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Initial Diagnose Report

Corn harvesting and culture in Guatemala

THIS, then, is the beginning of the conception of humanity, when that which would become the flesh of mankind was sought.

Then spoke they who are called *She Who Has Borne Children* and *He Who Has Begotten Sons*, the Framer and the Shaper, Sovereign and Quetzal Serpent: “The dawn approaches, and our work is not successfully completed. A provider and a sustainer have yet to appear—a child of light, a son of light. Humanity has yet to appear to populate the face of the earth,” they said.

Thus they gathered together and joined their thoughts in the darkness, in the night. They searched and they sifted. Here they thought and they pondered. Their thoughts came forth bright and clear. They discovered and established that which would become the flesh of humanity. This took place just a little before the appearance of the sun, moon, and stars above the heads of the Framer and the Shaper.

IT was from within the places called Paxil and Cayalá that the yellow ears of ripe maize and the white ears of ripe maize came.

THESE were the names of the animals that obtained their food—fox and coyote, parakeet and raven. Four, then, were the animals that revealed to them the yellow ears of maize and the white ears of maize. They came from Paxil and pointed out the path to get there. Thus was found the food that would become the flesh of the newly framed and shaped people. Water was their blood. It became the blood of humanity. The ears of maize entered into their flesh by means of She Who Has Borne Children and He Who Has Begotten Sons.

Thus they rejoiced over the discovery of that excellent mountain that was filled with delicious things, crowded with yellow ears of maize and white ears of maize. It was crowded as well with pataxte and chocolate, with countless zapotes and anonas, with jocotes and nances, with matasanos and honey. From within the places called Paxil and Cayala came the sweetest foods in the citadel. All the small foods and great foods were there, along with the small and great cultivated fields. The path was thus revealed by the animals.

The yellow ears of maize and the white ears of maize were then ground fine with nine grindings by Xmucane. Food entered their flesh, along with water to give them strength. Thus was created the fatness of their arms. The yellowness of humanity came to be when they were made by they who are called She Who Has Borne Children and He Who Has Begotten Sons, by Sovereign and Quetzal Serpent. Thus their frame and shape were given expression by our first Mother and our first Father. Their flesh was merely yellow ears of maize and white ears of maize.

Mere food were the legs and arms of humanity, of our first fathers. And so there were four who were made, and mere food was their flesh.

-Popol Vuh, Sacred book of the Mayas-

INTRODUCTION

The structure of the Initial Diagnose report, of the Post-harvest loss reduction and food waste program, has taken into account not just the quantitative aspects of the current situation in the intervention zone but also, by using different techniques, has gathered qualitative information through the interaction with community leaders, farmers and families in general, within the region delimited by the program.

The study was conducted in the townships of Chiantla and Todos Santos Cuchumatán, of the Huehuetenango department, Guatemala. These two townships, of the western highlands of Guatemala, have different topographical, climatic, ethnic and cultural conditions.

With the data and analyzed information, it was possible to identify diverse corn harvesting (or tapisca), drying, storage and consumption practices within the studied communities. Furthermore, the socio-cultural situation and hygiene and health practices of the intervention area are described, in general and particularly for each township.

The methodological process for the preparation of this study consisted of 7 stages: a) Planning Process Assessment Stage, b) Establishment of Methodology and Sample Selection, c) Generation of Instruments for Data Collection Stage d) Training and standardization of Interviewer Personnel stage, e) Information Collection Stage, f) Processing and data Analysis Stage, g) Report writing stage.

Through a period of 4 months, the Innovation laboratory for the Post-harvest loses reduction staff – Guatemala team-, formed by the Production adviser, the Monitoring and Evaluation coordinator, of SHARE Guatemala, who design and implemented the study; in coordination with the scientific team of Kansas State and University and University of Nebraska-Lincoln; reviewed and analyzed the documentary information, and visited and interacted with around 280 families of 14 communities of the coverage area, to obtain data presented in this report.

The implemented methodology contemplated hiring local staff who handled not only the dialect but the local culture, to ensure the relevance and commitment necessary to meet the objectives. Under this work scheme the participation of community leaders, (COCODE[1] and/or local authorities) as well as the families of the communities in the covered territory by the program was achieved.

The present document, summarizes the information gathered to make the Initial Diagnose and has been subdivided onto 9 sections identified from A through G. The executive summary is in ***section A***, which provides an overview of the main findings and describes the field data obtained for each of the specific objectives of the study. The program's general context is presented in ***section B***, along with the place of intervention geographically located, general data of the townships, description of the food vulnerability (security) and characterization of the territory.

The Methodology used for the Initial Diagnose is described in ***section C***, detailing activities in each stage, actors involved, dates, statistical sample used, among others. The General Results are presented in ***Section D***, where results and findings described in the Executive Summary are more extensively described, defining the data that will be used by the Program as baseline. ***Section E*** includes General conclusions. ***Section F***, includes the glossary of Terms and finally in section **G** Annexes are presented.

[1] Community Development Council, is established with legal personality and is the governing management of the community development in Guatemala.

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Section A: Executive summary

Sustainability of corn production practices:

The identified *smallholder-agriculture* system in the zone where the studied areas are found causes families to obtain insufficient production to be marketed or obtain insufficient cash income, forcing them to buy whatever wasn't produced and to have subsistence agriculture. In addition, they live close to the level of survival, and when forced to distribute the scarce land among their family the problem of land access and natural resources degradation deepens.

Corn represents the main source of carbohydrates in the Guatemalan diet. It is a grain that has deep roots in the culture and tradition of the Mesoamerican region. In Guatemala, it goes beyond its status as the most widespread in the country's culture; is one of the most valuable symbols and rooted in their culture, from a historical perspective in which the cereal has left deep traces in the food habits of the population that are maintained to this day.

The national producers of corn are divided into two groups: grown for self-consumption and can produce marginal surplus, and the other that is composed of commercial producers who depend on the sale of corn. In Guatemala, much of the corn produced is for household consumption. On the other hand the domestic market is highly fragmented. The little surplus of small families' economies is affected by speculators. The corn farmer has limited technical and financial support, coupled with the lack of transport, proper storage and drying.

Many of the farmers in the studied areas use basic and empirical techniques, where little technology is used, which do not allow them to reach at least the average national production level in the cultivated land.

Within the agricultural context we can stand out the following from the study results:

- It was established in the diagnosis that 99.6% have land for agriculture. Of this, 90% own the land, i.e. about 10% leased land for planting.
- 80% of the interviewees indicated that they grow corn in their land, but that it is not enough for the average household consumption. The average per cuerda of corn produced was up to 2 quintals of corn which is below the national average level of 4 quintals per cuerda of land.
- It is important to point out how rooted ancestral practices and methods are, regarding corn; farmers create reluctance to accept new methodologies or ways of growing, harvesting, post-harvest treatment and even food preparation practices (preparation for consumption).
- The identified practices do not show positive effects in reducing post-harvest losses, since 67.96% of farmers say they have problems with fungi and molds at harvest time. Furthermore, the losses associated with excessive moisture in the post-harvest stage is around 49%.
- There is little involvement of women and children in corn harvesting practices. But their role is strengthened in housework.

Production practices and post-harvest associated with maize

Production cycle
There are generally two times or production cycles:

1. The one from January, that goes from January to October, generally in the high zones or in the plateau above 2600masl. This planting is done taking advantage of the moisture from the soil. The harvest of this cycle is performed in the month of November and extends through January of the following year.

2. May's harvest, that goes from May to December, in the lower regions and related to the raining season. The harvest of this cycle it performed in October and December.

For each region there are seeds, cycles and specific methodologies. Drying and storage of produced corn is done very similarly in the two types of cycles. There are specific practices for drying and storage, depending on the geographical area and the culture. For example, in some areas above 2,500 masl, farmers do not perform the practice of "dobla" (meaning bending corn plants in the field, to start the drying process) but they take the corn to their house, perform a pre selection of the (good, fair, poor) corn cobs and take them up to the tapanco. In areas above 3000 masl, farmers also perform bending, carrying the ears (complete with husks), and after a week they select ears, they defoliate them and take up the ears to the tapanco. The husk is used as feed for minor and major livestock.

Planting and production:
It became clear that the farmer families are involved in the production cycles; planting, maintenance, harvesting and storage. Being the storage and food preparation processes where the women are more actively involved. However, the study revealed an interesting fact; 62% of women at home participate in the process of tapisca or harvest.

Farmers are experienced in growing corn. Corn is an ancestral culture and even visualized as sacred, linked to lunar cycles, and Maya culture. In the case of corn, farmers choose the best grains of the last harvest and store them as seed for the next cycle. This is the reason that the hybrid or commercial seed varieties are underutilized.

About 94% of farmers have access to fertilizers. An important thing to note is that 67% of farmers who grow corn, have a compost heap.

Harvest:
When the harvesting process begins, in other parts of the highlands and places where maize is extensive, the practice of "dobla", consisting on bend or break stem of the plant corn, to interrupt the water and nutrient flow from the soil to the formed cob. However, about 67% of farmers in the study area do not perform this practice.

For "tapiscar" or harvest corn, farmers use different methods to determine the right time for this process. However, about 43% indicated that they start the harvest when the "doblador" or tusa (husk) is completely dry. There is already an established harvest time in the calendar for the communities and it coincides with the harvest season, to the time that the farmer has available to perform the harvesting activities and not necessarily to the humidity of the grain.

Drying:
Farmers save the corn after making the practice of drying, which may consist on laying it in the sun for a few days (about 88% of farmers indicated they did this practice) or let it dry on the plant. In practice, farmers harvest corn and proceed to dry it at that moment (without shelling it, i.e. corn cob presentation). Drying is only by sun exposure, however according to the families' conditions, it can be performed on the patio or porch of the house, on bags, nylon or sheets, or over the roof of the house.

According to field observations there is a small number of farmers using the tapanco as a mechanism for drying and storage; this could be seen in the community of San Jose Las Flores, Cumbre de la Botija and Tunimá Grande, in the township of Chiantla, which is due to damp conditions prevailing in the communities. According to losses reports of farmers in this study, it appears that the ears are not properly dried (12% moisture) to proceed to store.

Storage:
In some communities more than others, 81% farmers indicated to have preference for saving the shelled corn in sacks/bags (this includes the purchased corn). This practice is more widespread in the township of Todos Santos, compared to Chiantla.

The tapanco (loft) is another good way of corn storage, mainly corn cob. It has several functions: 1) Thermo regulator. Houses with tapancos have declared to be "fresh"; adjective to mention the thermo regulatory function. 2) Storage: used to store mainly wood, firewood, corn cobs, hay and corn husk. 3) Drying area: Some tapancos have semi transparent roofs that let heat and sunlight in, and are designed for drying wood and corn.

The silo is underutilized (14%), and 79% of the farmers that use silos use phosphine pills for pest control. Although field tests show that the tablet is used, the method or protocol is not precisely specified by the manufacturer, or it is not the most suitable one.

It's important to mention that 41% mentioned they kept the corn for four months or more, but field evidence shows that farmers and their families have high turnover (rotation) of purchased corn. That is, they are supplied with one or two quintals (100 pounds) of corn every 15 days or less and buy more after they consume it. Farmers maintain the practice of buying only the necessary to put in storage for three months or more. This practice is associated with corn market prices; ie if the corn is cheaper, farmers prefer to buy corn and keep the harvested corn for a longer time.

65% of farmers indicated to perform pest control during storage, however, this control is due as a corrective manner instead of being preventive, since 53% indicated that make pest control when observing the presence of rodents or insects (22%).

Corn loses

Loses during harvesting and during the drying process
As for the quantification of losses in the last harvest, 20% of farmers indicated they lost over 100 pounds of corn. Due that 71% of respondents reported having produced 5 and 10 quintals (500-1000 pounds) of corn in the previous harvest, having a 20% of farmers that lost 100 pounds or more of corn makes this significant at this stage of harvesting and drying process. This corn in most cases was replaced by purchased corn, however there are families who did not have capacity/means to obtain more corn, having to cut back on the consumption. During community meetings and consultations with community leaders, it was mentioned that the losses are estimated at up to 60% during the period of 2014 due to irregular winter and pronounced midsummer season.

Loses during the storage period:
Farmers reported having losses in storage. The main reasons identified by respondents were rot damage (32%), rodents (18%), moisture (12%) and by insects and birds (9% and 5% respectively).

44% of farmers indicated losing between 1-5 pounds the last season. 7% mentioned that loses ranging 25-50 pounds, 4% of 50-100 pounds and 6% reported having lost over 100 pounds. This is relative and associated with the extension of land sown with corn and the amount of corn harvested.

70% of the interviewed households give give corn that has some type of injury to animals, 20% consume it as they said this corn did not hurt them, or they have no other corn to replace it. 10% discards it.

83% indicated that they purchased corn in the last harvest to replace corn that had some type of damage or was lost. In the township of Todos Santos, this figure drops to 75% since they indicate that they try to exploit the grain as much as possible regardless of the damage.

Food availability (security):

74% of the respondents indicated to use more than 5 pounds of corn a day on average, to meet their food needs. In some cases between 12-15 pounds are consumed daily, due to the elevated number of family members. In Chiantla, 86% indicated to need more than 5 pounds of corn to meet their needs and in the township of Todos Santos 66% report being in this condition.

Comparing the food needs with food availability, we can show that there is a deficit, which in most cases farmers tend to adapt in different ways. In the case of not having the necessary resources one of these ways is to reduce the amount of food for consumption.

The -lack of food- crisis is manifested in some cases up to two months before the harvest, exacerbating food insecurity rates. 67% of farmers indicated that the stored quantity, or that they can afford to buy, is not enough to cover their needs until the next harvest.

Added to this, the low availability of food that is usually observed in the study areas and a good part of the country will be aggravated this year by prolonged canícula[2], which affected an average of 50% of the expected production. This will definitely affect the food security of many families in the rural area and will make derived products more expensive.

[2] The canícula, canicular period or days of the canículas makes reference to a season of the year where the heat is too strong, both in the north and south hemisphere (six months out of phase with each other). The duration ranges from four to seven weeks, depending on the location. In some territories it begins with the summer solstice (June 21st in the Northern Hemisphere and December 21st in the southern hemisphere) when, at dawn, by a point on the ecliptic / celestial Equator, the sun rises further away from a central point. It indicates the time when it is farther from the Earth Equator, when it reaches the highest positive declination between equators: 90 degrees. Then the sun makes its tour during the day above the Earth's Equator.

Presence of Mycotoxins[3] as key parameter for the quality loss of grains.

67% farmers indicated to observe fungus or mold damage at harvest time. This empirical observation of farmers may be associated with corn losses due to excessive moisture in the post-harvest stage.

The 49% loss may be several reasons (rot, moisture and fungi). This means that traditional knowledge and practices are not sufficient to mitigate corn losses.

In addition, factors such as excessive rain, condensation inside the tapanco by having a tin roof, poor cob drying practices, are crucial to accentuate the post harvest losses.

This hypothesis will be tested in phase B of the study, where the laboratory designated for that purpose will make the necessary tests to determine the presence of mycotoxins, fungi, insects and other organisms, as well as the temperature and humidity of grain, of the storage site and environment.

Hygiene, health and basic nutrition practices of the smallhorlder's families in the intervention zones of the study.

Safe water:
65% of the households have Access to water, and it's enough to cover the basic needs. This is more evident in the township of Todos Santos (85%) than in Chiantla (28%). Mainly due to the altitude above the sea level and the rugged terrain present in several communities of highland of Cuchumatan plateau.

Out of those households with access to water, 86% indicated that obtained by means of the "jar fillers" which are taps or water supply systems, arranged in convergent points of the community, 15% obtain water directly from a spring channeled by a pipe and 23% by collecting rainwater. The jar fillers and community water systems do not have the proper maintenance and monitoring is not given to the sediment filtering and chlorination.

94% of respondents indicated to purify water for human consumption. Of this, 92% use the method of boiling water. Only 7% by chlorination. Through field observations it was found that although farmers indicated some method of water purification, subsequent incorrect handling or use of the method causes gastro intestinal diseases to be always present in the rural population.

[3] Mycotoxins: Toxic substances produced by fungi that affect vertebrate animals in low concentrations, excluding those who specifically affect bacteria (e.g. penicillin) or plants. Mycotoxins may contaminate the food chain by infecting agricultural products intended for human consumption or for domestic animals. Mycotoxins are quite resistant to decay and destruction during digestion, so they remain in the food chain and in dairy products. They even resist cooking and freezing. The most common toxins in agricultural products are produced by species of the genera Aspergillus, Penicillium and Fusarium, among others.

Hygiene:
99% of respondents said the family wash their hands before eating; although field observations showed this practice is not evidenced with the reported frequency.

89% of the cases studied said the wife or housewife, is the one in charge of preparing the food. Women are the ones responsible for hygiene measures during food preparation and the cleaning of utensils. 99% indicated to clean utensils after each meal.

94% of respondents said cover plates and kitchen utensils after washing them. Field evidence showed that in many cases these utensils or dishes are uncovered and are thereby reachable to flies and environment elements, both potentially harmful to human health.

Disposition of human excreta
65% reported use pit latrine for disposal of human excreta. 21% reported using a washable toilet, and worryingly 12% said they didn't use any method.

Besides the above, it is common to observe gray water (drainage from washing dishes, sinks, etc.) running down the dirt roads without channeling or a proper place to dispose of them.

Conclusions

Agricultural practices in corn production in the studied areas, the issue of land productivity, and the lack of funding and technical support for maize sector in these last years has exacerbated the availability and access to food or income to obtain it. Within this social and agrarian context, the practices identified in corn ranging from planting, drying and storage until ultimately are not sustainable.[4]

Corn losses by various causes identified in this study, from harvest to consumption, are caused by the implementation of practices that are not optimal to increase productivity and reduce losses. This ultimately exacerbates the problem of food insecurity.

