# Farmers' Perception

# of Pests, Diseases and Agrochemical Input

# in Cacao plots

# in Southern Mexico

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# 1. Introduction

Pests and plant diseases have been associated with agriculture (and therefore human culture as such) since its beginning many thousands of years ago. With the possibility to grow and cultivate crops arose competition to other players in the agroecosystem, like microorganisms and insects, living on and in plants that are now cultivated instead of just collected. A number of actions against these undesired organisms were developed over time, such as crop-rotation, tillage, intercropping and selective breeding. Even though these agricultural practices do offer numerous advantages to farmers, pest-pressure was one of the factors that urged and still urges them to evolve better and more resistant crops, cultivation practices and, in more recent time, also a broad spectrum of agrochemicals designed to combat these biotic competitors for food.

Dealing with pests and crop diseases has nowadays become a big topic. A wide range of different approaches exists, from the vast use of agrochemicals in the 'classic' conventional farming system over Integrated Pest Management (IPM) to Organic and 'no-input systems'. There is, at least since the 1960s and the 'green revolution', a huge debate going on with very different-thinking stakeholders, each offering different concepts of dealing with plant health problems.

This thesis aims to address farmers' perception of pests and diseases, because they are mostly undesired agents in their day-to-day live, causing economic as well as some health damage (for example through the not adequate application of agrochemicals). A number of publications on this subject have been published over the last 20 years but very few compared to other pest and plant-disease related topics from a more technical or natural sciences point of view and institutional background that often does not include the farmers' perception. There are papers available from different disciplines like sociology, anthropology, agricultural sciences, economics and other related areas and often these different focuses are combined to get a more holistic picture. Research on the perception of pest organisms and so-called "local knowledge" of their biology and management is a part of a process that aims to understand how farmers perceive their environment. These 'ethno-phytopathologic insights' in how people deal with pests and diseases highlights important knowledge for all participants (farmers, researchers, extension workers) involved.

Today, cacao[1] plots usually consist of very diverse agro-ecosystems. Cacao is a now a day (and was also pre-Hispanic) cash crop native to Latin America, cultivated in Mexico and worldwide mainly by small-scale farmers. Cocoa prices depend very much on the market situation on which especially the small producers have no impact at all. Growing organic and/or fair trade certified trees are said to be one way to ensure a better income, even though the certification processes can be a potential barrier.

1 "Cacao" is the English term used for the cacao plant and fruits, "cocoa" is used for the harvested beans and products made of them

One of the questions raised in this thesis is if there is a difference in how cacao farmers deal with their pest organisms, apart from the implemented rules of organic production. And an even more abstract question: Is there a different way of perceiving these organisms ("pest perception") between farmers that use different farming systems?

## 1.1. Personal approach

My personal interest in the topic is made up of various factors: On the one hand I took a strong focus on plant protection and tropical agriculture within my studies of organic agriculture and on the other hand I am really fascinated by Latin America, its people and landscapes. One of the things I cared a lot about in choosing the topic for my thesis was that it should also include the farmer as the most important "ingredient" of agriculture – it is him or her who decides what to do, what and how to plant and it is also him or her who has to make a living out of these decisions. To combine these thoughts with cacao production was interesting for me because I really like the tree as such (beautiful cauliflory flowers, has a really tasty pulp), its history and, of course, chocolate.

Cacao cultivation has a long tradition in Mexico that, at least that were my thoughts before going to the field, may have resulted in a kind of "historical knowledge" about how cacao is cultivated and protected from pests different from, for example, the coffee crop which was introduced to Mexico much later. Another interesting aspect of carrying out research about cacao is that it is a classical cash-crop- this also raises the question if there is a different perception of pest organisms on plants grown for economic reasons and on crops for self-consumption (for example *milpa*[2] crops). Even though there won't be a detailed comparison between cash-crop and subsistence farmers' perception in this thesis the question remains: What is a pest as such in the producer's perception and when is it considered to do damage that is worth controlling?

I really liked two papers I found about this topic:

"Traditional knowledge and pest management in the Guatemalan highlands" by MORALES and PERFECTO published in the year 2000, who did research about farmers' knowledge on pest insects in *milpas* in Chimaltenango and describe their research process very intensely, among other things their difficulties on how to define the word *plaga* or pest. The article "Farmer's Perceptions, Knowledge, and Management of Coffee Pests and Diseases and Their natural Enemies in Chiapas, Mexico" also by MORALES and the co-authors SEGURA, BARRERA and NAZAR from 2004 deals with more detailed zoological aspects of the topic- there are accurate descriptions of each insect and a comparison of organic and conventional farmers' knowledge about them, a very interesting paper.

