor informants is not sustainable. For this reason, informants say that it is not possible to live only from maize cultivation and emphasize the difficulties related to cultivation. In summary, the more options people have for a better and safer income, the less maize they plant.

In spite of these problems and the limitations of maize production as a route to escape from poverty, our study reveals the enormous importance that maize continues to play in people's livelihoods, from ensuring food security to providing cash income for other basic needs. As one informant said, '*we need it to live; without it we don't eat*." For less poor farmers engaged in commercial production, improved maize stands a better chance of meaning the difference between getting by and prosperity. In both cases, there is no question that providing maize germplasm (through scientific improvement and creolization in the field) that increases yields and reduces risks will make a significant difference in people's well-being. It may not mean an escape from poverty, but this requires a more comprehensive poverty-reduction strategy more far-reaching than agricultural technology.

VII. Conclusions and Implications

The coast of Oaxaca and the Frailesca, Chiapas are highly contrasting regions. Poverty is pervasive, even in the more commercialized and developed Chiapas. Maize continues a key role in the livelihoods of the poor in both regions.

This paper has shown that modern varieties and particularly creolized varieties are widely planted in Oaxaca and Chiapas. While we cannot establish a direction of causality between the adoption of improved germplasm and poverty alleviation—we do not have a baseline study to compare the situation before and after adoption—we have shown the contribution of improved germplasm, and particularly of creolized varieties to the well being of poor farmers. Creolized varieties are perceived to provide traits that the landraces do not have and have less trade-offs than improved varieties. Creolized seed is also cheaper, farmers however, are willing to pay a premium for creolized seed compared to landrace seed.

Although farmers discuss varieties and their traits, farmers' distinctions between creolized seed and landraces are blurred: all seed that is not from 'the bag' (improved varieties, in a sealed package) is widely referred to as *'criollo.'* Furthermore, improved varieties are said to be quickly converted into creolized. This is seen to occur through seed recycling where seed is seen as "acclimating" to the land and therefore improving. Even where seed is seen to degenerate through recycling, it is still a popular practice because of the cost of new seed. The second way in which creolization is seen to occur is through planting different varieties near each other so that they cross. This occurs with different levels of intention. Some farmers deliberately plant varieties close together in the hope of getting better characteristics in the new variety. From whichever method, farmers have a high level of confidence in these creolized varieties because they have proven themselves over time and are seen as better adapted to local conditions.

In addition to selecting from one's own harvest, seeds are mainly obtained through informal social networks and to a lesser extent through government programs. Surprisingly, commercial seed outlets still play a very limited role. Social networks are key because they offer many options, are trusted, and most importantly, provide the opportunity for farmers to observe plants in the field before adopting. This need to see performance and reduce risk is true for all farmers, but particularly the poorest. Maize is seen as a highly precarious undertaking, involving numerous risk factors. Thus varieties that are 'known' --and those that reduce these risks--are important, especially to the poorest, most vulnerable farmers.

Government programs play a more important role in Chiapas than in Oaxaca, but suffer from a lack of trust in both regions. Farmers' experience with these programs have been problematic, including seeds arriving late, restricted access to credit, absence of technical support, politicization of seed distribution, and quantity and quality requirements that the poorest farmers can not meet. Experience with poor quality seed has left farmers suspicious of government seed and improved seed more generally. They also often do not trust advice about maize management practices, or can not afford to follow them. These accounts suggest that improved experience with government programs could accelerate the benefits of improved maize in a number of ways.

Several implications can be drawn from these results. First, it is important to get away from the dichotomy of traditional versus modern variety that has been common in adoption and impact studies. As shown here, there are many different types of germplasm, with different advantages and disadvantages, which are influenced by different factors and have different impacts on farmers' well being. It should be recognized, however, that moving away from this simple dichotomy also entails methodological challenges, that require the use of multiple methodologies that are not commonly used in adoption and impact studies, i.e. participatory methods, collection of maize samples from farmers.

A second implication that is closely related to the above is that we need to question the conventional adoption model for improved germplasm. This model assumes that the

breeding process finishes once farmers have adopted a variety and that a variety once adopted should stay unchanged. If the variety does change, the changes are likely to be negative; therefore the seed should be replaced either with new seed of the original variety or of one that is even "better." Improved varieties do change in farmers' hands and these changes are not necessarily negative; farmers may consider them positive. These changes are associated with farmers' selection and seed management practices. Rather than ignoring them, we should try to investigate ways to take advantage of them. It is not clear yet how to do this, however, but this is an area that merits further research. Since these practices and their impacts are more important among the poor, particularly in more subsistence oriented systems, this research should be particularly important to address the needs and conditions of the poor.

Third, there is a need to go beyond a simplistic concept of yield as the yardstick of impact and look at the set of traits that farmers' value, how those traits are being supplied by the germplasm available, and the trade-offs they entail. Decreasing these trade-offs has an important and positive impact on farmers' well being. That is the particular value of creolized varieties in the systems that we studied. Even yield is a more complex concept than ton/ha. As shown here, farmers have different concepts of yield which are not necessarily correlated, e.g. yield by weight, yield by volume, yield of dough to make tortillas.