It was evident that there are weaknesses in the processes of corn selection and preparation for consumption, since much of the damaged corn by various causes is used by the families to feed the farm animals or is consumed at home. This practice, according to evidence from the interviews, is attributed to the influence of culture and characterization of corn as an element of worship or sacred food. This is more prevalent in areas of Todos Santos Cuchumantán than in Chiantla.

The moments or processes where greater participation of women and in many cases children is observed during corn harevsting is cleaning, storage and preparation for consumption. Culturally these phases are more associated to the participation of women. However, despite the entrenched culture in the study areas, the diagnosis showed a broad participation of women in decisions regarding food security of the family.

[4] Sustainability means the existence of economic, ecological, social and political conditions for the functioning of a society in harmony over time and space. It is a term linked to the action of man in relation to its environment, referring to the balance that exists in a species based on its environment and in all the factors or resources to make the functioning of all parts without damage or sacrificing the capabilities of other environment.

The study showed extensive knowledge of the practices associated with basic hygiene and health. The majority of interviewees identified and expressed using basic techniques. However, during direct observation at home, it was found that the the manifested practices are dissociated from the knowledge. The results of this misunderstanding between knowledge and practice cause high prevalence in malnutrition, gastro intestinal diseases and other conditions.

Recomendations

Implement improved production practices, selection, drying and storage of corn, with economic and cultural relevance; so that they can be adopted by farmers in the project's target areas, and be sustainable over time and have the ability to be replicated.

Develop processes of knowledge transfer with relevance and cultural and social context, to motivate behavior change, depending on the effective adoption of health and hygiene practices and postharvest handling of corn.

Conduct methodologies that encourage the adoption of improved harvesting practices of food products in the areas of the program implementation (production and consumption of native plants for example), to complement the families' food availability and allow them to diversify their diet.

Develop methodologies relevant to the intervention areas that recognize the contributions that women make to the production process of corn and agriculture in general, and household food security; involving their active participation in a wider decision-making.

Section B: General context of the program

Justification

Corn is the leading crop in Guatemala and the main food source of the population, with an average annual production of 1.67 million tonnes. More than half of Guatemala's corn is consumed as tortillas (consumption of 165 kg per capita per year).

Post-harvest losses reduce the availability of corn by about 30%. Previous studies have shown that corn harvested in Guatemala has aflatoxin levels ranging from 130ppb to 1680ppb.

Aflatoxins are potent chemical substances and potential reasons for liver cancer. Additional toxic effects may include immune suppression, increased stunting and underweight in young children, decreased ability to make proteins and decreased essential micronutrients levels. The consumption of aflatoxins and fumonisins (another prevalent mycotoxin) in contaminated tortillas is associated with growth retardation in children and immune system disorders.

Guatemala has the highest national level of chronic malnutrition in the Western Hemisphere and one of the highest in the world. UNICEF reports that Guatemala has the third highest prevalence in the world of moderate to severe chronic malnutrition among children under five years of age. Malnutrition is the biggest contributor to child mortality in Guatemala. Fifty-one percent (51%) of the population lives below the poverty line, while more than 74% of people working in agriculture are poor. The rate of chronic malnutrition in the highlands of northwestern Guatemala (Huehuetenango) is 69.5%.

By the above, and to achieve greater effectiveness in implementing the program to reduce post harvest losses, this study was conducted. This report was established as the baseline which in on one hand will act as guidance for technical decision making that contribute to reducing corn losses due to mycotoxins contamination and their negative impact on health; and secondly, it will be the initial point of reference for effect evaluations carried out during the project, which will allow to demonstrate the change in the situation found in this study.

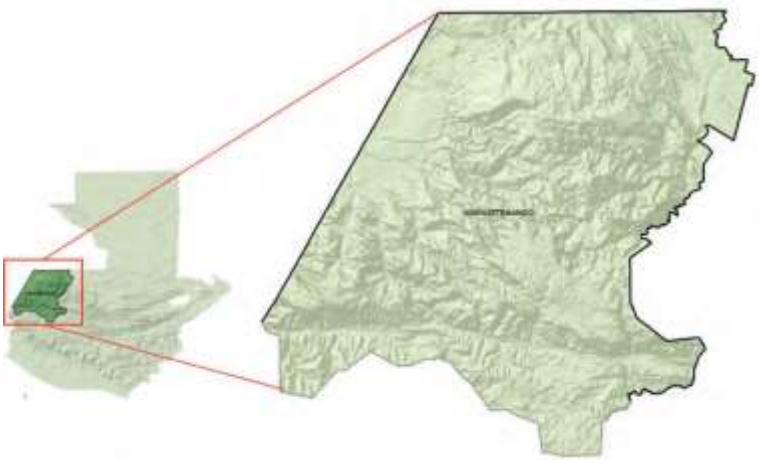
Geographical area of the Program

Huehuetenango department, Townships of Chiantla and Todos Santos Cuchumatan

Characterization of the territory:

Huehuetenango is located in the northwest of the country and belongs to Region VII. Bounded on the north and west by the Republic of Mexico, south to San Marcos and east to Quiché. Administratively, the department is composed of 32 municipalities; and its departmental capital is Huehuetenango. It has an area of 7,403 km2 (representing 6.8% of the country). The townships with the larger extension are: Barillas, Nentón, Cuilco, San Mateo Ixtatán and Chiantla which together cover 48.4% of the department.

Map 1. Guatemala: Huehuetenango Departament



Source: Ministry of Agriculture Data, Livestock and Food (MAGA by the acronym in Spanish).

Townships' size, altitude and distance to the capital

Departament	Township	Size (km^2)	Altitude above sea level (meters)	Distance of the department capital (km)
Huehuetenango	----	7,040	300 - 3,993	----
	Chiantla	536	1,980 - 3,993	7
	Todos Santos Cuchumatán	300	1,450 - 2,800	65

Huehuetenango shows a rather irregular topography because the Cordillera de los Cuchumatanes is located within it, which has the highest elevation in Central America. Its highest point reaches 3,993 masl (place of Xemal); but there are lower parts of only 300 masl. The Cuchumatanes are part of the sector with rocks of the Sierra Madre mountain range, having a length close to 400 km and are characterized by deep fractures leading to varied microclimates and living areas. Rainfall also show sharp contrasts, for five different levels 1) from 900 to 1,000m (Cuilco and Southern Nentón); 2) between 1,000 and 2,000 m; 3) between 2,000 and 3,000 m (Soloma and Todos Santos); 4) between 3,000 and 4,000 m; and 5) between 4.000 to 5.600 m (Santa Eulalia, San Mateo Ixtatán and Barillas) (CODEDE and SEGEPLAN, 2011). In general, the months comprising the rainy season are from May to October, and the maximum rainfall was recorded in June and September. The dry season covers the months of January, February and March.

Physical characteristics: Spatial location and natural resources

Huehuetenango is not a homogeneous territory. This is because the physical, linguistical, culturalal, demographic and socioeconomic characteristics are diverse, so there are several areas that overlap with the element to be taken into account to define the territory in the department. Thus, considering the ethno-linguistic characteristics of its population, it can be said that there in those 18 townships are different territories:

Mam (Cuilco, San Pedro Necta, Santa Bárbara, La Libertad, Todos Santos Cuchumatán, Colotenango and San Sebastián Huehuetenango); Chuj (Nentón and San Sebastián Coatán); Poptí (Jacaltenango and Santa Ana Huista); Akateko (San Miguel Acatán); Q´anjob´al (Santa Eulalia and San Juan Ixcoy); Tektiteko (Tectitán); Awakateko (Aguacatán, Chiantla and Malacatancito).

Living areas (forests)

The presence of forests with different degrees of moisture is prevalent, and because of the altitude differences, temperate, warm and dry subtropical forests can be found. As seen in the map below, there are two main living areas and five of less importance in the department. That represents a great variety of vegetation and natural resources and diversity of microclimates that allow growth of crops such as coffee, potato, garlic, onion and cardamom.

***Subtropical Lower Montane Rain Forest*.** With altitudes ranging from 1.500 to 2.400 masl; average rainfall of 1,000 to 1,500mm; annual average temperature of 15-23°C. It is the longest; where parts or all of the 18 townships from the department are located; covering 37% of the surface. The indicative species are: oak, pine and alder.

***Wet Forest, Subtropical Lower Montane*.** Presents altitudes ranging from 1.800 to 2.400 masl; average rainfall of 2,000 to 3,000 mm; average annual temperature of 12 to 18.6°C. Parts or all of nine municipalities are included within this region; (9.1% of the department). The indicative species are cypress; pine; oak and alder.

Subtropical Wet Forest (warm). It has altitudes ranging from 500 to 1,000 masl with an average rainfall of 2,000 to 4,000mm. Its temperature varies between 21-25°C. Its main plant species are volador, ceiba and conacaste. Barillas, San Mateo Ixtatán and Nentón townships are located in its extension.

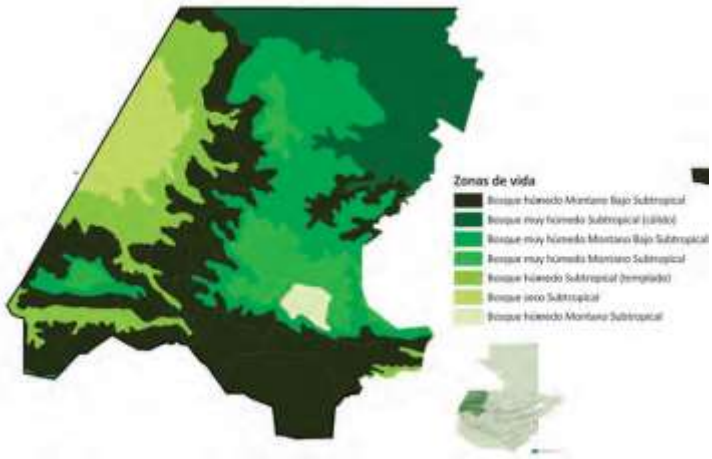
Subtropical Rainforest (mild). Altitudes of this area range from 1,000 to 1,500 masl with an average rainfall of 1,000 to 2,000mm. Its average temperature is between 18 and 24°C. It has well drained, dark gray, heavy textured surface soils with slopes of about 12%. The indicative species are pine and oak. It covers portions of six Townships.

***Subtropical dry forest*.** It is the lowest part with area altitudes ranging from 300 to 800 masl with an average rainfall of 600-800mm. It has an average temperature of 19 to 24°C. Species that are located in the area are: cypress and palm. The townships of Nentón, Santa Ana and San Antonio Huista Huista are located in these forests.

***Subtropical Montane Wet Forest*.** In this area the altitude varies from 2.800 to 3.000 masl with an average rainfall of 3,500 mm. Its average temperature is 11°C. The main species are: Some varieties of pine; fir and cypress. Five townships can be found in this living area..

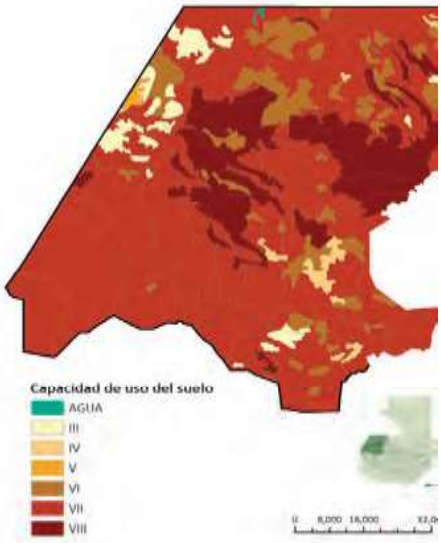
Subtropical Montane Rain Forest. It has altitudes ranging from 2,500 to 3,000 masl with an average rainfall of 1,200 to 1,600 mm with temperatures of 12°C. The main species are pine and cypress. The highest portion of Chiantla is located in this type of forest.

Map 3. Living areas (Zonas de vida)

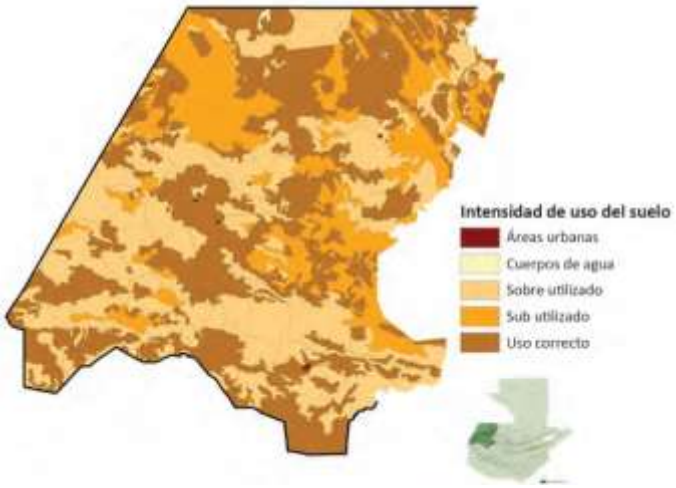


Usage capacity and current soil usage

64% of the land is suitable for forestry. Six different types of uses are identified. However there are three that stand out: type VI, which is land suitable only for perennial crops, as they are shallow, rocky, with undulating topography and steep, representing severe limitations for agricultural use; the type VII, land suitable exclusively for forestry because its topography is very strong and gorge with steep slopes; the type VIII is land suitable for national parks, recreation and wildlife, and drainage basin protection, with very rough, steep topography, with hogback or playones (flooded forests).



Map 4: Use and capacity of the soil



Map 5: Intensity of the used soil

In a considerable part of the south of the department, the soil is overused as the population uses it for agriculture, provoking erosion. In the northern area, however, a more correct use occurs and to some extent underutilization.

Sociodemographic characteristics

In the department, according to the 2002 Census, there were 879.987 inhabitants. However, latest estimates and projections (INE, 2010) indicate that currently there are 1.7 million inhabitants, with a floating population of 22,000 people.

The department's capital -Huehuetenango-, located 260 kilometers from Guatemala city, gives the main urban concentration and there are about 170,000 inhabitants located, representing a density of 519 people per km². According to the Labour Market Observatory (OML, 2010), this department has one of the highest growth rates and population density: 151 people per km².

Population density

Level	Density per Km²
National	121
Departament	151
Chiantla	177
Todos Santos Cuchumatán	112

In Huehuetenango the proportion of women is higher than men, above the national average. This implies that in these places a higher percentage of households is headed by women, who in the absence of jobs that allow them to combine the responsibilities of home care with productive work are in need of starting businesses (enterprises) as an alternative source of income. Social factors that explain the higher proportion of women are: increased life expectancy of women in relation to men and higher rates of migration of men towards women.

Population Distribution

Estrato	Population	% Men	% Women
National	14.5 millones	48.92	51.1
Departament (Hue)	1.7 millones	46.8	53.2
Chiantla	99 mil	47.5	52.5
Todos Santos	45 mil	44.8	55.2

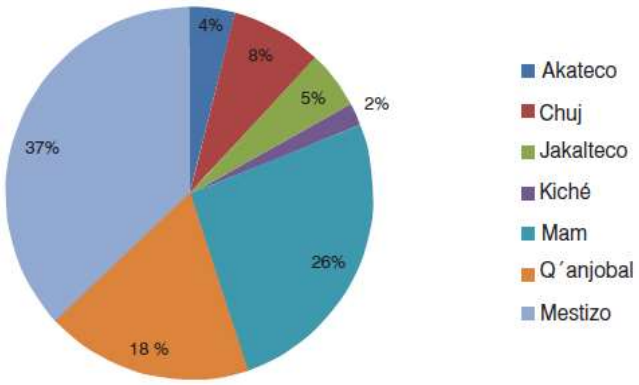
Ethnicity

In Huehuetenango over 65% of the population is indigenous, according to data from the 2002 census and its update of 2,010. Recent data from 2010 indicate that in Huehuetenango about 80% of its population living in rural areas more than 25 points above the national average. The extreme case is Cuilco, where over 95% lived in rural areas.

Ethnic distribution of Huehuetenango

Level	% Indigenous	% Non indigenous
Departament	65.1	34.9
Chiantla	7	93
Todos Santos	91.4	8.6

Linguistic groups



One feature of the department is its great ethno-linguistic diversity, expressed in the number of linguistic groups living within its boundaries. There are nine Mayan language groups: Mam, Q'anjobal, Awakateko, Tektiteko, Poptí, Chuj, Kiché, Akateko and Chalchiteko and Spanish speakers which are the most numerous in Huehuetenango, followed by the Mam and Q'anjobal group. The seven most numerous linguistic groups are shown in the graph.
Source: Database from the 2002 Census of INE (National Institute of Statistics).

Age Groups

According to projected data for 2012, people under 15 years and the group from 15 to19 made up more than 57% of the total population; i.e. in Huehuetenango the population is predominantly young. The group of those between 20 to 64 accounted for just over 38%; and those who were older than 64 years were less than 4%.

Section C: Methodology

General Objective

Quantification of sustainability of corn production practices and presence of mycotoxins as a key parameter for the loss of grain quality.

Specific Objectives

For this phase of the study, two specific results were developed:

1. Determine small farmers' production and post harvest practices associated with corn in the western highlands (Townships of Chiantla and Todos Santos Cuchumatan, of Huehuetenango).
2. Determine the families' of small farmers hygiene, basic health and nutrition practices, of the intervention areas of study.

Methodology

The methodology was based on recognized scientific and statistical methods; in addition to techniques and tools that enabled the collection and consolidation of quantitative and qualitative data. The methodology also considered inclusion, gender, diversity and multiculturalism approaches.

The study corresponded to a suitable design, with preparatory measures and no control group.

Considering the above, the proposed evaluation approach required the development of five stages:

a) Planning of the Evaluation process Stage

One result of this planning phase was to identify and include in the data collection instruments, which practices do the families of small farmers have, about harvesting, drying, storage and consumption of corn; and the inclusion of gender, health and hygiene practices in the areas of intervention. The needs of information held by each consortium partner: Kansas State University (KSU), Nebraska-Lincoln University (N-LU) and SHARE of Guatemala were also taken into account; before starting the research process and agree on how each stakeholder group would participate or get involved.

b) Establishment of the methodology and sample selection

Under different methods of consensus like cross-face meetings and communications via email, among others; prints and specific expectations were obtained, looking whether there were special analysis requirements related to the defined objectives of this study. At this stage sample design was refined, specifying what information was collected, when and by which methods, improving data collection instruments, identifying areas of intervention of the study and identification of study subjects (families).