2 The *milpa* is a Mexican (or better: Mayan) crop-growing system that usually consists of a field on which various crops are grown, especially maize, beans and squash. Typically, *milpas* serve for subsistence and do also imply a net of social interactions between farmers of a village.

# 2. State of research

## 2.1. What is a pest / what is a disease?

A pest is not a biological phenomenon; it is an anthropomorphic designation (CAPINERA 2001:16). Pests are organisms that injure humans, animals, crops, structures or possessions, compete with humans, domestic animals or crops for food, feed and / or water or spread disease to humans, domestic animals or crops (ECPA 2012). What is seen as a pest depends on when, where and how organisms do occur and how they are perceived by humans. A certain organism that may be perceived as a pest in one context may be perceived useful or neutral in another. The word pest is usually associated with animals, especially invertebrates or mammals like rats. But there are other biological organisms like bacteria, virus or fungi as well as plants that are in competition with the crop-cultivator ('weeds' or 'plant pests') that can be called pests, too (ENCYCLOPAEDIA BRITANNICA ONLINE 2013).

If an organism is labeled as a pest depends on various factors: When insects are designated as pests because of their simple occurrence or minor feeding on a crop, according to CAPINERA 2001:16, the insects are said to be 'aesthetic (or cosmetic) pests' – contrary to 'economic pests' that do cause the decrease of value of a certain commodity. He then states that "there is no absolute distinction between aesthetic and economic injury, especially with respect to vegetable crops." Another differentiation can be made between direct (insects attacking the part of the crop that is harvested for food) and indirect pests (insects attacking other portions of the plant that are not harvested). The quantity in number is an important aspect: indirect pests that do occur in large numbers can cause severe damage, too (CAPINERA 2001:17). Knowing about pest identity, biology and damage potential is important to distinguish between the expected severities of the pest occurrence in a certain crop and to determine adequate control measures (CAPINERA 2001:16).

Not only economic damage does determine the pest or non-pest status an organism- many aspects are involved: The farmer's or cultivator's personal evaluation of the situation depends on his or her experience, customs and beliefs as well as scientifically based knowledge about the pest organism and control possibilities (SEGURA et al. 2004).

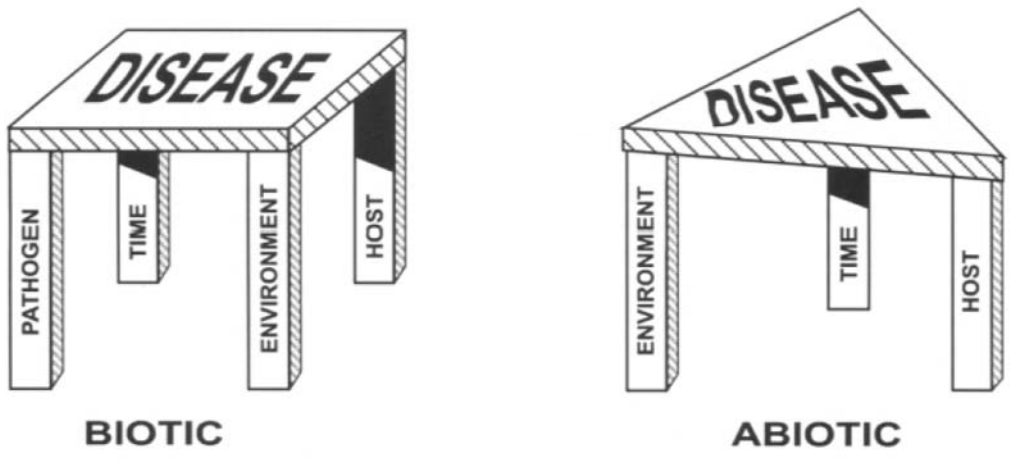


*Illustration 1: Factors involved in causing plant disease (SCHUBERT et al. 1999)*

'Plant disease' on the other hand is a different concept. SCHUBERT et al. 1999 define disease as "an impairment of the normal state of the living (plant) that interrupts, modifies, (or stresses) vital functions. Disease is a response to specific causal agents (biotic or abiotic), inherent defects of the organism, or combinations of these factors". The difference lies in the anthropomorphic perspective of the concept of 'pest': whether plant pathogens or parasites are defined as pests depends on the degree they (negatively) interfere with humans. If a plant is diseased does not depend on human perception – there is a causal agent that causes a certain response in the plant's immune system, noticed by humans or not. Plant diseases can be seen as negative, neutral or even positive, depending on human perception: grapes infected with *Botrytis cinerea* are used to create a special type of sweet desert wine or corn infected with corn smut (*Ustilago maydis*) is a Mexican specialty called *Huitlacoche*. Various factors are involved in causing a plant disease (Illustration 1) which all influence if and how intense the plant host develops symptoms and/or the causal agent shows signs, both together called disease syndrome (SCHUBERT et al. 1999).