Fourth, the implications of being poor for farmers, their demand for traits, and the constraints they face are not the same in a subsistence-oriented system and a commercially oriented system. For example, improved germplasm, particularly hybrids are better able at benefiting the poor in a commercially oriented system, but have a much more limited value in a more subsistence and isolated system. An *a priori* classification of areas by the dominant orientation of maize production should be very useful to target agricultural research to address the needs of the poor.

Finally, our results also suggest that tools used by poverty alleviation programs to target their efforts are useful for agricultural research. This suggests that by focusing our research efforts on areas of high and very high marginality, we can target the research to address the needs and issues relevant to the poor.

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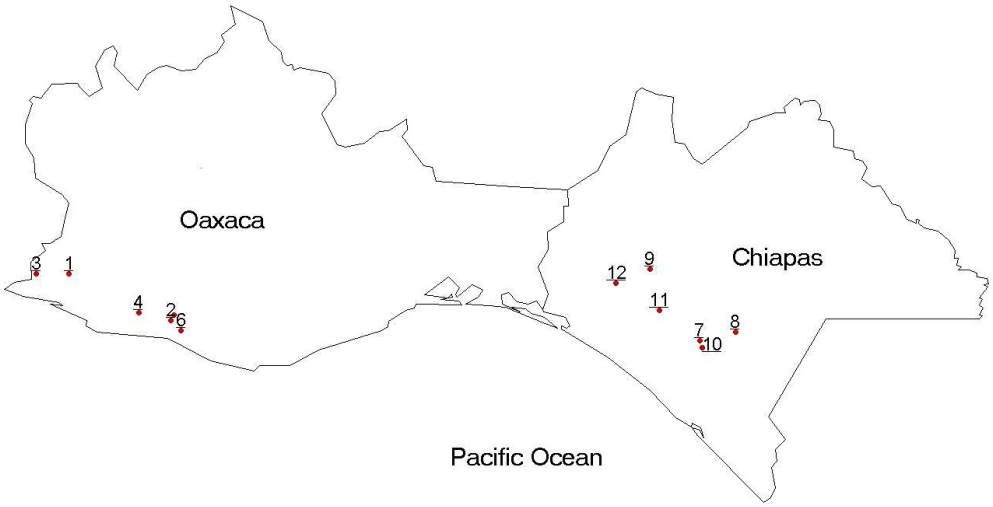
Figure 1. Map of the communities included in this study, Oaxaca and Chiapas



Coast of Oaxaca:
1. Santa Maria Cortijos
2. San Pedro Jicayan
3. Santiago Jocotepec
4. Santa María MagdalenaTiltepec*
5. Santos Reyes Nopala*
6. San Pedro Mixtepec

La Frailesca, Chiapas:
7. Libertad Melchor Ocampo
8. Primero de Mayo
9. Roblada Grande
10. Dolores Jaltenango*
11. Querétaro*
12. Rizo de Oro

* Communities included in the case studies

Table 1. Indicators of poverty by region, the coast of Oaxaca and the Frailesca, Chiapas

	Coast of Oaxaca	Frailesca, Chiapas
Number of farming households		
Total	3,539	1,994
Extreme poor	2,645	1,261
Poor	666	521
Total population	21,471	10,507
FTG Poverty indices		
Headcount index	0.80	0.72
Poverty gap	0.34	0.27
Severity of poverty index	0.17	0.13

Table 2. Criteria to classify varieties identified in survey into five categories

Category	Criteria
Hybrid	• Named provided by farmer of a known hybrid • Seed came from a "bag" and first year of planting • Focus group identified the name as being introduced to the community by government or commercial outlet • Maize taxonomist indicated that sample with same name was of a hybrid or recycled hybrid •
Recycled hybrid	• Idem, but farmer had planted the seed from the previous harvest up to four years •
Open Pollinated Variety	• Idem, but name provided by the farmer was from a known OPV • Seed had been planted for the first time or recycled up to four years •
Creolized	• Any of the above, but farmer had recycled the seed for more than four years and up to fifteen •
Landrace	• Named provided by farmer of a known maize race (e.g. Zapalote, Tepecente, Olotillo) • It did not have a specific name (*maiz blanco*) but had been planted for many years either by the farmer or somebody else in the community • it did not come from a bag • focus group identified the name as a local variety • maize taxonomist indicated that the sample with the same name was a landrace