Sampling method

- First selection level: Communities. Community conglomerates refer to communities or settlements known as villages, landscapes, villages, towns, cities, etc. The selection of these community conglomerates, was such that the characterization and selection criteria established were satisfied in conjunction with the scientific and technical team.

- Second selection level: Households. A random selection of households was done using maps and drawing sketches. The number of homes that were part of the sampling frame of each Community conglomerate was documented in field as well as the number of homes visited.

Sample size definition

The sample calculation[5] was done for the selection of which families to interview and/or visit.

To determine the sample for evaluation, the following formula to estimate the sample of families was proposed:

$$\boldsymbol{n = \frac{(confidence\ level)^2\ x\ P(1-P)}{(Estimating\ or\ accuracy\ error)^2}}$$

- n = Total number of families within the townships and communities to visit, which in this case the exact number is unknown and is therefore not set as a variable in the formula.
- Zα2 = 1.962 (confidence level at 95%)
- p = Idea of the approximate value of the parameter we measure (in this case a ratio). When choosing a value for p, the design leaned a value of 0.50. The reason is that the measured variance of the indicators eachs a maximum as it approaches 0.50. The safest course would always choose p = 0.5, as this will ensure an adequate sample size, regardless of the actual value of p. By the above, the p value was = 0.5 (50%).
- q = 1 – p (in this case 1-0.50 = 0.50)
- d^2 = accuracy or acceptable error limit (in this case 6%)

Giving a result of "n" equal to 267 families to interview, as sample size.

Sample size adjusted to loses:

In all sampling frames of any reseach, the calculation of possible losses of study subjects, for various reasons (data loss, abandonment, no answer) must be determined. Therefore sample size must be increased. The magnitude of loss depends on two factors: (1) the degree of similarity or homogeneity of elements within conglomerates and (2) the number of units of measurement to be taken from each conglomerate.

[5] The sample is a subset of the population to be studied. Its main features are:
Item or subject of study: Minimum unit that makes up a population. The item can be a single entity (a person) or a complex entity (family), and is called investigative unit or subjects of study. For this analysis, the subject of study was constituted by farmers and their families.

The simple size adjusted to expected loses (SI) can be determined as follows:

Adjusted simple to losses = n (1 / 1–R)
• n = number of subjects without losses
• R = expected losses proportion

"R"= simple size adjusted to lost (2% is expected)

This resulted in **272** families to participate in the post-harvest practices survey.

Final simple collected

Because of a good community approach process of and their willingness to work till the end of the study, answers of 280 farm households were obtained, distributed as follows:

Chiantla:	35.71%
Todos Santos:	64.29%*

* Although in Todos Santos' population and territory is less than Chiantla, the reason that the selection of the sample is proportionately greater in Todos Santos is because in the territory fulfills all the selection criteria (listed below) while in the case of Chiantla it did not not meet the "a" criteria (lacks type C altitude).

Community selection

The communities were selected based upon the following criteria:

a. Altitude (A, B y C) [6]
b. Access to corn (1 y 2)[7]
c. 2 additional communities were included as control.

The total number of families to interview had to be at least 272, and considering that the average data collection was 50 minutes to an hour per family (family = sampling unit), an interviewer had to do about 5-6 surveys per day (including mobilization; this due to scattering of homes in communities).

It was estimated that 14 communities would be covered in the study according to the above calculation and the minimum of 20 households to interview per community. Field experience and following the methodology of proportion, relative to population size, it was decided that the weight distribution by township was of:

- 8 communities of Todos Santos
- 4 communities of Chiantla
- 2 communities as control group (1 per township)

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6 Type A altitude (very cold) Until 3,600 masl (meters above sea level)
Type B altitude (mild) Until 2,700 masl
Type C altitude (template to warm) Until 1.500 masl

7 Type 1 (mainly plants corn. Storage for selfconsumption)
Type 2 (Buys corn for consumption)

Attached in Appendix 1, the list of communities
Selected for the study

c) Generation of data collection instruments Stage

The instruments were proposed and refined by the joint technical team (KSU, UNL and SHARE). Also, before training the interviewers, time was spent for the instruments' validation (survey) in communities. The latter was made by the Technical Advisory Programme, in communities and interview subjects not included in the study.

Only one survey was used for data collection, consisting of 80 questions and focused on obtaining technical aspects of context, gender issues, hygiene and sanitation, general knowledge of corn post-harvest processing, among others.

Attached in Appendix 2, the instrument or
data collection ballot. (Exhibit "A")

d) Staff training and standardization of interviewer Stage

Within SHARE's assessment processes, proper training and standardization of staff who will be part of any assessment process or field study takes high importance.

This training was designed so that at the end of the workshop the participants would manifest knowledge and mastering: the study objectives, the instruments or surveys to be used, protocol or interview techniques that SHARE uses in their studies, areas where the study would be done, logistics and community contact, route planning, among others.

In addition a day of fieldwork was scheduled in order to validate the skill and mastery of instruments of interviewers in the training workshop. This validation was performed with people in the Taluca community of Chiantla. As mentioned above, this community was not selected to participate in the project, but had similar characteristics of those that were selected. It was then possible to verify the quality of transmission of knowledge to interviewers and proper use of the techniques of data collection.

e) Collection of information Stage

- Fieldwork: once developed, approved and validated in the field, the data collection instruments were applied in locations identified in the sample; following the plan and protocols defined for that effect.

Phase A:

Collection of data related to identifying smallholder's corn production, harvesting and storage practices.

This stage lasted 12 working days and was executed from the week of August 25th, 2014 (first year of implementation), in selected communities (9 communities in Todos Santos Cuchumatan and 5 in Chiantla).

Communitary contact protocol:

- After the selection of communities, a roadmap (scheduling according to the community's geo-location) in conjunction with field staff was established.
- Team leaders (field staff supervisors) estimated at least two working days before the start of the study, to contact the Community authorities (COCODES or community leaders), to inform them of the purpose of the study and request authorization.
- After obtaining the Community's authorization field work was performed. The purposes and goals of the study was explained to all families involved.

Selection of sampling units (households-families)

For the sample units (households) selection, it was necessary to take into account the representativeness.

Random selection: To accomplish this, in partnership with community leaders, sketches or maps of the homes in the community were developed. A selection through a systematic random sampling was done to select the required number of households within each community.

Before visiting the homes for the study, the criterion of ethics was met. This consisted of informing the family about the study objective, and what their participation would consist of. Also to ask for their consent to participate.

Requiered profile

The design include the hiring of two teams:

1. **Technical team for data collection**
   Two teams for field data collection were employed: Community interviewers (3 per team), led and monitored by field supervisors (2). These teams were monitored and supervised by the Monitoring & Evaluation Coordinator SHARE of Guatemala.

   Staff for data collection was comprised of members who know the language and culture of the selected municipalities. And also have proven experience in handling interviews or surveys of this nature.

2. **Data analysis team**
   BS Humberto Mendez, a renowned consultant who designed databases and information outlets, was hired (based on the agreed plan of analysis). He analyzed the data generating output tables and/or data boxes.

   Monitoring this stage was also in charge of SHARE's Monitoring and Evaluation coordinator.

Tabulation and data analysis plan

- Transfer of gathered information of "Instrument A" (survey) to database/software built for this purpose (EPI-info, double-entry program, tending to zero error).
- Establishemnt and agreement of the hired consultant, the treatment plan and statistical analysis of results.
- Additionally, it was proposed for all processed data:
    - Include the calculation of the defined indicators, cleanup criteria, cutoff points, etc.
    - Definition and method of generation of impact indicators
    - Brief comments on the process of digitization of data
- Presentation of results (as preliminary) to SHARE Guatemala for discussion, extension or correction.
- Making of final report on this activity.

Administration of the diagnostic process:

1. The study was led and coordinated by the Office of Human Development, with the supervision of the SHARE's technical Advisor and the Monitoring & Evaluation coordinator; who established:

    a. The review time for the assessment, tools and methodologies design; this included the validation of instruments in the field and feedback on the results.
    b. Schedule of regular meetings to check the progress of the implementation plan of evaluation.
    They established the random data collection in coordination with field supervisors and interviewers.

2. The logistics of the evaluation was managed between the program’s Technical Advisor Program and the M & E cordinator.

3. Communication line
    Technically responds to Human Development Management and Technical Advisor of the program and staff of the partner institutions of the consortium.

Section D: General Results

Family composition of interviewees.

Within the participating families 37.86% have 1-5 members, 22.5% have 6 members and 39.64% have more than 7 members. The 33.21% of the surveyed households have children under 5 years, 41.07% have 1 boy/girl under five years and 25.71% had two or more children under five. Knowing that malnutrition can be corrected in children under five years, it is important to know that in the communities comprised in this study 66.80% of surveyed households have children under 5 years.

Referring to children of ages 5-12 of the surveyed households: 34.05% of families do not have children, 31.18% reported having a boy/girl 22.22% mentioned have two boys or girls, and 12.54% reported more than 3 children in the household. This is important for characterizing the population of the areas of study, because in general, children aged 5-12 years are of school age and are considered for workforce development in family activities such as grazing and handling pets, hauling firewood, and corn activities such as sorting, shelling and grinding for obtaining masa (corn dough).

62.08% of interviewed families stated affirmatively that enrolled all their school-age children in school and 8.18% said they did not register all their children. Usually, girls are the ones denied the access to school if the parents' circumstances are not the best.

Among the reasons why parents do not provide the opportunity to study to all of their children, we can mention: economic capacity, the motivation of children themselves to continue studying, and early incorporation of boys/girls as hand work, boys in farm work and girls in activities within the home and attention and care for younger siblings.

Farmers and land tenure

99.57% of respondents have land for agriculture. However it is important to note that 89.96% of respondents own the land while 10.04% rents or borrows land. Regarding the extension of owned land used for harvest it can be mentioned that 29.61% of respondents owns the 1-3 cuerdas, 33.98% were between 4-8 cuerdas and 36.41% have more than 9 cuerdas of property. Overall it is a subsistence agriculture; mainly produced for home consumption. There is no abundant revenues for the accumulation or capital growth, or use of skilled labor.

82% of farmers stated that they plant corn, 27.07% does it in an area of 1-3 cuerdas, 34.5% in an area of 4-8 cuerdas and 38.43% in 9 or more cuerdas.

15.72% of the farmers rent land, of them: 30.56% rent between 1-3 cuerdas, 50% rent 4-8 cuerdas and 19.44% rent more than 9 cuerdas. Finally, 10.92% of farmers grow corn on borrowed land and 0.87% use family land. Although there is land available it is sometimes not enough so farmers must rent or loan. Taking into account that the main destination is the consumption, it must be associated that there is not enough land available to reach the household demand. This could be related with the weather conditions that affect production as well as the average number of members in the family since 62.14% of the surveyed households was comprised of 6 or more members.

Table No.1 Tenure and land use according to size.

Land size in No. of cuerdas	% Of farmers own the land. -TENURE-	% of farmers who plant on their land. -USE-	% of farmers who rent land. -RENT-
1 to 3	29.61	27.07	30.56
4 to 8	33.98	34.5	50.00
More than 9	36.41	38.43	19.44

Much of the decision to plant soil is associated with the corn availability, the economic capacity for hiring labor and buying fertilizer, as well as the little support from government social programs.

Decision making between genders

Of the interviewed farmers it was possible to demonstrate the different roles or functions performed by both genders in agriculture as in the house.

Table No. 2. Distribution of decision making based on gender.

Decision making between genders	Man %	Man and Woman %	Woman %
What to plant in the land and how	33.33	64.04	2.63
If the harvest is consumed in the house or sold	25.00	64.48	10.53
What food is consumed in the house	3.07	32.46	64.47
Who eats more and first in the house	55.07	40.97	3.96

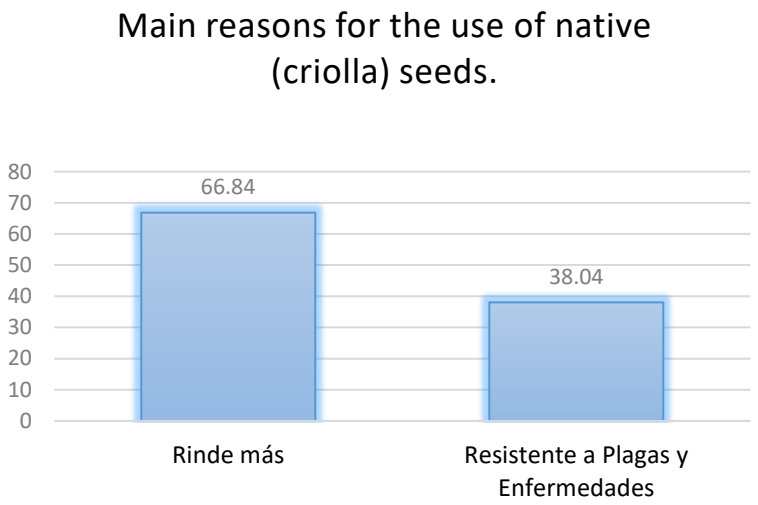
These data is consistent with the national context, where the role of women focuses on the decisions of the diet, as well as how to prepare food. It is she who finally decides what to do with the "damaged" corn kernels; i.e. to be eaten in the family, or to be used for animal consumption, or discarded entirely.

On the other hand there is a shared decision between the genders regarding sowing and planting, with some percentage of the unilateral decision of the male.

Corn harvest and participation based on gender.

80.35% of the farmers produce corn, but 100% of farmers manifests buy corn for home consumption. This finding validates the thesis that the production is not sufficient for the annual household consumption and therefore they must buy corn.

There are generally two planting seasons: the "January" cycle is from January to October, usually in the high areas or higher plateau at 2,600 masl. This planting is done taking into advantage the natural ocurring moisture from the ground. The "May" cycle from May to December, in the lower regions, related to the rainy season. For each region there are specific seeds.



(Rinde más = Higher yield, Resistente a Plagas y Enfermedades = Pest and disease resistant)

95.65% of farmers declared using native seeds. Among the most outstanding varieties we can find: annual White Corn, short white corn, white corn, San Lorenzo yellow, Dog teeth, native (criollo) yellow, pinto corn, Salqueño corn, black corn, Sarquilito corn and native Chucuy corn. These are the common names for the heritage seeds which have been used for years keeping their best features. According to such features, the farmer will use that seed for the following year of production. The round yellow seed is unique to the areas of the plateau of the community of San Antonio Las Nubes.

The reasons why respondents reported using native seeds are:

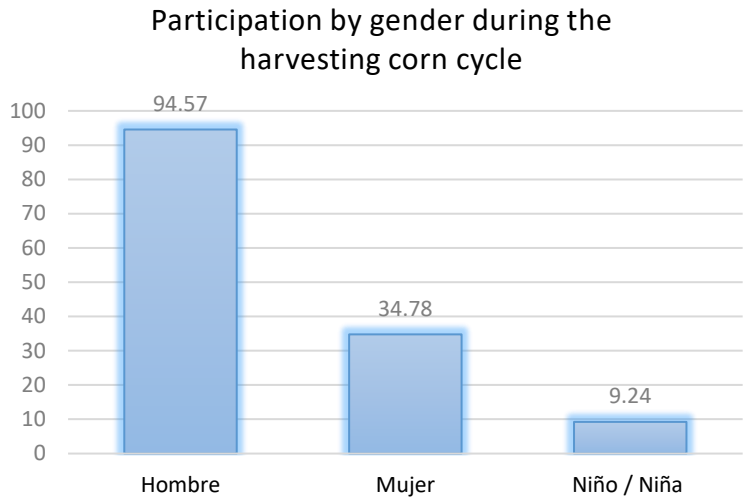
The prevailing cold conditions in the area under study makes the native corn the prefered choice. Farmers in the community of San Antonio Las Nubes mentioned that the seed "Diente de Perro" (Dog Teeth) is used for tortillas and the Salpor seed for baking bread.

Regarding the availability of inputs and tools to plant corn, it was found that 99.45% has tools (hoe, shovel, etc.).

Furthermore, 93.96% indicated having access to fertilizers, 10.99% have improved seeds, and 61.54% native seeds. Only 3.3% said to access to irrigation equipment. One important thing is that 66.67% have a compost heap.

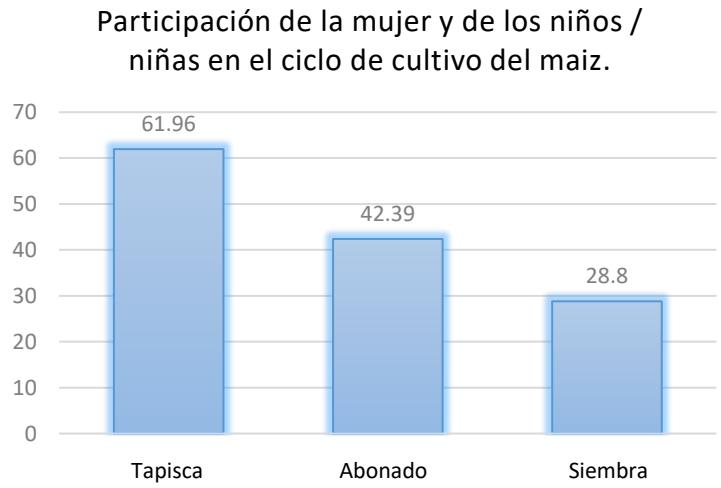
There is a strong involvement of family members in crop work (74.46%), compared with 24.46% of people who recognize the recruitment of laborers or gañales.