## 2.2. Farmer's perception and Ethno-Sciences

### 2.2.1. 'Traditional knowledge' in Ethnosciences

'Traditional knowledge', as it is for example indigenous or local forms of knowledge, is described by RIST and DAHDOUH-GUEBAS 2006 as, in contrast to 'western scientific knowledge'[3], holistic, functional and adaptive to changes in social as well as natural environments and has been transmitted over numerous generations. With 'functional' the authors refer to functional classification systems of organisms that are opposed to the 'classical' Linnaean classification system. These functional classification systems can exist on their own or simultaneously (for example a gardener does simultaneously use Linnaean and functional classification like the differentiation of plants into ornamental and/or edible as well as into their botanical families). Indigenous knowledge has often been dismissed as unsystematic and incapable of meeting the rapid economic growth needs of the modern world. Formal science is believed to be a universal, autonomous and value-free knowledge system but according to RIST and DAHDOUH-GUEBAS 2006 "its imposition without proper attention to local knowledge and wisdom has led to considerable disappointment". The concept of "local knowledge" should not be seen as a 'cognized construct' but is also a practice that unfolds through actual engagement and performance of environmentally situated actions (KRAUSE et al 2010).

Ethnosciences can play a role in advancing transdisciplinary and sustainable development when understood as a scientific realm which aims to understand how humans, in spite of their fragmented and

3 What RIST and DAHDOUH-GUEBAS 2006 define as "Western scientific knowledge" will be substituted with "formal knowledge" in this thesis as the geographic distribution of formal science is no longer restricted to Europe or the USA and the term refers better to the institutionalized knowledge system (BENTLEY et al. 2009)

limited interaction with the world, are developing different forms of knowledge and beliefs. Humans do vary their knowledge and beliefs within different ecological and historical contexts in order to express the manifold possibilities offered by human cultures – ethnosciences refer to the set of concepts, prepositions and theories that are unique to each particular culture group in the world. According to RIST and DAHDOUH-GUEBAS 2006, integrating ethnosciences into societal modes of knowledge production allows systematically taking account of the cultural differences and similarities of the forms of knowledge of the actors involved in specific issues of sustainable development.

The importance and implications of ethnoscience are discussed in various publications and books (for example BERLIN 1992). Ethnosciences are by default cross-disciplinary: they include social sciences and humanities (like anthropology, philosophy or sociology) as well as natural sciences such as biology, agronomy, climatology or medicine, just to mention a few (RIST and DAHDOUH-GUEBAS 2006). According to BERLIN 1992:3 ethnobiology can be seen as a discipline that combines institutions, skills and biases of both biologists and anthropologists in often unequal mixtures and as the study ("in the broadest possible sense") of the complex set of relationships of plants and animals to present and past human societies.

Knowledge building via cultural transmission is one basic factor for knowledge gaining in societies as such. Cultural traits and innovations are spread, maintained and also altered horizontally within one generation, vertically from parents or from the older generations (oblique transmission) (REYES-GARCIA et al. 2009).

### 2.2.2. Ethnophytopathology and Farmers' perception of plant health problems

The main aim of an ethnoscientific approach is to focus on a, in any way, distinguishable group of people and their relationship towards plants (or animals, fungi, bacteria, weather, etc.). Ethnophytopathology is a relatively small sub-area of this whole complex and tries to figure out the relationships between farmers and natural agents that affect their crops' health negatively. The term "traditional agricultural knowledge" addresses the cultural and technical knowledge that farmers, in a specific area, possess. Farmers inherit part of this knowledge from their ancestors and build upon it constantly, based upon other sources of information and their own experiments and experience. The richness of this knowledge is often enormous (MORALES and PERFECTO 2000).

Research papers in documenting or measuring farmers' knowledge of pests, diseases and pesticide use have become more popular in recent years. One focus of many workshops and field schools that were carried out for example by SHERWOOD 1997 was the introduction or examination of the Integrated Pest Management (IPM) approach that should help to reduce the often vast, health as environment endangering and expensive use of inadequate pesticides (RANGA-RAO et al. 2009, MORALES and PERFECTO 2000, KEKEUNOU et al. 2006).