Table 3. Distribution of type of germplasm by area and number of farmers

Coast of Oaxaca	Extreme poor area (ha)	Extreme poor farmers	Poor area (ha)	Poor farmers	Non poor area (ha)	Non poor farmers	total area (ha)	total farmers
Total	3,011.67	2,645	833.01	666	320.58	228	4,165.26	3,539
Relative distribution (%)								
Hybrids	1.5	3.1	0.0	0.00	7.1	6.7	1.6	2.7
Recycled hybrids	2.0	3.1	8.5	8.7	12.2	13.3	4.1	4.8
OPVs	7.0	7.0	2.0	2.8	2.5	8.1	5.7	6.3
Creolized	14.3	10.4	12.8	15.4	24.2	20.0	14.8	12.0
Landraces	75.2	84.2	76.7	85.3	53.9	66.7	73.9	83.3
Frailesca, Chiapas	area (ha)	farmers	area (ha)	farmers	area (ha)	farmers	area (ha)	farmers
Total	5,789.36	1,261	2,213.81	521	1,035.85	212	9,039.03	1,994
Relative distribution (%								
Hybrids	19.8	30.9	22.2	31.1	63.3	54.8	25.3	33.5
Recycled hybrids	8.8	9.9	18.5	26.0	3.9	17.5	10.6	14.9
OPVs	20.0	33.1	12.8	22.8	4.3	10.5	16.4	28.0
Creolized	26.6	36.7	31.8	38.8	25.3	37.6	27.7	37.4
Landraces	24.9	32.6	14.8	10.3	3.1	11.1	19.9	24.5

Table 4. Percentage of farmers who rated a characteristic as very important in the coast of Oaxaca and the Frailesca, Chiapas, Mexico, by gender

	Coast of Oaxaca				Frailesca, Chiapas			
	Males	Correl.[1]	Females	Correl.[1]	Males	Correl.[1]	Females	Correl.[1]
Number of households	162		162		161		158	
Vulnerability								
Resistant to lodging	69.8		98.8		82.6		94.3	-.120*
Tolerant to drought	75.9		83.3	-.117*	75.2		72.2	
Tolerant to excess water	54.3		84.6		70.8		88.6	
Does not rot (good husk cover)	61.1		75.2	-.162**	68.9		80.4	
Duration (growing cycle)	49.4	.169**	80.9		62.1		82.3	
Resistant to pests	66		83.3	-.145**	69.6		80.4	
Resistant to insects in storage	58.6		75.9		61.5		80.5	
Produces something even in a bad season	58		75.9		64.6		76.7	
Good for sale	55.9	.181**	65.4		63.8		81.8	
Consumption related:								
Good for consumption	59.9		80.2		70.2		84.9	
Good for atole	59.3		91.4		68.9		90.6	
Good "elote" for sale and consumption	50.6	.118**	69.8		60.2		74.2	
Good for "antojitos"	58.6		75.9		65.2		79.2	
Easy to shell	70.4		76.5		42.9		73	
Good for nixtamal	61.1		84.6		68.9		83.6	
Good pasture	27.8	.155**	54.8		49.1	-.122*	64.8	
Productivity:								
Yield of dough to make tortillas	77.2		92		83.9		89.2	
Yield by weight	84.6		67.9		89.4		67.1	
Yield by volume	67.9	.120**	61.1		72.7		68.4	

[1] Non parametric correlation between expenditure and rating of importance. A negative sign indicates that the importance increases with poverty, and vice versa.

*, **, correlation significant at the .10, .05 level respectively.

Table 5. Comparisons of different types of germplasm with respect to traits with statistically significant different ratings, Coast of Oaxaca by gender

A. Males

Categories in row rated as superior to categories in column	Improved varieties	Creolized varieties	Landraces
Improved varieties			• resistant to lodging***
Creolized varieties	• yield by weight*		• resistant to lodging*** • yield by weight***
Landraces	• ear rot*** • ease of shelling**** • good for nixtamal* • good for pasture**	• ear rot** • good "elote"** • ease of shelling**** • good for nixtamal*** • good for pasture**	

B. Females

Categories in row rated as superior to categories in column	Improved varieties	Creolized varieties	Landraces
Improved varieties		• produces something even in bad season**	• resistant to lodging*** • resistant to pests** • produces something even in bad season*
Creolized varieties			• resistant to lodging****
Landraces	• ease of shelling**		

*, **, ***, ****, statistically significant at the .10, .05, .01, .001 level respectively for a 2-tailed t-test.

Table 6. Comparisons of different types of germplasm with respect to traits with statistically significant different ratings, Frailesca, Chiapas by gender

A. Males

Categories in row rated as superior to categories in column	Hybrids	Creolized varieties	Landraces
Hybrids		• resistant to lodging*** • good for sale*** • yield by volume**	• resistant to lodging**** • good for sale*** • good pasture** • yield by volume**
Creolized varieties	• ear rot* • resistance insects in storage****		• resistant to lodging***
Landraces	• ear rot**** • resistance insects in storage****		

B. Females

Categories in row rated as superior to categories in column	Hybrids	Creolized varieties	Landraces
Hybrid			
Creolized varieties	• tolerant to excess water**** • resistance insects in storage** • good for nixtamal**		• resistance insects in storage**
Landraces	• tolerant to drought**** • tolerant to excess water**** • good for nixtamal*** • yield of dough for tortillas*	• tolerant to drought****	

*, **, ***, ****, significant at the .10, .05, .01, .001 level respectively for a 2-tailed t-test.