Gender participation throughout the cycle of corn is as follows:



(Hombre = man, Mujer = woman, Niño/Niña = Boy/Girl)

The participation of women and girls/boys from the clearing until harvest or tapisca is reflected in greater proportion in the following stages:



(Tapisca = Harvesting, Abonado = Fertilized, Siembre = Planting)

Lower participation activities are weeding with 6.52%, and fumigation 0.54%. 24.46% reported women and children do not participate in these stages. This shows that these duties that pose a risk of poisoning from pesticides are tasks performed predominantly by men.

Table No. 1. Comparisson of the role of the woman and boys/girls in the pre-harvest and post-harvest activities

No. of activities	Pre-harvest	Post-harvest
	%	%
0	23.91	4.35
1	29.35	30.43
2	33.15	46.74
3	9.78	18.48
4	3.8	ND

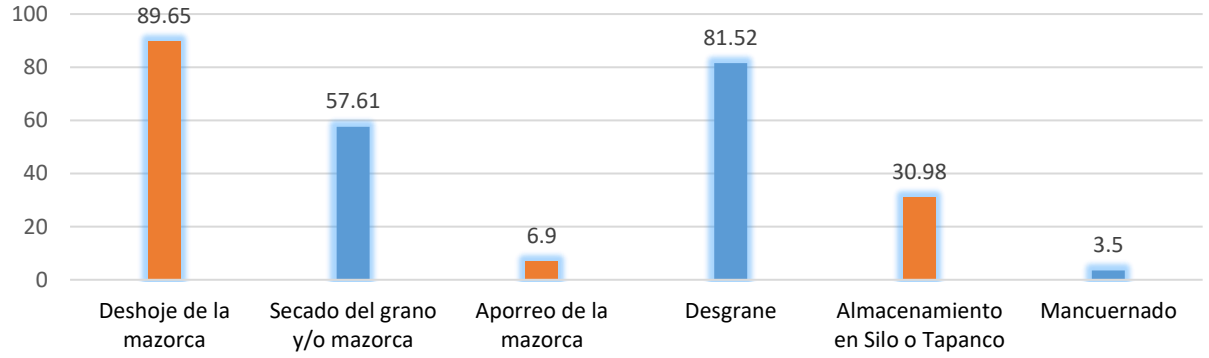
ND: No data

In the previous table, the increased participation of women and children in the stage of post harvest is reflected, which is congruent since these are less risky and less stressful activities and generally focus on decisions of the proper management of corn in the household.

The process of post harvest is a family activity where only the 7.61% reported hiring laborers or gañales for this type of work. In some of these cases, respondents were women who live alone or single mothers.

The participation of women and children is much more noticeable mainly in the defoliation of ears (89.65%), drying of grain or cob (57.61%), shelling in the storage silo (81.52%) or the tapanco (30.98%) pounding (aporreo) the cob (6.9%) and in the process or making mancuernas (corn hanging) (3.5%). Children and women are not involved in the task of spraying and 3.8% reported not to be involved in these Post harvest tasks.

Participation of the woman and boys/girls during the Corn post-harvest stages



(Deshoje de la mazorca = husk removal, Secado del grano y/o mazorca = Kernel and/or corn cob drying, Aporreo de la mazorca = shelling process by hitting the cob, Desgrane = regular shelling process, Almacenamiento en Silo o Tapanco = Silo or Tapanco storage, Mancuernado = drying the corn by hanging it in the open air)

The activity of grain cooking and torteo (making tortillas) is an exclusive activity of women.

Traditional knowledge in relation to the harvest and post-harvest corn handling

The farmers are experienced in planting corn, 92.93% said to have more than five years managing their land, many a lifetime. The fate of the corn planting is self-consumption (98.91%) and only a small part for sale. Corn is an ancestral culture, linked to lunar cycles, Mayan culture and worldview. It is also the most commonly used resource or agricultural product in the Guatemalan diet.

As for the practice of bend (dobla), it is not widely practiced in the study area. 67% of the farmers do not do this practice, the rest is carried out by very specific conditions such as excessive rainfall in the area, or period of prolonged rain, or because it is effectively an adopted practice.

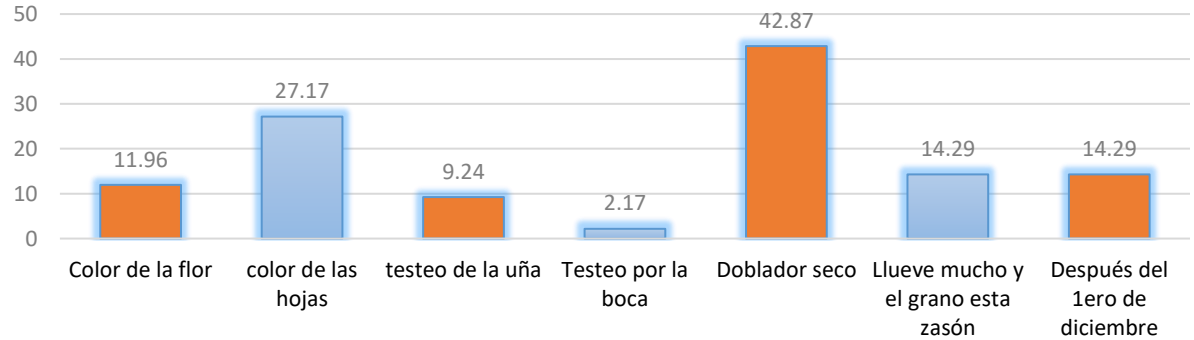
Observations and Practices to determine the moment of dobla (fold) during corn harvesting (in %)

(Color de la flor = flower color, Color de las hojas = leaves' color, Testeo de la uña = Nail test)

Although the bend is not widespread, 33% said they do it. Here are some observations and practices used by the farmer to determine the proper timing for the bending.

The "color of the leaves" is a widespread practice and involves determining the degree of dehydration of leaves at plain sight, this accompanied with the "nail test", which consists in evaluating the grain hardness by introducing the nail to the grain. Traditional practices have accompanied the farmer in making a better decision. Referring to the tapisca (harvest), the farmers do it according to certain practices and observations that have been inherited by generations, being the following:

Observations and Practices to determine the moment of harvesting of corn (in %)

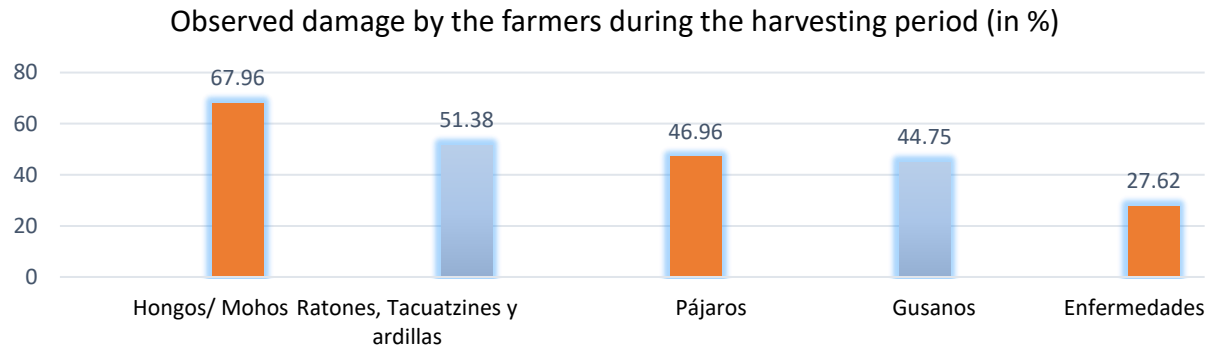


(Color de la flor = flower color, Color de las hojas = leaves' color, Testeo de la uña = Nail test, Testeo por la boca = mouth test, Doblador seco = "dry bender" Folded cob is dry, Llueve mucho y el grano esta sazon = It rains a lot and the grain is ready, Despues del 1ero de diciembre = After Dec 1st)

The "mouth test" is used to know the hardness of the grain through a bite of a corn kernel. Referring to "dry bender" is when the cob is completely dry or dehydrated due to dobla (bend). During the rainy season, temporary or constant rain, when the farmer notices that the cob is "sazon" (ready, that is almost dry), he prefers to proceed to the tapisca process than to let the corn rot in the fields, or prevent germination of the grain in the ear. Some farmers even have dates set for harvest and use important calendar dates (either Catholic or civil calendar) to guide its production cycle of corn, as in the case of farmers in Todos Santos, who prefer to perform this task after the Saints day fair, celebrated on November 1st.

76.06% of the respondents do this activity entirely by hand. The remaining farmers mentioned use tools such as machete or knife to facilitate this task. Some farmers in San Antonio las Nubes mentioned that the tapisca (harvest) is performed on full moon, as it result in much harder grain and more resistant to pest attack during storage.

Observed corn damage



(Hongos/Mohos = Fungi/molds, Tacuazines y ardillas = armadillos and squirrels, Pajaros = birds, Gusanos = worms, Enfermedades = Disease)

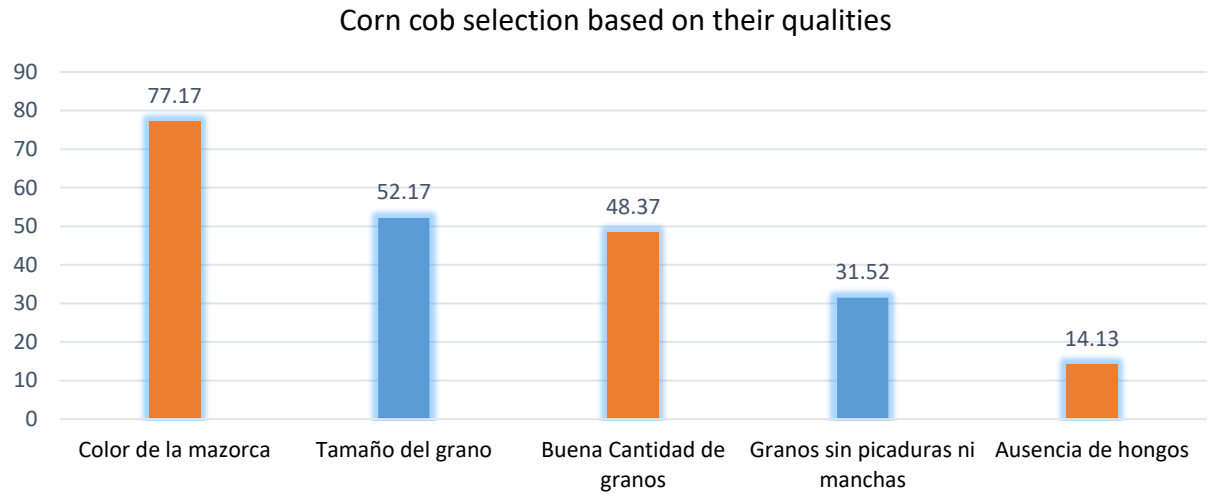
Upon tapisca 98.37% of farmers said they have some type of damage either on the corn plant or on the cob. In most cases they manifested both kinds of damage.

Table No. 3.
Number of observed damages in the corn planto or in the corn cob during the harvesting process

No. of observed damage.	Percentage
0	1.63
1	17.93
2	34.78
3	27.17
4	17.39
5	1.09

Corn cob and kernel selection process

Corn cob selection either for storage and later use or for seeds for the next production cycle, is performed under the following characteristics:



(Color de la mazorca = Corn cob color, Tamaño del grano = kernel size, buena cantidad de granos = Plenty of kernels, Granos sin picaduras ni manchas = kernels without physical damage (due to bugs/birds) or stains, Ausencia de hongos = abscense of fungi)

Other less frequent but important features mentioned were cob weight and the combination of weight and color.

The activity of seed selection takes place in the field during harvest (37.36%), before drying (37.91%) or when corn is being stored (28.02%.)

Table No. 4. Number of observed qualities for the identification of a good corn cob

No. of qualities	Percentage
0	0.54
1	35.33
2	24.46
3	24.46
4	10.33
5	4.89

Storage and grain usage practices

Table No. 5. Cultural practices to know when to proceed to grain storage

Practice	Percentage
Tactile or nail test	32.24
Kernel hardness test, by bitting the kernel.	16.94
Sound test and by eye	45.36
No Data	5.46

94.57% of people stored corn after making the practice of drying, the rest begins to consume it because it coincides with the limited availability of corn in communities and there is no data available about it.

1.72% of farmers who sold corn, do it in the local market or sell it to family in the community. It was observed that this happens on Wednesdays, Thursdays, Sundays (local market days).

Corn and food availability.

According to the data, corn production fell by 20-60% due to prolonged drought in the area under study, putting in risk the food availability for farmers in 2015. During this study it was determined that 67.39% of farmers reported having harvested less than the previous year.

Table No. 6. Corn production in the study zone 2013-2014

Harvest range (in quintals, qq)	Percentage of farmers
5 to 10 qq	71.20
15 to 20 qq	15.76
25+ qq	13.04

The high percentage corresponds to the minimum range, this is the reason why the availability of grain is not fully satisfied. Previous studies by SHARE have expressed dissatisfaction of food in the months of June to September, period where corn and beans stocks are depleted and harvesting has not yet been obtained by the natural cycle of the crop.

During 2014 the prolonged drought began in July 18 and ended on August 14. This drought affected the proper development of plants and therefore the harvest.

Selection and Drying practices.

93.48% of the farmers who produce corn indicated to use some type of corn drying practice before storage. There are many ways and times for the practice of drying, the main practices were:

a) **3.49% in the whole plant (milpa), before cutting the cob**

b) **In the cob, after cutting it**
In this mode of drying, 88.37% farmers indicated to dry the ears using the sun before storing, 10.47% said they place the ears on the roof. However, farmers said they can combine different techniques (i.e. sun-drying and drying in tapanco), and it is for this reason that out of the 172 farmers who reported growing corn, 5.25% also dry the ears directly into the tapanco.

c) **After the shelling**
After being shelled, 9.98% (17 of 172) places the corn in nylon followed by sun dry and only 2.91% (5 of 172) places the corn inside the house (which may be in the tapanco).

The common practice is to dry the ears after being harvested. According to field experience, there are farmers in San José las Flores that have tapancos above their bedroom with tin roofs. They use it as a space for drying corn over a period of approximately one month (November to December), and then place it in wooden boxes located inside the house, in silos or bags. This practice is due to rainy conditions of the place making it impossible to do sun drying, as is commonly observed.

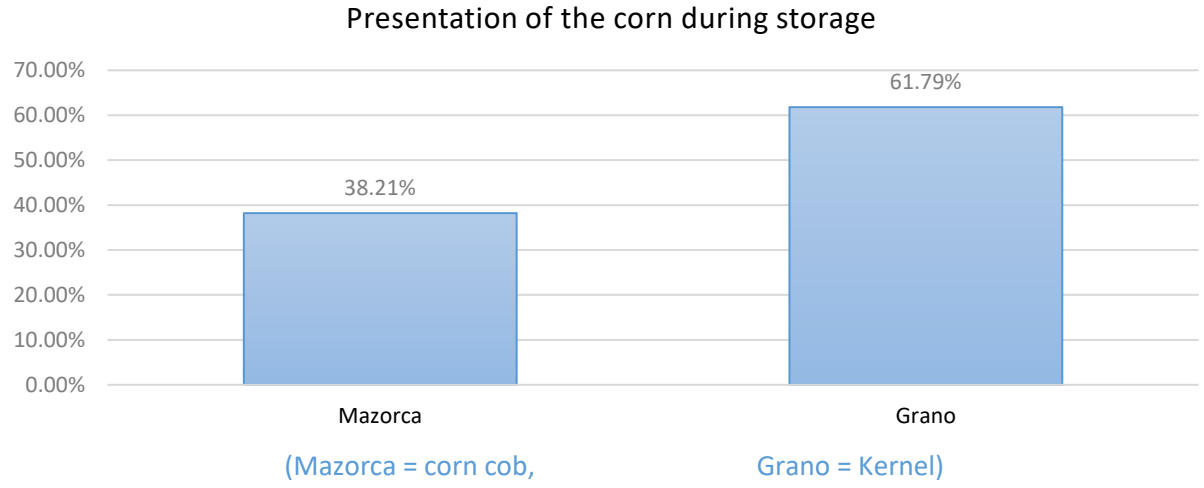
Regarding the selection of the ears, this is usually seen during the drying of the cob in the patio or porch of the house. Mulco corn or Cheque corn are terms used to refer corn (or corn cobs) damaged by fungi, insects or rodents. Is it in this moment where the fate of this corn is defined: For human consumption mixed with the good corn, it can be used for animal consumption or eventually discarded; a decision that usually lies in women.

Handling and Storage conditiones Section

Type or storage médium

The design of the diagnostic instrument was developed based on information from the two forms or chains of corn production identified during the diagnosis on families in the communities. The two identified chains are self production and corn purchasing either to meet their food needs or to supplement domestic production.

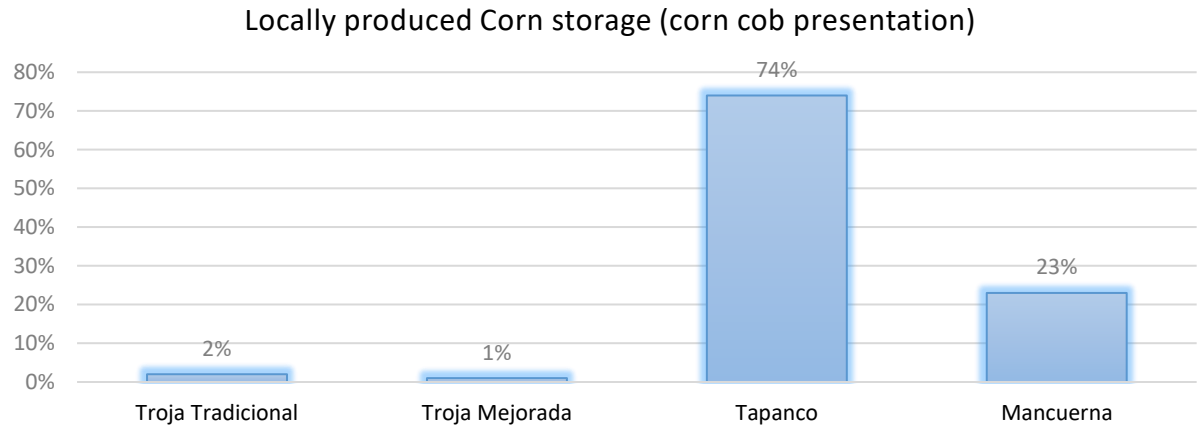
The data obtained support the finding that production is not sufficient to meet the food needs of families, so they have to buy corn regularly. In this regard, families were asked how they kept their corn (no matter if it was purchased or produced on site):



Many farmers associate corn storage with the corn that is wrapped and packaged in bags. This corn, depending on economic conditions of farmers, is bought in relatively small amounts (from 25 pounds to 4 bags), which will be consumed from one week to one month.