Farmers' perception of animals and other inhabitants of their agro-ecosystems depend on various factors: As BENTLEY and RODRIGUEZ 2001 describe in their article about Honduran Folk Classification of insects, there are two main approaches to explain the underlining mechanisms of nomenclature: the Universalist and the Utilitarian school. The universalists (or intellectualist) school claims that some living things are "so striking real" or salient that people give them names – for example colorful birds (BERLIN 1992:4). The cultural relativist or utilitarian school in contrast observes that plants and animals are named because people use them, for example as edible plants. BENTLEY and RODRIGUEZ 2001 tried to combine both schools and explored folk knowledge of insects according to a hypothetical scheme that includes cultural importance (perceived importance, whether useful or harmful) and the ease of observation (large, colorful, loud, abundant and other traits). They argue that folk taxonomies show both tendencies – that some folk categories are named for their roles in local culture and others for their biological properties. Folk knowledge is deepest for creatures that are both culturally important and easily observed. In their research on insects that were easy to observe and culturally important like honey bees, people had a deep, vast knowledge. About easy to observe but culturally unimportant species like spiders there was knowledge found that agreed mostly with formal science, but was not as deep. Pest caterpillars, as difficult to observe but culturally important insects, were believed to come with the rain as farmers were not able to explain otherwise how an invasion of caterpillars came to their fields in such a short time; an explanation not consistent with formal science. By contrast, difficult to observe and culturally important insects like nematodes or parasitic wasps on the other hand nothing was known (Table 1).

*Table 1: Characteristics of folk knowledge according to BENTLEY and RODRIGUEZ 2001*

| | Culturally unimportant | Culturally important |
|---|---|---|
| Easy to observe | Thin but consistent with formal science | Deep, much of it unknown to formal science |
| Difficult to observe | Absent | Complex but often inconsistent with formal science |

The main groups dealing with plant health problems are scientists (working for commercial or non-commercial institutions), extension workers and farmers. To describe pests and diseases of plants these groups usually use different vocabulary – on the one side a scientifically based, Linnaean binomial name for a certain organism that at the same time categorizes it into a certain genealogy. On the other side the more practical naming of an often easy to observe, economical important harmful organism in the local language, often based on the symptoms it causes on the plant (BENTLEY et al. 2009). Language is one of the most important topics in Ethno-Sciences: What terms are used in which language by whom, in which situation to describe what and finally: why is that so? As it is stated by BENTLEY et al.

2009 there are usually two meanings in the local name for a plant health problem: one is a literal translation of the name, often a kind of shorthand description of the symptom. The second and most important kind of meaning is the detonative meaning (the thing in the real world which the name actually refers to): Local names often refer to something. It is more likely that the local word labels the symptom that can be observed rather than the actual disease because micro-organisms are difficult to observe in the field without equipment and deeper knowledge (BENTLEY et al. 2009).

## 2.3. Cacao cultivation and trade worldwide

The world's largest cocoa producers nowadays are Ivory Coast, Indonesia, Ghana and Nigeria (Illustration 2). These four countries produced 73.5 % of the world's total production (4,230,790 tons) in the year 2010 (FAOSTAT 2012). The area of cacao harvested worldwide is estimated by the FAO to total 8,919,483 ha in 2010. Its production at 4,230,790 tons makes cocoa one of the smallest cash crops traded on the international market in London and New York markets. Cocoa is a primary good with its price determined at the stock markets in New York and London and can be exported as dried beans, cocoa butter, cocoa powder / cake (called cake because of the form left when the cocoa butter has been extracted), cocoa paste or cocoa husks / shell. Cocoa is not only used in the food industry but also in cosmetics, the pharmaceutical industry and others. Dried cocoa beans are mainly imported by the USA, the Netherlands, Germany, France and the UK (FAOSTAT 2012). These are countries that have the possibility to accumulate the product and speculate with prices, in contrast to most cocoa-producing countries (MARTÌNEZ ARBOLEYA 2007).

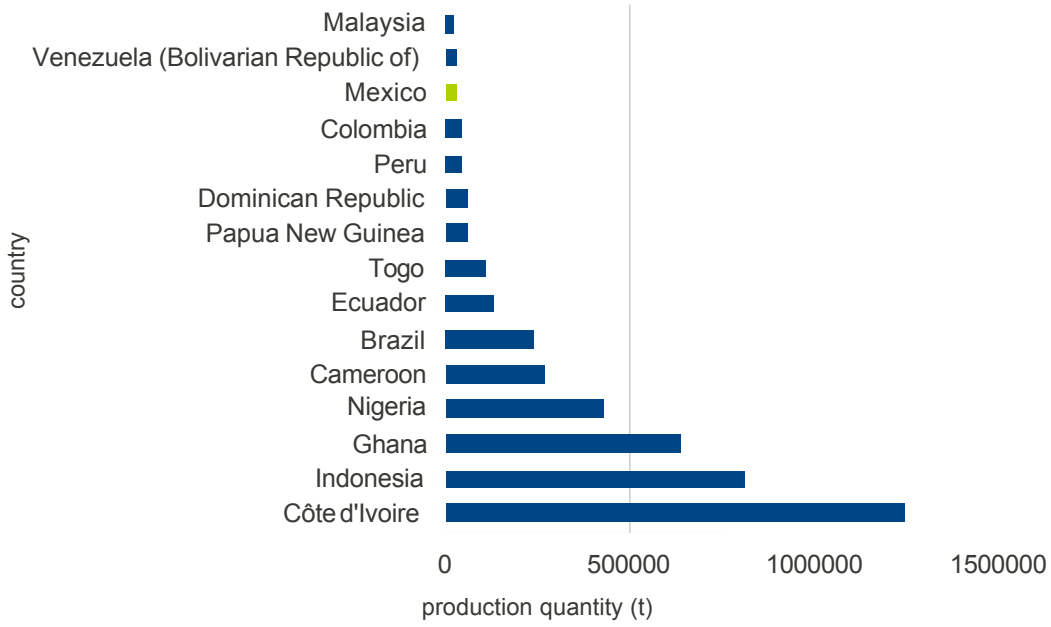


*Illustration 2: Production of cocoa beans worldwide in tons per year in 2010 (FAOSTAT 2012)*

Most cocoa producing countries are located in the so-called "global south" that exports cocoa (and other cash crops) to so-called "global north"[4] where chocolate-consumption is much higher. Cocoa producing countries rarely consume cocoa products which makes the cacao tree a typical cash crop and cocoa is usually not produced for self-supply/consumption. In Ivory Coast and Ghana, cocoa export is the main source of income for the countries' economies and world price shifts of cocoa affect smallholder cacao farmers as well as a majority of the population. And cacao cultivation is mainly a smallholder business: 80% of Western Africa's cacao farms are less than 3ha in size (PLOETZ 2007). Another problem of cocoa exporting countries is that the value-adding processes of transforming cocoa beans into food products or cosmetics as well as its commercialization is carried out in the importing countries.

In West Africa, with Ivory Coast, Ghana, Nigeria and Cameroon together producing 60% of the world's cocoa beans in 2010 (FAOSTAT), there have been prominent reports of severe human right abuses, especially child slavery in cacao plots[5] in Ivory Coast. Various reports (MANZO 2005 and RYAN 2011:43) refer to the fact that abducted children, over all from Mali, work in conditions of the worst forms of child labor, including slavery and hazardous work as defined by the International Labor Convention 182. RYAN 2011:62 states that the common problem of child labor has to be seen in the greater context of the cocoa farming business as such: Smallholder farmers tend to have little land, little production per hectare, are often without access to fair loans and tasks in the cacao-plots are labor-intense.

## 2.4. Pests and Diseases in Cacao

### 2.4.1. Cacao diseases worldwide

Animal pests in Cacao do cause fewer losses than diseases. According to PLOETZ 2007 one main reason for the decline of cocoa production in the Americas after the beginning of the 20th century were diseases that did not occur in Africa or Asia. A clear geographic distinction lies between the center of cacao tree origin in the Upper Amazon and the first domestication areas in Mesoamerica. In Mesoamerica, there were no coevolved natural enemies of cacao at the beginning of its cultivation at least 2600 years ago. Nowadays, both coevolved and newly encountered diseases expand their geographic ranges to cacao cultivation areas worldwide (EVANS 2007).

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4 "Global north" and "global south" are difficult terms: North respectively south do not necessarily imply the geographic location but also a political and socio-economic division. Defining the "development" of countries is a very controversial and complex topic that is not within the scope of this thesis.

5 The term "plot" will be used throughout this thesis instead of the more common term "plantation"– but as cacao-cultivation is dominated by smallholders with little land, the word plot reflects the actual size better.

Cacao trees are affected by diseases that attack their vegetative parts, especially their fruits (somestimes called pods) but also leaves, stem and flowers. Regarding cacao pod diseases, several factors are involved in disease susceptibility, such as the fruiting cycle, fruit size, age, position on the tree and cacao genotype (TEN HOOPEN et al. 2012). The cacao tree is a highly susceptible to diseases as well as to some animal pests. This is, among other reasons, because of related hosts for diseases in tropical forests: wherever cacao has been introduced, endemic natural enemies adapted quickly to the cacao tree (EVANS 2007). As far as it concerns diseases of cacao, mainly named and considered the most harmful (PLOETZ 2007) are one virus, one oomycete and three fungal agents (Table 2).