Type of corn storage, when locally produced:

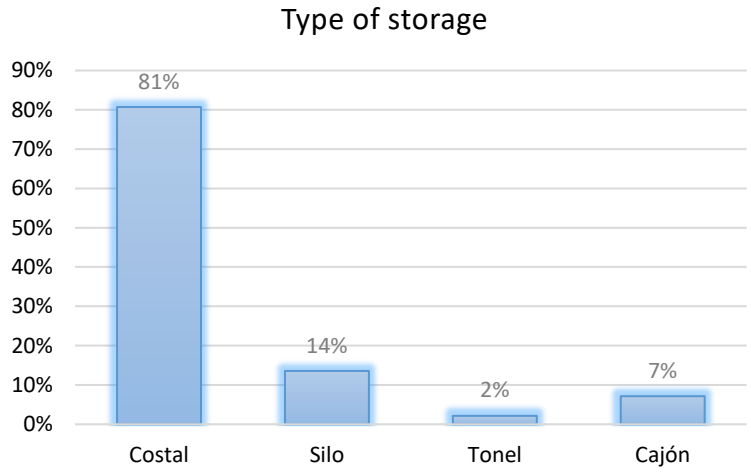
It was found that 74% of the farmers prefer to use the tapanco as storage for ears. This practice allows farmers to not only protect it from the elements, but also to dry it. In the field it was found that families keep the practice of letting the heat of the roof dry the cobs, however they do this even for freshly harvested cobs with high moisture content.



(Troja tradicional = Traditional troja, Troja mejorada = Improved troja)
Troja = Simple structure built from trunks of trees or shrubs that grow in the locality or scrap wood tables and wire.

Type of corn storage, shelled (bought or produced)

The diagnosis showed that farmers have a preference for saving shelled or purchased corn in bags. Overall, 81% of farmers said to store corn in bags. This practice is more widespread in the township of Todos Santos (64%) than in Chiantla (46%).



(Costal = bag, Silo = silo, Tonel = cilindrical container, Cajon = wooden box)

The practice of using the purchase package (bag) as a storage medium is done due to its convenience and versatility, in addition to the comfort to stow in the storage room.

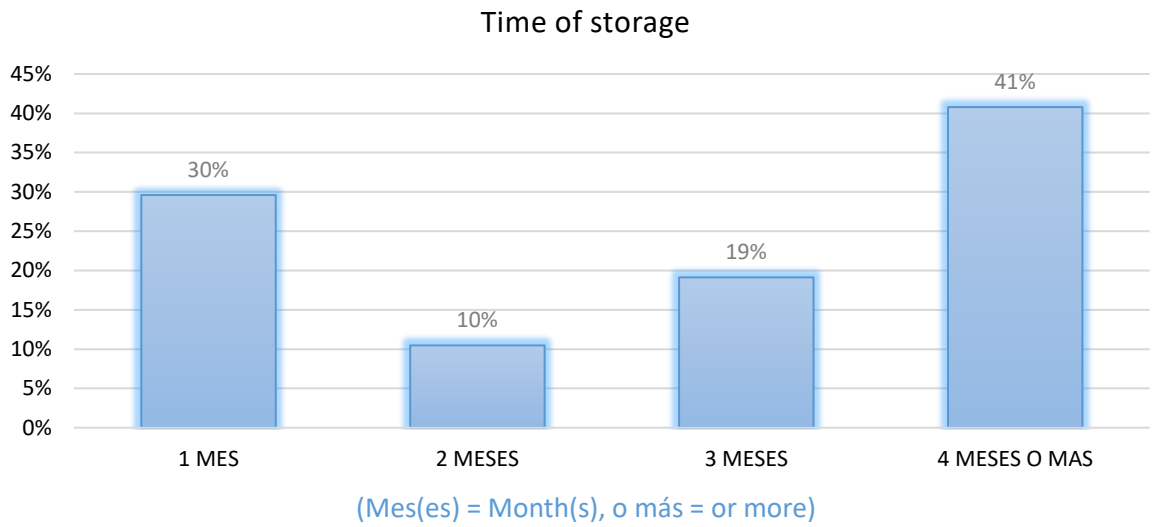
Out of the 14% of respondents who use silos[8], 79% indicated using the "pill" phosphine and phosphamine for fumigation and pest control.

Through field evidence it has been possible to see that although farmers indicated to use the pill, the method of implementation or use is not precisely appropiate.

Corn storage can be shelled or cob: Shelled corn can be stored in bags, bins, drawers, primarily; and cob in bags, tapanco and wooden boxes when it is used for consumption. Corn is placed in Mancuerna (hanging corn) within the corridor of the houses when intended for seed pods.

There are several ways to place the corn in the tapanco: cobs with husk, half husk or without husks. The way to place the cobs in the tapanco are: Without any order, in bags or type Presa or Press.

Time of storage

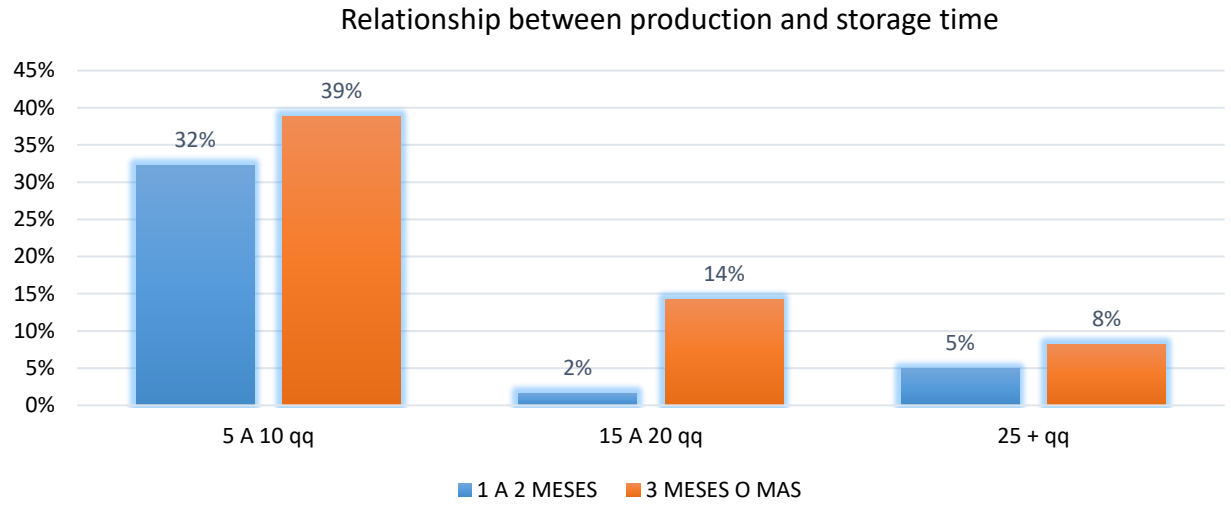


Respondents indicated that 41% of the farmers store the corn for 4 months or more. Of this, 21% belongs to Chiantla and 20% to Todos Santos. This contrasts with the practice of buying corn, where it was found that a good number of farmers do not buy corn in quantities sufficient to keep it stored for more than 90 days (3 months).

An interesting evidence of this section is the relationship between the amount of corn produced in the last harvest and storage time reported by respondents (corn producers).

It can be seen from the graph that for those farmers with lower production (between 5 and 10 quintals), storage time is vastly superior compared to farmers with production above 25 quintals. This can be attributed to farmers increased production capacity, using part of their harvest for sale, as well as those who produce little, keep it to dry thoroughly and keep it as a reserve, while buying corn in the near term meet the immediate demand of grain, taking advantage of low prices on the market.

[8] 14% of the farmers that store their corn in silos, do so just for bought shelled corn.



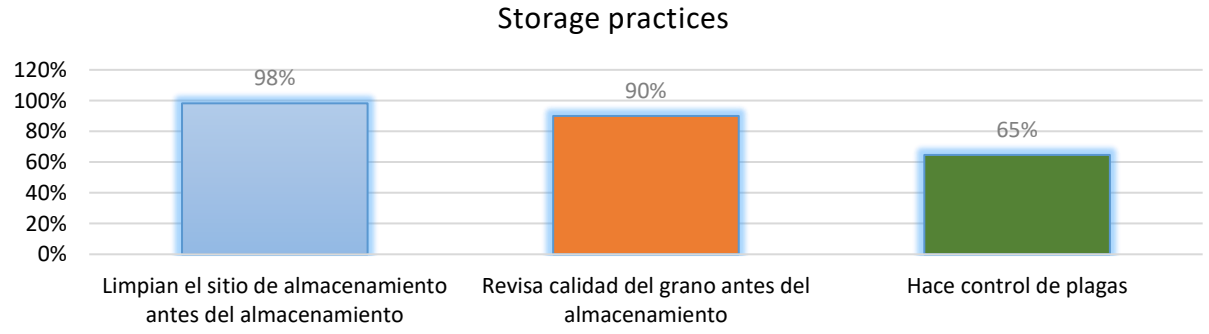
(1 a 3 meses = 1 to 3 months, 3 meses o mas = 3 months or more)

According to visits during the study it was also found that there are families who buy corn for a week or one month; their economic capacity does not allow them to purchase large quantities of grain. This is commonly observed in communities located in altitude "A" stratum, ie greater than 3000 masl, where the economic conditions of families are deteriorated.

Storage practices

Cleaning of warehouses or storage site

In both Chiantla and Todos Santos townships, it was evident that the practice of cleaning the storage site, was above 98%. Of this 98%, 90% indicated to clean the storage site before saving the new corn (freshly harvested or purchased). 8% indicated to clean the storage location each month and 2% every two months.



They clean the storage site before storing the corn
They check the quality of the corn before storage
They do pest control

The practice of cleaning the storage site is solely to sweep the tapanco or cleaning the wooden or silo. Pest control focuses on rodent control in the tapanco which is very common to observe, also moth and weevil control.

Farmers mentioned that smoke generated from the kitchen, fue to cooking food aid in pest control located in the tapanco. The location of the tapanco sometimes coincide in the part where the stove or handmade kitchen stove is located.

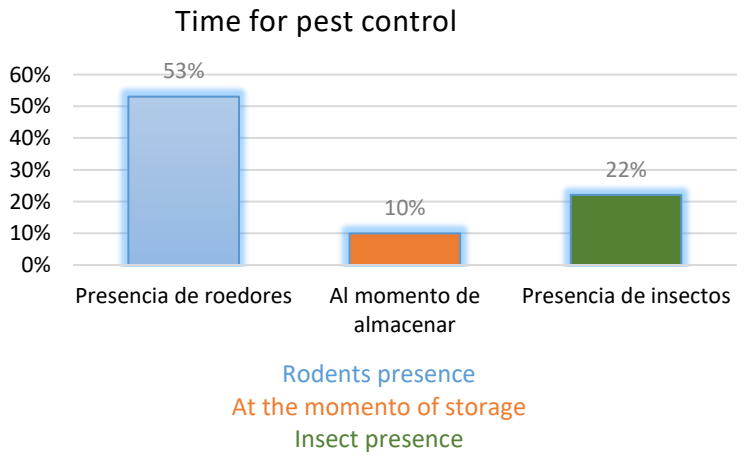
Grain Quality Review

90% of farmers said to do grain quality check before saving it in the storage room. Once stored, farmers indicated to continually check the corn. The following table lists the frequency of revision:

Corn check during storage	
FREQUENCY	**%**
1 time per week	61.45
1 time every 15 days	14.06
1 time per month	17.27
1 time every two months	5.22
Doesn't know, Doesn't answer	2.01

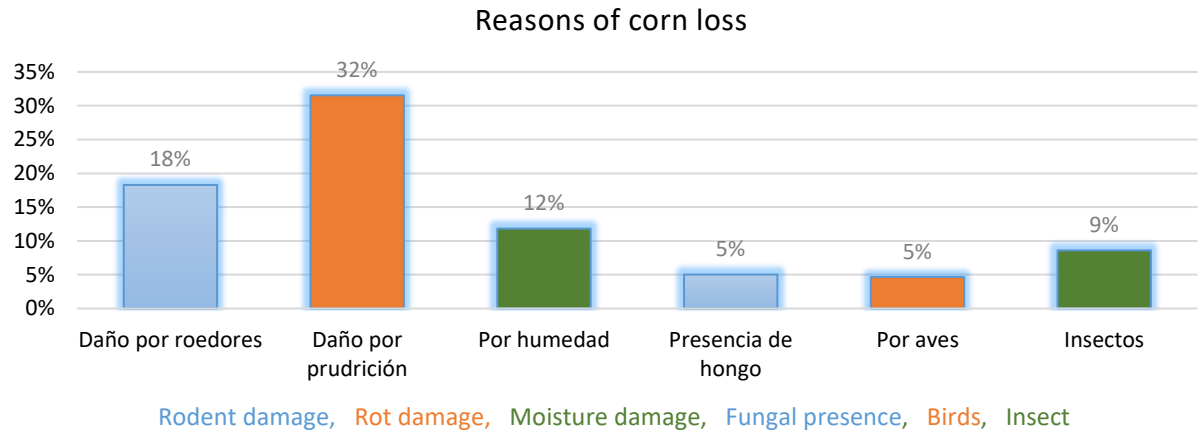
Pest Control

It is noteworthy that 65% of farmers perform pest control for grain storage. From the above, farmers indicated that 53% perform various mitigation practices pests when they observe the presence of rodents. Only 10% do so at the time of storage and 22% indicated to perform some pest control practice when they observed damage in the kernels, presence of moths, weevils and other insect damage. In most cases, the control is not not preventive but corrective.



Post-harvest Corn losses

When asking about the main reasons for losing corn from tapisca (harvest) to consumption, farmers expressed different reasons, such as damage by rodents (squirrels or mice), rot (excess water and moisture), due to grain and environmental moisture, and by fungus among other reasons.



The rotting of ears and kernels is the most identified reason of loss by farmers.

It is important to mention that rot damage, moisture or presence of fungi are related, ie 49% of farmers reporting losses due to excessive humidity or mishandling of moisture in the grain. This represents an opportunity for the project on improving these postharvest handling practices.

Loss Quantification:

The study evidenced that eventhough farmers produce corn, about 95% buys corn to meet their food needs. In many cases, first consume the purchased corn leaving the harvested one for the end of the season.

A small number of producers (about 3%) have a surplus in their production. That is, producing more than the household can consume in a year. Based on this, farmers cataloged their losses depending on several factors:

- Corn losses in the stages of harvesting and drying (corn proiduction chain)
- Losses of purchased corn in the stages of drying and storage (chain of those who do not produce corn)
- Combined losses in the stages of harvesting, drying and storage (can produce corn, but still purchase

Corn production chain: Loses during harvest.

The information reported by farmers as a loss at this stage was different in the previous season, depending on the volume of production of each farmer. A production of 2237 quintals of corn was reported. From this, farmers reported a loss at this stage of 146.7 quintals (6.6% loss).

In terms of variability of losses, we could establish the median and the average of the range of data evaluated:

Median*	1.5%
Average*	5.7%

* Of the total list of percentages identified as loss, sorted ascending, the median is the value which occupies the central position in the series.

* The average loss is the result obtained by dividing the sum of the amounts reported as "losses", expressed in percentage (%) by the number of addends or frequencies identified as losses (including those who report no loss).

These results do not vary significantly between townships. As evidenced by the following table:

Township	Produced corn	Reported loss in harvest	% Loss
Todos Santos	1,197.03*	82.55*	6.9%
Chiantla	1,040.00*	64.15*	6.2%

*in quintals (100 pounds)

NOTE: The reported number of losses must be understood from the point of view that "damaged" cob is a concept handled differently for farmers. In practice, they discard very little corn even when it is damaged. Much of corn that is elsewhere considered as damaged in these regions it is still used for human consumption or animal consumption, so we can deduce that losses may be an undervalued factor at this stage.

"Purchase" of corn chain: Losses during the drying and storage.

Like the previous category, what was reported by farmers as "loss" varied depending on the volume of purchased corn. Farmers reported a total of 5,229 quintals of purchased corn in the previous season. From the above, a loss of 82 quintals was reported representing a 1.47% loss.

Like for the previous data, and in terms of variability of losses, we could establish the median and the average of the range of the evaluated data:

Median*	0.6%
Average*	1.8%

Similar to the data presented above, these results do not vary significantly between townships. As evidenced by the following table:

Township	Produced corn	Reported loss during harvest	% Loss
Todos Santos	3,282.47	48.42	1.48%
Chiantla	2,247.00	33.10	1.47%

*in quintals (100 pounds)

This seems insignificant, but we need to refer back to the field evidence that indicates that corn defined as "loss" is little quantified due to cultural reasons. In one way or another families identify different uses for corn that turns out to be "not so good". Among others: animal feed for poultry, self-consumption (regardless of state), and a very low percentage discards it. The next topic includes the issue of the final destination of corn that has some kind of damage.