*Table 2: The major diseases of cacao worldwide (PLOETZ 2007 modified)*

| Disease | Estimated annual losses in tons | Agent(s) | Current geographical distribution |
|---|---|---|---|
| Black pod Rot | 450 000 | *Phytophtora sp.* | Various *Phytophthora* species causing damage on different continents; for example *P. capsici* in Latin America, *P megakarya* in Africa and *P. palmivora* pantropical |
| Witches' broom | 250 000 | *Moniliophthora perniciosa* | South and Central America (Brazil, Bolivia, Grenada, Panama and others) |
| Swollen shot | 50 000 | Cacao swollen shot virus | Africa (Ivory Coast, Benin, Togo and others) and Asia (Indonesia, Malaysia) |
| Frosty pod Rot (*Moniliasis*) | 30 000 | *Moniliophthora roreri* | Latin America (from Peru to Mexico) |
| Vascular strike back | 30 000 | *Oncobasidium theobromae* | Asia (Indonesia, Thailand, Burma, China and others) |

No geographical area of cacao cultivation suffers from all these diseases but there is fear that especially *Moniliophthora roreri* and *Moniliophthora perniciosa* (two closely related hemi-biotrophic basidiomycetes) may spread from the Americas to Western Africa. The losses these two fungal agents cause are immense regarding the fact that the major cocoa cultivation areas are not affected at the moment.

#### 2.4.1.1. Frosty pod Rot

*Moniliophthora roreri*, known as Frosty pod Rot or just Frosty pod, is considered the most worrisome cacao disease at the current time. In Peru, where *M. roreri* has occured since 1989 along with Black pod and witches' broom, it is the most prevalent (PLOETZ 2007). According to RAMIREZ-GONZALES 2008, *M. roreri* has its origin in Colombia from where it spread during the years after 1800 until now into 11 Central and South American countries, including Mexico in 2005 (LOPEZ ANDRADE et al. 2007). It's possible that once spread to Africa, Frosty pod will cause severe damage to the major cacao cultivation areas, too (PLOETZ 2007).

*M. roreri* causes losses up to 90 % of total cocoa production depending on ecological conditions, cultural practices, control measures and the cacao varieties cultivated (LOPEZ ANDRADE et al. 2007).

*Illustration 3: So-called 'chocolate spot' of M. roreri on a cacao pod (Photo taken by the author 2011)*

There are at least five varieties of the *M. roreri* fungus (RAMIREZ-GONZALES 2008), affecting different regions: the variety affecting cacao in Mexico, Panama and Costa Rica differs from the variety causing losses in Peru and Bolivia. Frosty pod, in Spanish known as *Moniliasis del Cacao, helada, Pudrición del Fruto or Enfermedad de Quevedo* (VENTURA and GONZALES 2007) belongs to the Order of Agaricales (Phylum: Basidiomycota) and has an interesting life cycle: the supposed conidia (asexual spores) have been shown to function as meiospores (haploid spores produced by sexual reproduction). These spores, believed to be much-modified basidia, are multifunctional, serving for sexual exchange, dispersal, infection and survival (EVANS 2007). It is hypothesized that with the uplift of the Andes, *Theobroma* host species of *M. roreri* were separated together with the pathogen, leading to high dispersal and survival pressure on *M. roreri*. Because host trees were scattered on the western Andean Cordillera, the pathogen had to develop strategies like increased spore production and a more resistant form to disperse than the short-living, short-range basidiospores (EVANS 2007). The fungus' spores are therefore more competitive than the spores of most other fungal diseases and this may explain why Frosty pod has quickly displaced both Black pod and Witches' broom disease as major threats to cocoa production in the countries that it has invaded (EVANS 2007).

*M. roreri* attacks only the cacao pod but in all stages of its development. Once the infection shows symptoms on the fruits surface (30 to 45 days after the infection), the cacao seeds are already damaged. Symptoms are so-called "hunches" (*gibas*, *chibolas* or *jorobas* in Spanish) in the young green fruits. Small dark dots on the surface that later become brown or yellow are known as "chocolate spots" (Illustration 3). Theses spots then cover the main part of the fruit. The spots have an irregular border on the fruit part that still looks uninfected. Later in development these "chocolate spots" will be covered with white spores (*mancha blanca* in Spanish) (Illustration 4). Other symptoms can be a premature maturation, rotten seeds inside the fruit which are not easily removable and an augmented weight of the fruit because of water accumulation. The basidiospores, that can cover the surface of the whole fruit, are transmitted mainly by wind, but also by insects and water drops (LOPEZ ANDRADE et al. 2007).

*Illustration 4: Cacao pod infected with M. roreri (left) next to a healthy pod (right) (Photo taken by the author 2011)*

Losses to the cacao harvest caused by Frosty pod, in the absence of control efforts, depend on climatic conditions of each region and their relationship to crop phenology. Favorite conditions for the pathogen are rainfalls (areas with short or undefined dry season), high temperature (about 20–30 degrees daily range or higher) and when the pod of the cacao tree is developing coinciding with high humidity. Losses range from 20% up to 90% of the harvest, depending on these factors (CABI 2012).

There is no chemical control for *M. roreri*. The prevention-practices that are propagated by facilitation workers are to remove the infected fruits as soon and often as possible, shade regulation as too much humidity favors the fungus and a good drainage system. Infected fruits should be buried outside the plots or at least covered with leaves if left within. Experiments with antagonistic fungi look promising thus far but products are still expensive and not widely common (LOPEZ ANDRADE et al. 2007). Another problem that arises with the infection with *Moniliasis* is access to labor – to remove the infected pods much more manual labor than before is necessary and if it cannot be provided by the farmers, hiring *jornaleros*[6] for money can cause economic problems (MARTÌNEZ ARBOLEYA 2007).

6 *Jornaleros* are Mexican day laborers

#### 2.4.1.2. Witches' broom

Witches' broom, *Moniliophthora perniciosa*, is a major problem especially in Brazil where annual production from 400,000 tons fell to 150,000 tons after the arrival of this pathogen in the 1970s (PLOETZ 2007). Losses are reported that range from 30 % to 90 % in South America and the Caribbean (PLOETZ 2007). Host and geographic range are not yet fully known, indicating that there is a continuum of plant families, genera and species that serves as hosts in Brazil (EVANS 2007). Even though Witches' broom (*escoba de bruja*) is not yet found in Mexico (SENASCO 2012), infections are already reported in Middle America and there is reasonable concern that it may spread into Mexico's cacao cultivating areas (CESAVECHIAPAS 2011).

#### 2.4.1.3. Black pod Rot

The *Phytophthora* sp. complex consists of various *Phytophthora* species that induce Black pod disease in cacao, causing losses from 20 % to 25 % of the worldwide expected crop. Each continent has its own complex of *Phytophthora* species causing Black pod. *P. megakarya* in Ghana and Nigeria may be one of the most problematic species (GUEST 2007) because of its much denser sporulation on the pod surface (compared to other *Phytophthora* species) that led to an increased inoculum load (EVANS 2007). *Phytophthora* is considered to be a fungi-like organism, actually it is placed as an Oomycete in the kingdom of Chromalveolata and more closely related to plants than to fungi. Many *Phytophthora* species are known to be plant pathogens. Most prominent is *P. infestans*, causal agent of potato blight and responsible for the Great Irish Famine of 1845 – 1849, but there are many others (KROON et al. 2012).

Cacao fruits can be attacked in different development stages and present symptoms of a coffee-colored spot with well-defined borders. The spot can expand in seven to ten days to a development stage that covers the whole pod. The infected pods gets softer and weigh less than healthy pods and the white, superficial mycelium appears dark when the black spores mature. The cacao-beans can get necrotic when the ooymycte develops into the pod. *Phytophthora* species can also cause necrosis on young sprouts as well as canker on the trunk, root and buds. *Phytophthora* infections can usually be controlled with copper-based products (RAMIREZ-GUILLERMO and LOPEZ-ANDRADE 2011).

#### 2.4.1.4. Other cacao diseases

Cacao Swollen Shoot Virus (short CSSV; a member of the *Badnavirus* genus) is restricted to the Eastern hemisphere, first described in 1963 in Ghana and genetically very variable, causing different symptoms depending on the host's genotype (PLOETZ 2007). CSSV is vectored by at least 14 species of mealy bugs (Homoptera: Coccidae) and infects about 40 species of the Malvaceae that develop symptoms. Its origin is unclear as it was not introduced via cacao into Africa but it is in the cacao crop, moved by people, that the virus is now spread (PLOETZ 2007). There are other diseases on cacao plant like the ceratocystis wilt, cushion gall or black rosellinia root rot but none of these reach an equal damage level as the diseases mentioned above (PLOETZ 2007).