Combined loses in Harvest, Drying and Storage phases (Farmers that produce corn, but still buy)

Farmers reported a total of 7767 quintals of corn produced/purchased in the previous season. From the above, a loss of 228 quintals was reported, representing a loss of **2.9**%. Again with respect to variability of losses, we were able to establish the median and average the tested data range:

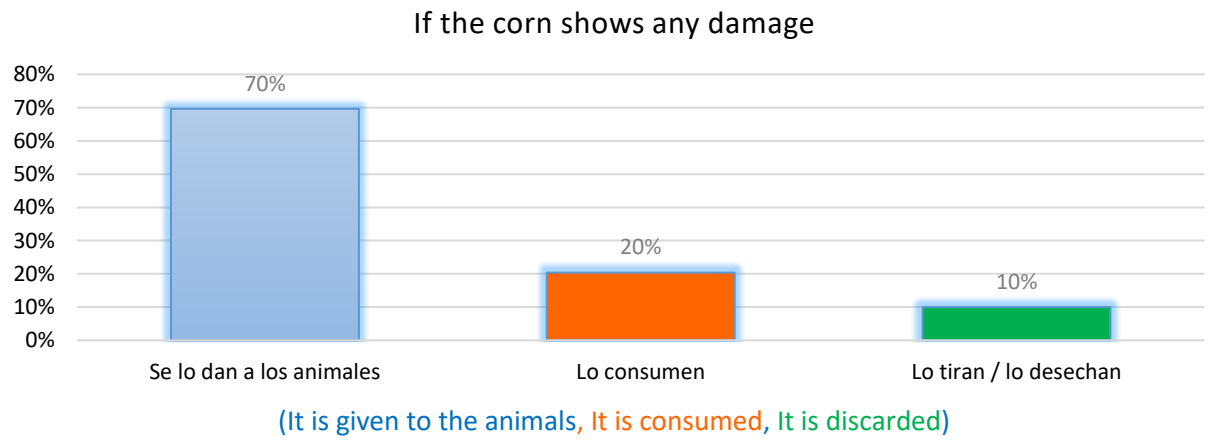
Median*	2%
Average*	3.1%

Likewise or following the same pattern of the data presented above, these results do not vary significantly between townships:

Township	Produced corn	Reported loss during harvest	% Loss
Todos Santos	4,479.50	130.97	2.92%
Chiantla	3,287.00	97.25	2.96%

*in quintals (100 pounds)

Final destination of corn that presents any sort of damage

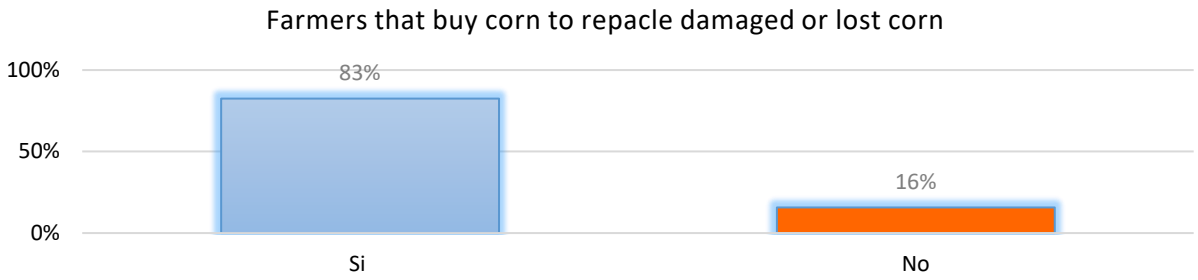


(It is given to the animals, It is consumed, It is discarded)

70% of the interviewed households indicated that corn that shows any sign of damage is given to animals. Interestingly, although corn is damaged, 20% of the families still consume it. This practice is more frequent in Todos Santos than in Chiantla.

The waste of corn in Todos Santos, according to what was mentioned by promoters of the program, is not considered socially accepted. It is said that "People who waste or throw the corn kernels may develop rash on their skin" and it is also associated with sin or "punishment of God".

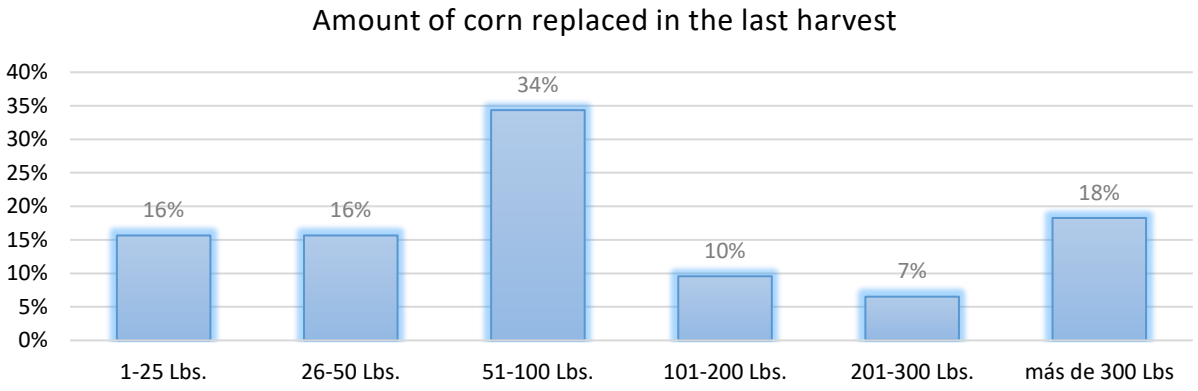
Replacement of corn that showed damage or that was lost during harvest



(Yes, No)

83% of farmers buy corn to replace what has gone bad. From the above, we can highlight the fact that in Todos Santos one quarter of all respondents indicated that farmers do not buy corn even if they see damage. This practice is probably explained by the above graph which shows that farmers try to exploit the grain eventhough it shows damage. In Chiantla, 94% of farmers reported having replaced the damaged corn.

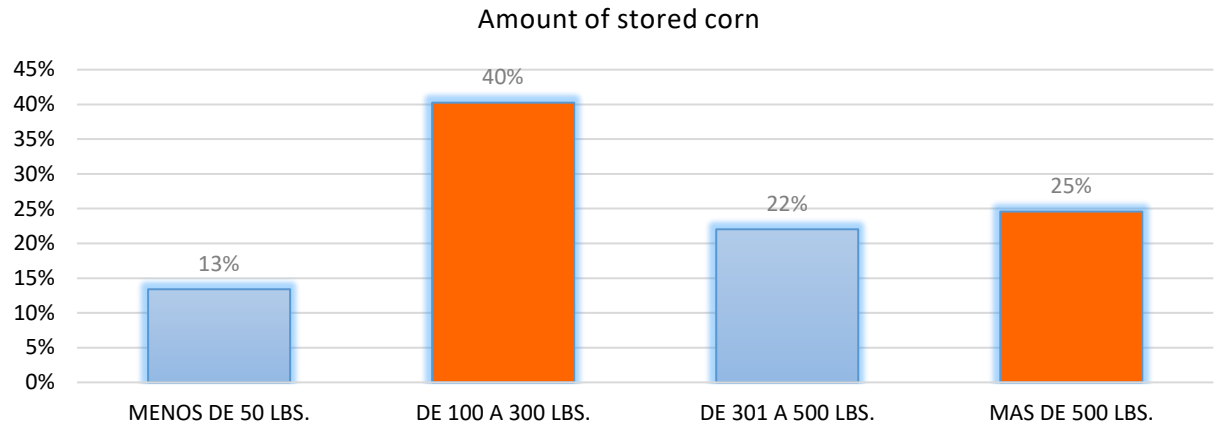
Amount of corn replaced in the last season/harvest



(más de = more than)

The study indicates that the ranges where more corn purchasing (for replacement of damaged) is evidenced is 51-100 Lbs with 34% of farmers reported having bought corn, followed by the range of more than 300 Lbs. purchased with 18%, and from 1-25 lbs and 26-50 lbs, with 16% each.

Current corn availability



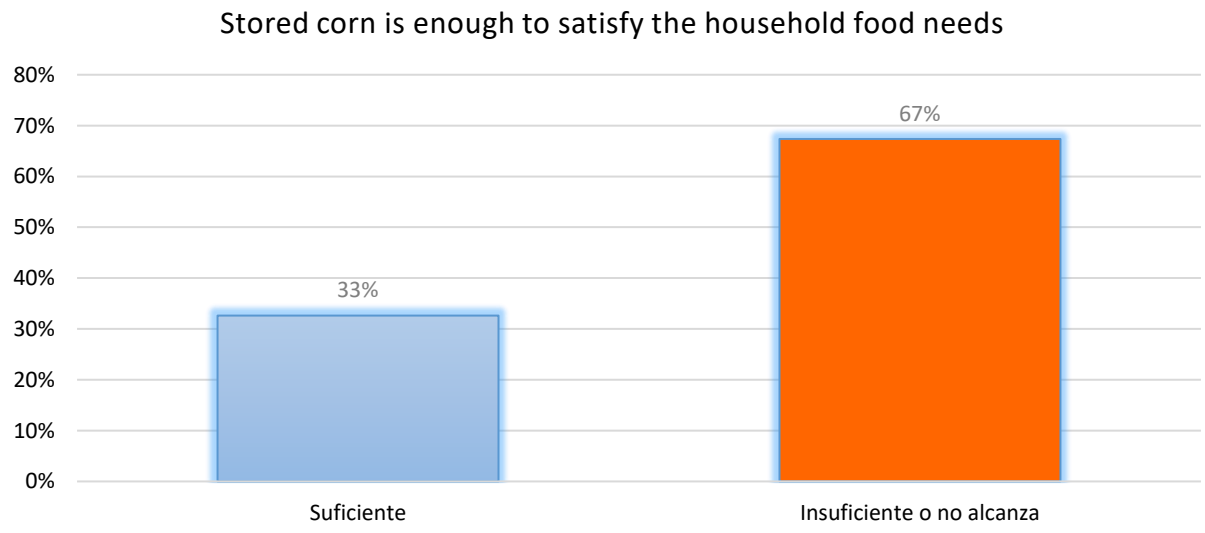
(less than 50lb, From 100 to 300lb, From 301 to 500lb, Over 500lb)

84% of respondents indicated having corn in storage at the time of data collection.

Of those who indicated having stored corn, 13% said they have less than 50 pounds and 40% have between 100-300 pounds of stored corn. This fact becomes significant as it confirms the above statement, because after two months of the 2014 harvest, the amount of corn is insufficient to meet the food needs of families. These data do not show significant variability between the two townships.

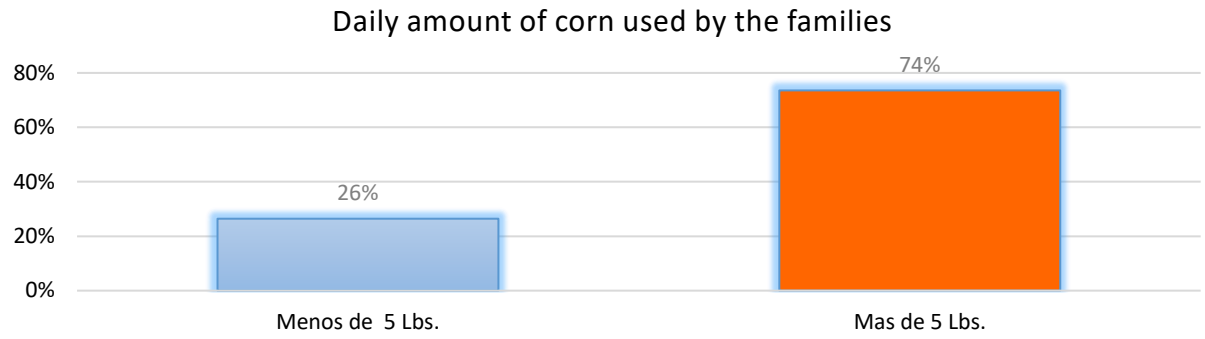
On the other hand, it is noteworthy that 25% of respondents reported having more than 500 lb of corn in storage. This is higher in Chiantla with 28% and 23% in Todos Santos.

It is important to mention that, after asking if the current stored corn was sufficient to meet the food needs of the family until the next harvest, 67% of respondents indicated that it is not enough.



(Enough, Insufficient or not enough)

Amount of corn used by the families



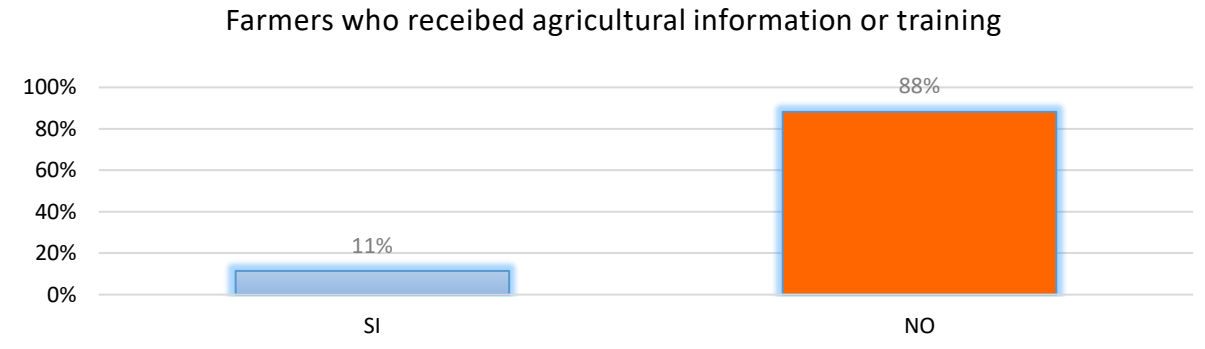
(Less than 5lb, More than 5lb)

In the (food) culture of Guatemalan families, corn plays a central role and this is the case for both townships. Respondents indicated that 74% need more than 5 pounds of corn per day per family. These data varies and in some cases they even use between 12 and 15 pounds. Compared to the township level, the study found that in Chiantla this practice is more widespread and that 86% of the families need more than 5 pounds per day. By contrast, in Todos Santos this pattern occurs in 66% of respondents.

The previous data confirms again that the availability of corn is not sufficient to meet the food needs of families. This is exacerbated in atypical years like 2014, as erratic rainfall and extremely long heat wave caused much of the country's food insecurity. Families are aware of this situation, but the study showed that only 39% of respondents indicated that in case of having more corn available they would prepare more food for their family. Chiantla presents a higher proportion with this perception (47%) compared to Todos Santos (35%).

Community organization and technical formation

Of the communities participating in the study only 15% reported knowing the presence of community organizations, such as farmers' associations, cooperatives and agricultural groups. This data is more relevant in Chiantla, since only 4% manifested to know such organizations. This is due to the weakening of the country regarding extension programs and training to farmers, which has virtually disappeared and has not been systematically executed when done. The programs lie in the distribution of food rations and delivery of two pounds of Urea and "20-20-0" fertilizer every year.



(Yes, No)

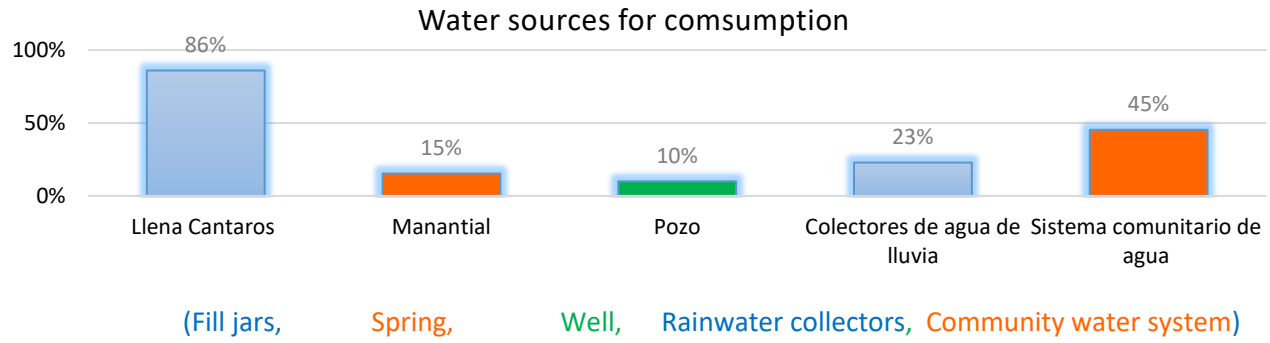
The previous data is related in that 11% of respondents reported having received some kind of agricultural training. In Chiantla only 4% reported having been involved in some agricultural training, while in Todos Santos 16%.

Of the few who have been trained, 40% indicated having received training through the Food security program, promoted by SHARE from 2006 to 2011, and 50% through local cooperatives. The majority said that trainings have been conducted in community assemblies or educational talks. Basically the source of training has been Non-Governmental Organizations present in the study areas.

Hygiene and health

Water availability and quality, for human consumption

65% of the farmers' homes have water and this is sufficient to various family needs. This situation is much better in Todos Santos, since 85% reported having access to sufficient water, while for Chiantla it was only 28%. This can be due to various factors such as where they are located (altitude), the type of soil and the lack of resources to mount systems for capturing rainwater. In the highland communities located on the plateau of the mountain range of the Cuchumatanes, the shortage is focused by the lack of wells/springs, water availability is mainly done by gathering rainwater.

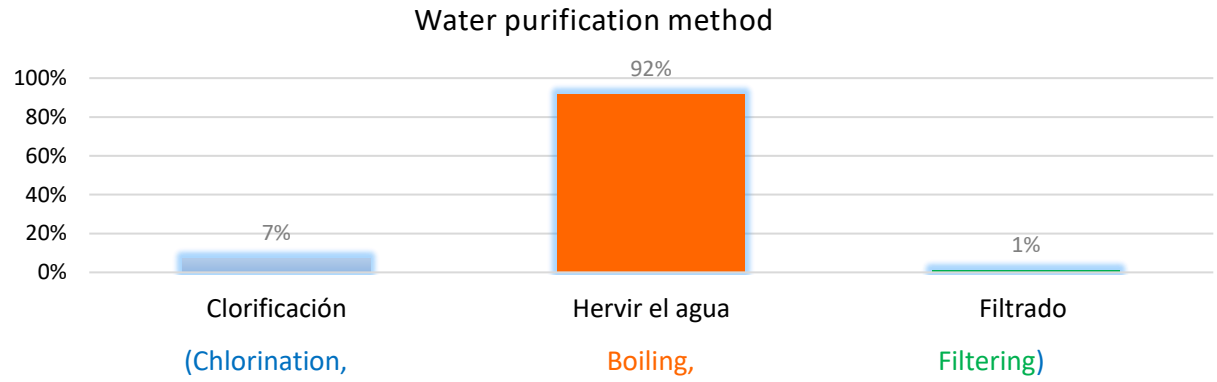


The graph shows that people in communities can use several sources of water for human consumption. The most used source is "fill jars" (community systems of public faucet). This type of water source is used by 86% of respondents. The practice to implement rainwater collectors is widespread in the highlands for both townships. Although collection systems are artisan, in most cases, they can not be paid for by all farmers. 23% of respondents indicated using rainwater collectors. Of this total, the majority belongs to Chiantla.

As background information, 21 out of the 37 most common diseases among the population of Latin America are related to lack of water and contaminated water. Taken to a worldwidelevel, these diseases account for 25 million deaths annually. In recent years, while there has been significant progress in the coverage of these services about 3 million Guatemalans do not have access to public drinking water and about 6 million dont have access to sanitation water (non potable). Even when there is no General and periodic assessments of the quality of the water, empirical evidence indicates that these services are of low quality. The biggest deficit of coverage of public water service

(unimproved sources) occurs in rural areas of the Northeast regions (26.9%) and Northwest (32%); and regarding the departments, one of the highest deficits is observed in rural areas of Huehuetenango[9]

This information was presented by The Network for Water and Sanitation in Guatemala, (RASGUA), focusing on the weaknesses of rural and indigenous areas. The report shows the relationship between inadequate treatment for human consumption and malnutrition.

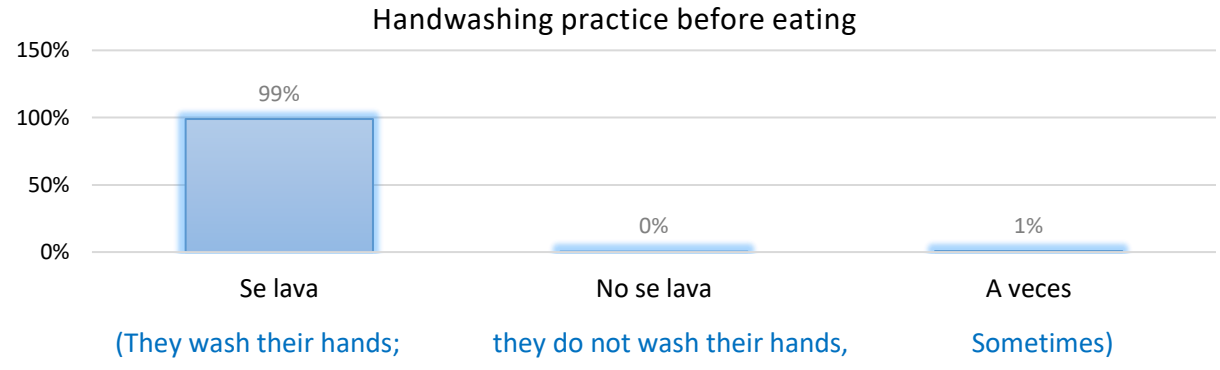


In the case that concerns us, the study shows that regardless of the source of obtaining water, 94% of respondents indicated to purify it before drinking it. The most common method for purifying water is boiling (92%).

The empirical evidence indicates that although people boil water, the cooking time or subsequent treatment like transfering the water to contaminated cooking utensils, trigers the rate of associated diseases. Not all families cover/protect the clean dishes.

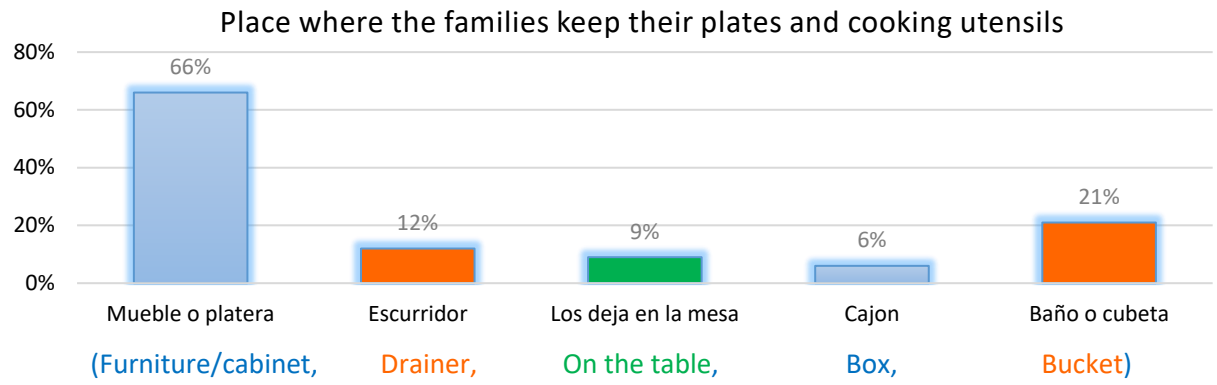
Hygiene methods for the food preparation and consumption

The study showed that the woman is the one who prepares the food at home. Of this, 89% of respondents indicated that it is the wife or housekeeper, who is dedicated to this task and in other cases daughters or daughters in law. In this specific part of the study, the interview turned to the woman of the house or housekeeper. It was shown that 99% of respondents indicated washing the food before preparing it as well as washing their hands before the preparation or cooking.



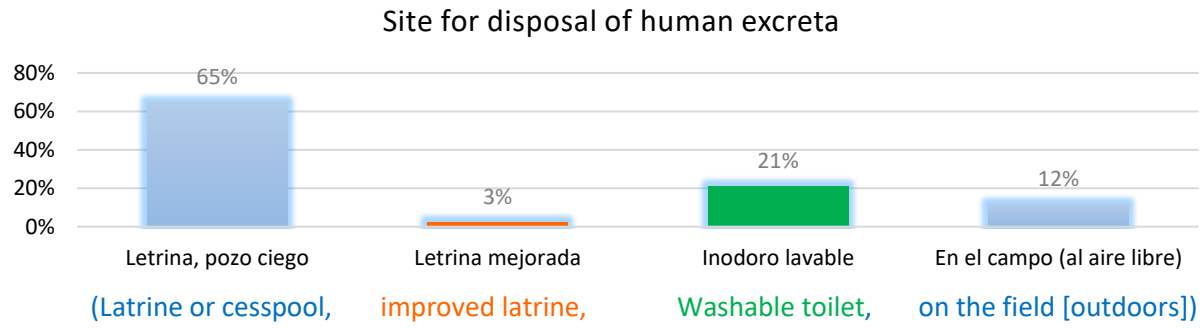
9 NATIONAL PLAN OF PUBLIC SERVICES FOR POTABLE WATER AND SANITIZING FOR HUMAN DEVELOPMENT 2008-2011. Technical Secretariat of the Cabinet, SEGEPLAN; March 2008,

Likewise, 99% of respondents indicated that family members wash their hands before eating food. However, empirical evidence indicates again that in this case is quite contrary to what people say they do with what they actually do. Eventhough there is evidence of adoption of hygienic practices, it is still incipient. 99% of respondents said that they wash dishes and kitchen utensils after eating.



After drying the dishes, they proceed to place them in various specific sites and in many cases housewives do a combination of these sites. Although 94% of respondents said to cover kitchen utensils after washing, on empirical evidence again, we observed that in many cases these utensils or dishes, are uncovered and available to flies and potentially harmful to environmental elements. This asseveration is closely linked with the data presented by RASGUA, indicating that in Guatemala about 6 million people lack adequate systems and sanitation practices (mostly in rural areas).

It becomes difficult to understand the relationship between storaging dishes/containers with diseases related to environmental sanitation at home, and the high rates of food insecurity. However, hygiene practices have much to do with the rates of food insecurity.



The Figure shows that there is still poor proper management practices for excreta disposal. Only 3% of respondents said it to have an improved latrine (this type of latrine has some of the different types of drainage, sedimentation, methods of ventilation and treatment, which helps prevent the water table contamination nor to let a high amount of spores to be released in the environment. Most cases (65%) indicated that own and use a pit latrine, this is a hole in the ground, without any type of filtering method, sedimentation and many times not covered.

It is common to observe gray water drains "a flor de tierra", a term that indicates the passage of gray water on the soil without a drain, usually lead to the backside of the houses.

Section E: Conclusions and recommendations

Conclusions

80% of respondents cultivate corn in their land, but the corn produced is not enough for family consumption. The above reflects that there is little land available for planting (61.57% of farmers plant less than 8 cuerdas, almost 1 cuerda per family member), the number of members per family is above the national average and production per cuerda of land is below the overall average, 2 quintals per cuerda of land, while the national average is in 4 qq per cuerda.

Regarding the participation in the production process, the wife and children participate more in during the tapisca or harvest (61.96%), in the fertilizing process (42.39%) and planting (28.8%). As for the post-harvest process, participation of women and children focuses on defoliation of the ear (89.65%), grain drying (57.61) and shelling (81.52). The woman is the decision maker in the composition of the diet of the family. It is she who decides whether damaged grain corn is consumed or not. The study also showed that women play a key role in what is sown in the land and the fate of harvest and/or purchased corn.

The fate of damaged corn during storage stage is given as follows: 70% for animal consumption, 20% eat it anyway and only 10% discard it. Damaged corn consumption is an established practice primarily in Todos Santos, and is a decision made by the women. When is a greater than 50 lbs of losses, it is more likely to replace damaged corn (i.e. buying), as it is a considerable amount. If we associate the fact that 74% of farmers need more than 5 pounds per day of corn, some up to 12-15 pounds, to consider replacing over 50 pounds becomes significant.

67.96% of farmers mentioned they have problems with fungi or molds during the tapisca or harvest. On the other hand the losses associated with excess moisture in the post-harvest stage were found in 49% of the sample population (by decay, moisture and fungus) which means that the knowledge and practices are not sufficient to mitigate corn losses. Factors such as excessive rain, condensation inside the attic, to have a tin roof, poor drying practices are crucial.

The availability of corn for 2015 will be exacerbated by the irregular winter and prolonged heat wave that affected in a range from 20 to 60% production of 67.39% of farmers. This will definitely affect the food security of many families in rural and will increase the price of products derived from corn.

62% of farmers prefer to store shelled corn, either because they buy in that presentation or because after having dried the cob they shell it. When shelled or bought, the preferred storage medium is bags with 81%, followed by silo with 14%. While the structure or storage medium preferred by farmers who produce corn is the tapanco with 74%, followed by the technique of mancuerna with 23%.

The study showed that farmers with lower production (between 5 and 10 quintals), have a vastly superior storage time compared to farmers with production above 25 quintals. This can be attributed to farmers increased production capacity, using part of their harvest for sale; as well as those who produce little keep it to dry thoroughly and keep it as a reserve, while in the short term buy corn to meet the immediate demand, taking advantage of lower prices in the market. However the economic conditions of families forced to purchase corn for each week or one month; this mainly in the case of those living in areas above 3,000masl. This is attributed that the means of production are scarce for families who live in those areas.

The absence of the State of Guatemala regarding rural extension programs of the Ministry of Agriculture and the littel covergage Governmental Organizations have had on post harvest issues, has evidenced in this study that there is little knowledge and practices of farmers in terms of appropriate post-harvest handling. Only 11% of respondents reported having received some type of agricultural training. Of the few who have been trained, 40% reported having received training from the food security program, which SHARE promoted in 2006 to 2011, and 50% through local cooperatives.

It is worth mentioning that the entrenched practices and culturally ancestral methods regarding corn are not sufficient to increase production, to reduce post-harvest losses and to decide the fate of damaged corn.

Much of families indicate having good hygiene and basic health practices. However, intestinal disorders (for example), product of poor management of excreta and preventive care in preparing food, show otherwise. In this sense, poverty also affects the health and nutrition indicators; the relationship education-information/results is undeniable.

Recomendations

Implement processes and improved practices techniques of production, sorting, drying and storage of corn, of economic and cultural relevance; so that they can be adopted by farmers in the project's target areas, be sustainable over time and have the ability to be replicated.

Develop transfer-of-knowledge processes of cultural and social relevance, to motivate a behavioral change, depending on the effective adoption of health and hygiene practices and postharvest handling of corn.

Conduct methodologies that encourage the adoption of improved harvesting practices of food products in the areas of program implementation (production and consumption of native plants, for example), to complement the food available to families and allow them to diversify their diet.

Develop methodologies relevant to the intervention areas that recognize the contributions that women make to the production process of corn and agriculture in general and to the household's food security; involving their active participation in a wider decision-making.

Section F: Glossary

1. **Cuerda:** Unit of measure of 25 X 25 square varas equivalent of 20 X 20 meters. A manzana contains 16 cuerdas.

2. **Aporreo:** Practice of hitting corn cobs in a bag for easy shelling.

3. **Mancuerna:** Practice join two ears using the husks and place them primarily within the corridor/hall of the house to dry. This practice is associated with the cobs to be used as seeds for the next crop cycle.

4. **Dobla:** to fold the corn plant to interrupt the transport of water and nutrients to the formed cob, accelerating dehydration or drying.

5. **Tapanco:** attic-like structure, used as a warehouse, as wood drying area, but mainly for drying and storage of corn cobs or grains.

6. **Presa:** Cobs placement in a circular manner leaving the stalk of the cob on the outside of the circle. Since this is the hardest part, is more resistant to attack by rodents in the storage area..

Section G: Appendix

1. Selection of the communities for the study

No	Chiantla	Selection criteria
1	***San Antonio Las Nubes*** (2,599 masl)	Control Community, elevated community participation showed during the visit and there is a group of farmers who have worked in the improvement of corn with ACODIHUE (Association of Cooperation for Integral Development of Huehuetenango) in previous years, with potential of adoption and divulgation of results. Altitude = Type B (mild), Access to corn: Type 1 (mainly planting corn and storage for self-consumption). Previously participated in Food security program, "SAM" of SHARE and financed by USAID (finalized already). The community did not present problems in their organization or on their participation.
2	**Cumbre de la Botija** (3,267 masl)	Altitude= Type A (very cold), Access to corn: Type 2 (Buy corn for consumption). Currently there is the presence of PCI, with the program of food security PAISANO (MYAP with USDA funds). Referring good participation.
3	**Tuinimá (Chiquito and/or Grande)** (3,222 masl)	Altitude= Type A, Access to corn: Type 2, Currently there is the presence of SHARE through the program of Support for Education (USDA). There is a history of active involvement of people.
4	**San José Las Flores** (2,373 masl)	Altitude=Type B, Access to corn: Type 1 mainly. Currently there is the presence of PCI, with the program of food security PAISANO (MYAP with USDA funds), and FUDAECO -with USDA funds- that has plan to help with the stablishment of the watering system for 28 families. SHARE previously gave support with a feasibility study.
5	**Cul Chemal** (3,422 masl)	Altitude type A, Access to corn: Type 2. SHARE has had a good coordination with the parents and teachers, since the previous Education program to date. The community is located on the asphalt adjacent to San Juan Ixcoy.

No	Todos Santos	Selection criteria
1	**Tuiboch.** (1,565 masl)	Altitude: Type C. (warm). Access to corn: Type 1 and Type 2, the latter one predominates. Actualmente existe presencia de PCI, con el programa de seguridad Alimentaria PAISANO (MYAP con fondos de USA Currently there is the presence of PCI, with the program of food security PAISANO (MYAP with USDA funds). Currently there is the presence of SHARE through the program of Support for Education (USDA). There is a history of active involvement of people. Presence of ACODIHUE with the program of Improvement of Ocho River's Basin, funded by Heifer International.
2	**Tuipocomal.** (1,640 masl)	
3	**Río Ocho Grande and/or Chiquito** (1,688 masl)	
4	**Chenihuitz** (from 2,400 to 2,500 masl aprox.)	Altitude: Type B, Access to corn: Type 1. There is a group of farmers who have worked in the improvement of corn with ACODIHUE in previous years, being a potential for the integration and dissemination of technologies. This group previously participated in the FSP, "SAM" of SHARE and funded by USAID (completed). The community does not present problems in their organization or

		participation. It can be the Community Control.
5	**Chicoy.** (2,300 masl)	Altitude: Type B, Access to corn: Type 1. It is a community with many traditional agricultural and corn production practices. They have previously participated in the FSP, "SAM" of SHARE and funded by USAID (completed). The community does not present problems in their organization or participation. Currently there is the presence of SHARE through the program of Support for Education (USDA).
6	**Los Lucas.** (2,467 masl)	Altitude: Type B, Access to corn: Type 2. They are farmers with strong production capacity of produce for export. Therefore they demand silos for storage of corn. This community was visited by members of KSA and UNL. They previously participated in the FSP, "SAM" of SHARE and funded by USAID (completed). The community does not present problems in their organization or participation. It can be the community CONTROL.
7	**Tzipoclaj.** (2,695 masl)	Altitude Type B. Access to corn: Type 1. There is currently presence of CIP in Food Safety program PAISANO (MYAP with funded from USAID). Currently there is the presence of SHARE through the Program of Support to Education (USDA). They previously participated in the FSP, "SAM" of SHARE and funded by USAID (completed). The community does not present problems in their organization or participation. Producers of native corn.
8	**Chixim** (3,564 masl)	Altitude Type A. Access to corn: Type 2. Presence of FUNDAECO -with USDA funds- to rehabilitate the system of collection and distribution of water for human consumption. Currently there is the presence of SHARE through the Program of Support to Education (USDA). They previously participated in the FSP, "SAM" of SHARE and funded by USAID (completed). The communities did not have problems in their organization or participation.

2. Instrument “A” (Survey) for data collection:

REDUCTION OF POST-HARVEST LOSSES

INITIAL DIAGNOSIS

I. GENERAL DETAILS OF INTERVIEWEE	
Department:	Date of interview
Municipality:	
Community:	Gender: F_____M_____
Name(s) and last name(s) of interviewee	

General Instructions: Listen carefully to the interviewee's answers. For every answer provided, circle the letter of the chosen answer or mark with an "X" in the appropriate box. When applicable, write the interviewee's answer.

II. HOUSEHOLD COMPOSITION	
How many people live in your house? (including children)	
How many children under 5 years old are currently living in your house?	

How many children between 5 and 12 years old are currently living in your house?

1	Have all of your school aged children been enrolled in school this year?	a. YES	
		b. NO	
		c. NOT ALL	
		d. DO NOT KNOW/NOT SURE	
III. AGRICULTURE AND CORN HARVEST SECTION			
2	Is anyone in your family engaged in agriculture?	0. NO **(Go to question 7)**	
		1. YES	
3	Do you have land for agriculture? (either rented, leased or owned)	0. NO **(Go to question 7)**	
		1. YES	

4 What is the area of land used for harvesting, according to land owner or tenant?

		Mark with an X the ones the interviewee answers		Indicate the number of cuerdas
a	Own: _____		Cuerdas	
b	Rented: _____		Cuerdas	
c	Leased:_____		Cuerdas	
d	Communal: _____		Cuerdas	
e	Cooperative: _____		Cuerdas	
f	Family: _____		Cuerdas	
g	Other: _____		Cuerdas	

		_____ _____	Cuerdas of: _____
5	Who in your household makes the decision for the following? **(READ THE AVAILABLE ANSWERS AND WRITE "H" IF THE ANSWER OF THE INTERVIEWEE CORRESPONDS TO A MAN OR "M" IF IT CORRESPONDS TO A WOMAN)**	a. WHAT IS PLANTED IN THE LAND AND HOW IS IT PLANTED b. IF THE PRODUCTION IS CONSUMED IN YOUR HOUSE OR SOLD c. WHAT FOOD IS CONSUMED IN THE HOUSE e. WHO EATS MORE AND FIRST IN THE HOUSE	**H / M**
6	**Do you plant or produce corn in your land?**	0. NO **1. YES (Go to question 8)**	
7	**Do you buy the corn for house consumption?**	0. NO **1. YES (Go to question 34)**	
8	What varieties of corn do you grow?	a. _____ b. _____ c. _____	
9	Is the seed you use for harvesting criolla (native) or improved?	1. CRIOLLA (they choose the best seed) 2. IMPROVED (purchased in agroservice)	
#	Why do you use this variety?	a. BETTER YIELD b. PEST AND DISEASE RESISTANT	

		c. BETTER RESALE VALUE	
		d. HARDY (more resistant to breakage)	
		e. MORE RESISTANT DURING STORAGE	
		f. DO NOT KNOW/NOT SURE	
11	Do you have agricultural supplies (tools, seeds, fertilizers, etc.)?	0. NO **(go to question 13)**	
		1. YES	
#	What types of supplies do you have?	1. TOOLS	
		2. FERTILIZERS	
		3. IMPROVED SEEDS	
		4. CRIOLLA SEEDS	
		5. IRRIGATION EQUIPMENT	
		6. LIVESTOCK PRODUCTS	
		7. OTHERS (specify):_____ _____	
#	Who does the field work?	1. FAMILY MEMBERS	
		a. MEN	
		b. WOMEN	
		c. CHILDREN	
		2. IN COOPERATION WITH COMMUNITY	
		3. HIRED LABORERS	
#	How do women or girls in the house collaborate in the planting and harvesting of the crops?	1. IN THE DISMOUNTING	
		2. PLANTING	

		3. FERTILIZING	
		4. FUMIGATION	
		5. CUT OR HARVEST (TAPISCA)	
		6. THEY DON'T PARTICIPATE IN THE PROCESS	
		7. OTHERS (specify) _____	
#	Who does the work after the harvesting process? (Drying, cleaning, shelling, storing, fumigating, among others)	1. MEMBERS OF THE FAMILY a. MEN b. WOMEN c. CHILDREN 2. IN COOPERATION WITH COMMUNITY 3. HIRED LABORERS	
#	How or in what part of the post-harvest process do women or girls in the house collaborate?	1. DRYING 2. SHELLING 3. DURING STORAGE (SILO, LODGE, ETC) 4. FUMIGATION 5. CORN WASH 6. THEY DON'T PARTICIPATE IN THE PROCESS 7. OTHERS (specify) _____ _____	
#	How long have you been cultivating in this land?	1. RECENTLY (LESS THAN 1 YEAR AGO) 2. 1 - 5 YEARS AGO 3. MORE THAN 5 YEARS AGO	

#	In what moment do you realize it's time for the folding process (dobla)?	1. FLOWER COLOR 2. LEAF COLOR 3. NAIL TEST 4. MOUTH TEST 6. OTHER (specify) _____	
#	In what moment do you realize it's time for harvesting (tapisca)?	1. FLOWER COLOR 2. LEAF COLOR 3. NAIL TEST 4. MOUTH TEST 5. WHEN THE PLANT IS COMPLETELY DRY 6. OTHER (specify) _____	
#	How do you harvest or cut the corn? (Do you use some tool or machine?)	1. BY HAND (ripping off the cobs by hand) 2. USING HAND TOOLS (machete, sickle, knife) 3. MACHINE	
#	What do you use your harvested corn for?	1. HOUSEHOLD CONSUMPTION 2. SALE 3. BOTH 4. DON'T KNOW/NOT SURE	
#	During the corn harvest (tapisca), have you observed any damage in the corn plants or cobs?	1. YES 2. NO **(Go to question 24)** 3. DON'T KNOW/NOT SURE	
#	What damage did you observe?	1. INSECT PRESENCE	

		2. WORMS	
		3. FUNGUS/MOLDS	
		4. DISEASE	
		5. DAMAGE CAUSED BY BIRDS	
		6. DAMAGE CAUSED BY MICE, SQUIRRELS, OPOSSUMS, OTHER	
#	When and in which moment do you do the cob selection?	a. IN THE FIELD DURING THE HARVESTING	
		b. BEFORE DRYING	
		c. DURING CORN STORAGE	
#	How do you know if the harvested cob is good?	a. COB SIZE	
		b. SHELL (grain) SIZE	
		c. SHELL NUMBER PER COB	
		d. ABSENCE OF FUNGUS	
		e. NO STAINS OR WITHOUT DAMAGES (PEST ABSENCE) IN SHELLS	
		f. OTHER (specify) _____	
#	How much corn did you produce last year? **(THE ANSWERS THAT THE INTERVIEWEE MENTIONS)**	a. 5qq	
		b. 10qq	
		c. 15qq	
		d. 20qq	
		e. 25qq	
		f. 30qq	
		g. 40qq	
		h. More than 50qq qq = quintal	

#	Did you produce more corn in this harvest, compared to the previous one?	a. YES b. NO c. DON'T KNOW/NOT SURE	
#	Do you dry the corn before storing it?	0. NO **(Go to question 30)** 1. YES	
#	How or in which way do you dry the corn?	**1. IN THE CORN FIELD, BEFORE CUTTING THE COB (DOBLA)** **2. IN THE COB, AFTER BEING CUT** a. Putting the cobs on the roof b. Putting the cobs on nylon and exposing them to the sun c. Inside the house d. Using a dryer e. Other way (specify) _____ **3. AFTER SHELLING THE COB** a. On nylon, sun-dried b. Inside the house or cellar c. Using a dryer d. Other way (specify) _____	
#	At what point do you know that the corn is well dried and suitable for storage?	1. NAIL TEST 2. MOUTH TEST 3. FIELD TEST (SOUND) 5. OTHER _____	
#	After the drying process, do you store the corn?	0. NO **(Go to question 34)**	

		1. YES	
#	Do you sell the corn that you produce?	a. YES b. NO **(Go to question 34)** c. JUST A PART, I CONSUME THE REST	
#	Who do you sell your corn to? (who buys your corn?)	a. LOCAL MARKET b. RESELLER (COYOTE) c. COMMERCE COMPANY d. FAMILIES e. OTHER (specify) _____	
IV. HANDLING AND STORAGE CONDITIONS SECTION			
#	Do you have a space to store all the corn you get through either purchase or harvest?	a. YES b. NO c. DON'T KNOW/NOT SURE	
#	Do you store your corn shelled or in cobs?	a. IN COBS b. SHELLED **(Go to question 38)**	
#	If you store the corn in cobs, where and how is it stored?	a. TRADITIONAL CORN CRIB (TROJA) b. IMPROVED CORN CRIB (TROJA MEJORADA) c. LODGE (TAPANCO) d. SACKS e. MANCUERNA	
#	If you store the corn in cobs, how long is it stored?	a. 1 MONTH b. 2 MONTHS c. 3 MONTHS	

		d. 4 OR MORE MONTHS	
#	If you shell the cobs, how do you do it?	a. BY HAND b. USING A SHELLER (MACHINE) c. OTHER (specify) _____	
#	Do you clean the corn after being shelled or purchased?	0. NO **(Go to question 41)** 1. YES	
#	How or in what way do you clean the corn?	a. BY HAND (separating bad grains and garbage one by one) b. THROWING IT FROM SIDE TO SIDE TO LET THE AIR CLEAN IT (letting it "air out") c. WASHING IT d. SIFTING IT e. DON'T KNOW/NOT SURE	
#	Where do you store the shelled or purchased corn?	a. SACKS b. SILO **(Do question 42)** c. BARREL D. DRAWER e. OTHER_____	
#	If you store it in a silo, do you use pills to treat the corn (phosphin treatment)?	a. YES b. NO c. DON'T KNOW/NOT SURE	
#	How long do you keep/store the produced or purchased corn?	a. 1 MONTH b. 2 MONTHS c. 3 MONTHS d. 4 OR MORE MONTHS	

#	Do you clean the place designated to store corn? (Silo, loft, drawer)	a. YES b. NO **(Go to question 46)** c. DON'T KNOW/NOT SURE	
#	How often do you clean the corn storage space (Silo, loft, drawer)?	a. BEFORE PLACING THE NEWEST CORN TO STORAGE b. EVERY MONTH c. EVERY 2 MONTHS d. EVERY 3 MONTHS e. OTHER_____	
#	During the time that you store the corn, do you check both grain and storage quality? (moisture, leakage, pests)	a. YES b. NO **(Go to question 48)** c. DON'T KNOW/DON'T ANSWER	
#	How often do you check your corn during the time that it is stored?	a. ONCE A WEEK b. ONCE EVERY 15 DAYS c. ONCE A MONTH d. ONCE EVERY 2 MONTHS e. DON'T KNOW/DON'T ANSWER	
#	During the harvesting and drying, how many sacks or pounds of corn are lost by decay, insect or rodent damage so that it cannot be consumed?	a. 1 - 5lb b. 5 - 15lb c. 15 - 25lb d. 25 - 50lb e. 50 - 100lb f. MORE THAN 100lb lb = pounds	

#	During storage, how many sacks or pounds of corn are lost by decay, insect or rodent damage so that it cannot be consumed?	a. 1 - 5lb b. 5 - 15lb c. 15 - 25lb d. 25 - 50lb e. 50 - 100lb f. MORE THAN 100lb lb = pounds	
#	Do you have Pest Control (insects, mice, fungus), during the storage process of corn?	a. YES b. NO **(Go to question 52)** c. DON'T KNOW/NOT SURE	
#	At what point do you do Pest Control?	a. _____ b._____ c. _____	
#	Which do you think are the main reasons of corn losses, from harvest to the final consumption?	_____ b._____ c. _____ b. _____	
#	What do you do with the corn that has poor quality (broken, with pests)?	a. YOU GIVE IT TO ANIMALS b. YOU THROW IT AWAY c. YOU CONSUME IT d. DON'T KNOW/NOT SURE	

#	Have you ever had to buy more corn to replace poor quality corn?	a. YES b. NO **(Go to question 56)** c. DON'T KNOW/DON'T ANSWER	
#	How much corn do you need to buy for replacing the poor quality one (broken, with pests)?	Lb_____ lb = pounds	
#	Are you currently storing corn?	a. YES b. NO **(Go to question 59)** c. DON'T KNOW/NOT SURE	
#	Approximately how much corn do you have currently in storage?	a. LESS THAN 50lb b. 50lb c. 100 TO 300lb d. 301 TO 500lb e. 501 TO 1000lb f. MORE THAN 1000lb lb = pounds	
#	Is this corn enough for your family to be able to eat until the next harvest?	a. YES b. NO c. DON'T KNOW/NOT SURE	
#	How much corn do you need in one month to satisfy your family's needs?	a. LESS THAN 5lb b. 10lb c. 10 TO 20lb d. 20 TO 30lb	

		e. 30 TO 40lb	
		f. MORE THAN 40lb lb = pounds	
#	How much corn do you use in your house each day when preparing the meal?	a. LESS THAN 2lb	
		b. 2 TO 3lb	
		c. 3 TO 4lb	
		d. 4 TO 5lb	
		e. MORE THAN 5lb lb = pounds	
#	If you had more corn available, would you make more food for your family?	a. YES	
		b. NO	
		c. DON'T KNOW/NOT SURE	
V. COMMUNITY ORGANIZATION AND TECHNICAL EDUCATION			
#	Are there any type of agricultural organizations in your community or surrounding communities? (Ex: association, cooperative or group)	a. YES	
		b. NO	
		c. DON'T KNOW/NOT SURE	
#	Have you received or are you currently receiving any information or training related to farming or grain storage?	a. YES	
		b. NO **(Go to question 66)**	
		c. DON'T KNOW/NOT SURE	
#	What enterprise, organization or who has given you this information or training?	a. _____	
		b. _____	
		c. _____	

#	In what way have you received this information or training?	a. TECHNICAL TALKS	
		b. COMMUNITY MEETINGS	
		c. TALKS BEFORE HARVESTING	
		d. OTHER_____	
VI. HYGIENE AND HEALTH SECTION (to be answered by the wife or female in charge of the house)			
#	Do you have enough water in your household?	a. YES	
		b. NO	
		c. SOMETIMES	
		d. DON'T KNOW/NOT SURE	
#	Where do you get the water for human consumption?	a. FILL COMMUNITY JARS/PITCHERS	
		b. WELLSPRING	
		c. WELL	
		d. RIVER	
		e. LAKE OR LAGOON	
		f. OTHER_____	
#	Do you purify or disinfect the water used for drinking or cooking in your household?	a. YES	
		b. NO **(Go to question 70)**	
		c. DON'T KNOW/DON'T ANSWER	
#	What method do you use to purify or disinfect water?	a. CHLORINATION	
		b. BOIL THE WATER	
		c. SUN WATER (SOLAR WATER DISINFECTION)	
		d. FILTER (eco filter, homemade filter, other)	

		e. OTHER _____	
#	Before cooking the corn, do you put it in a place far away or protected from hens, other birds or mice?	a. YES b. NO c. DON'T KNOW/NOT SURE	
#	¿Who is in charge of preparing the meals in the household?	a. GRANDMOTHER AND/OR MOTHER IN LAW b. WIFE c. DAUGHTER AND/OR DAUGHTER IN LAW d. OTHER _____	
#	Do the family members wash or clean their food ingredients before preparing or cooking them?	a. YES b. NO c. SOMETIMES d. DON'T KNOW/NOT SURE	
#	Do the family members wash their hands before preparing the meal?	a. YES b. NO c. SOMETIMES d. DON'T KNOW/NOT SURE	
#	After preparing the household meal (breakfast, lunch, dinner, etc.), is it covered and in a place that can't be reached by flies or other animals?	a. YES b. NO c. DON'T KNOW/NOT SURE	
#	Do the family members wash their hands before eating?	a. YES b. NO c. SOMETIMES	

		d. OTHER _____	
		e. DON'T KNOW/NOT SURE	
#	Do you wash the dishes after eating?	a. YES	
		b. NO	
		c. SOMETIMES	
		d. DON'T KNOW/NOT SURE	
#	Where do you store all the utensils and containers?	a. CABINET	
		b. DRYING RACK	
		c. TABLE	
		d. DRAWER	
		c. BATHROOM (inside a plastic container)	
		d. OTHER _____	
#	¿Are all the utensils and containers covered, where you store them?	a. YES	
		b. NO	
		c. DON'T KNOW/NOT SURE	
#	Where do your family members relieve themselves?	a. LATRINE OR CESSPOOL	
		b. IMPROVED LATRINE	
		c. WASHABLE TOILET (COMPOSTING LATRINES OR SOME KIND OF IMPROVE-MENT)	
		d. IN THE FIELD (IN A HOLE OR BUSH)	
		c. DON'T KNOW/NOT SURE	
#	Do they wash their hands after relieving themselves?	a. YES	

		b. NO	
		c. SOMETIMES	
		c. DON'T KNOW/NOT SURE	

DOUBLE-CHECK THAT ALL ANSWERS APPLICABLE TO EACH CASE HAVE BEEN ANSWERED BY THE INTERVIEWEE

THANK THE INTERVIEWEE FOR THE TIME DEDICATED TO THIS STUDY

VII. ADMINISTRATIVE SECTION

Interviewer's name

Review signature of field supervisor

Survey No.

Date of review

3. Pictures:

Different kinds of corn native seeds from San Antonio Las Nubes

Corn storage, using the tapanco technique

Mancuerna corn storage technique in a household hall

"Presa" corn storage technique to mitigate rodent attack.

Silo usual layout in the houses of the community, for the storage of shelled corn.

Stacking and storage location of the bags of purchased corn (shelled)

Another example of the use of a tapanco, as a drying site for firewood (corn in mancuerna)

“Mulco” or damaged stored corn

View of the communities above 3,500 masl

"Tapisca" or harvesting process in Todos Santos C. community

Damaged corn obtained from the recent harvest or tapisca in San José Las Flores community, Chiantla