### 2.4.2. Cacao pests worldwide

Insect pests are quite diverse depending on the cultivation area. One example is the cocoa pod borer *Conopomorpha cramerella* which is said to be the main threat to cocoa production in South East Asia (DUFFEY 2009), causing annual losses of about 40,000 tons (PLOETZ 2007). Various species of mirids (Heteroptera: Miridae) do cause estimated annual losses between 100,000 and 200,000 tons. Species involved are *Sahlbergella spp.*, *Distantiella theobroma* and *Helopeltis ssp.* in West Africa as well as *Monalonian spp.* in Latin America (PLOETZ 2007). Depending on the geographic cultivation area, there are numerous mammals and bird species that can cause significant, but mainly local, damage and a wide range of insects that damage diverse plant parts or serve as vectors for cacao plant diseases (PLOETZ 2007).

### 2.4.3. Pests and diseases in Cacao in Mexico

Reports state that from the year 1765 to 1772 and in 1793 and 1805, grasshoppers (span.: *langostas*) attacked cacao and maize plots and that they were considered a major pest (WEST 1987 and LOPEZ-MENDOZA 1987). TUDELA et al. (1989) describe that one of the oldest diseases reported in cacao in Tabasco, probably since the 18th century, are *Phytophthora palmivora* and *Phytophthora capsici* (both species cause Black pod disease) infections. The disease was referred to as *pudricación negra* (black powdering) and symptoms of Black pod were described. Before the 1930s, Black pod together with natural forest habitants (for example monkeys, squirrels, birds, ants and termites) were the only known pests in cacao plots (TUDELA et al. 1989) and agrochemicals were considered not necessary (or available). The process of technical change in cacao plots caused the reduction of biodiversity: shade trees were homogenized and dramatically reduced; the traditional cultivation under natural rainforest canopy got replaced. TUDELA et al. (1989) argue that in 1972, 35% of the area of cacao cultivation was treated with agrochemicals while in 1978, 82% of the cocoa producers used pesticides to combat pests. Various, cacao-related institutions like the INIFAP experimental station Rosario Izapa, the UNPC or the CONADECA started to recommend different products which led to a disorientation of the cacao farmers that tended to use cheap and multi-purpose products sold by agrochemical salesmen. Pesticides were used from February until September (except in June where the trees were, due to the beginning of the rain season, relatively free of pests). Major pests, according to TUDELA et al. (1989), were trips, aphids, true bugs and others that were treated with Foley (methyl parathion), Lindano (Lindane), Tridente and Difadol (methyl parathion) as well as spider mites and leaf folders that were treated with Nuvacron (Monocrotophos). Cupravit (Copper oxychloride) was used to treat fungal diseases, especially Black pod. TUDELA et. al. (1989) state that pests started to affect shade trees, especially the mote (*Erithrina sp.*) which previously caused no problems. In March 2005, *Moniliophthora roreri* (Frosty pod) was first reported in the *municipio* of Pichucalco, Chiapas, near the Tabascan border (RAMIREZ GONZALES 2008). It spread rapidly first to Tabasco, then to the Southern cacao cultivating regions of Chiapas until 2007 when all cacao cultivating areas in Mexico were infested. The

losses because of this newly-transported disease totaled about 50 % of the total production: Estimations were that of the 40,000 tons of cocoa produced before, in the year 2006 in Tabasco and Chiapas 20,000 tons were lost due to *M. roreri* (RAMIREZ GONZALES 2008).

## 2.5. Cacao cultivation in Mexico

Cacao has been cultivated in Mexico for thousands of years. If the Mexican cacao varieties themselves originated independently from the Amazonian varieties in Southern Mexico was not clear for a long time. Due to recent genetic analyzes, the cacao tree has developed in the Amazon region and Mexican varieties descend from them (MOTAMAYOR et al. 2002). The results obtained of the microsatellite and RFLP [7] analysis by MOTAMAYOR et al. 2002 of different cacao varieties suggest that, because of the low genetic diversity and the high level of homozygosity, the ancient Criollo variety of cacao in Central America originated from South American cacao trees and was spread by humans toward north.

Cocoa was cultivated in Mesoamerica since the so-called "Classic Period" (500 BC to 900 AD.) when the Mayan culture in Tabasco began. In Mexico, cacao cultivation was distributed on both sides of the continent: on the Pacific coast from Colima to the Soconusco region in Chiapas and at the Atlantic side in Tabasco up to parts of Oaxaca and Veracruz (WEST 1976 cited by LOPEZ MENDOZA 1987) (Illustration 5).

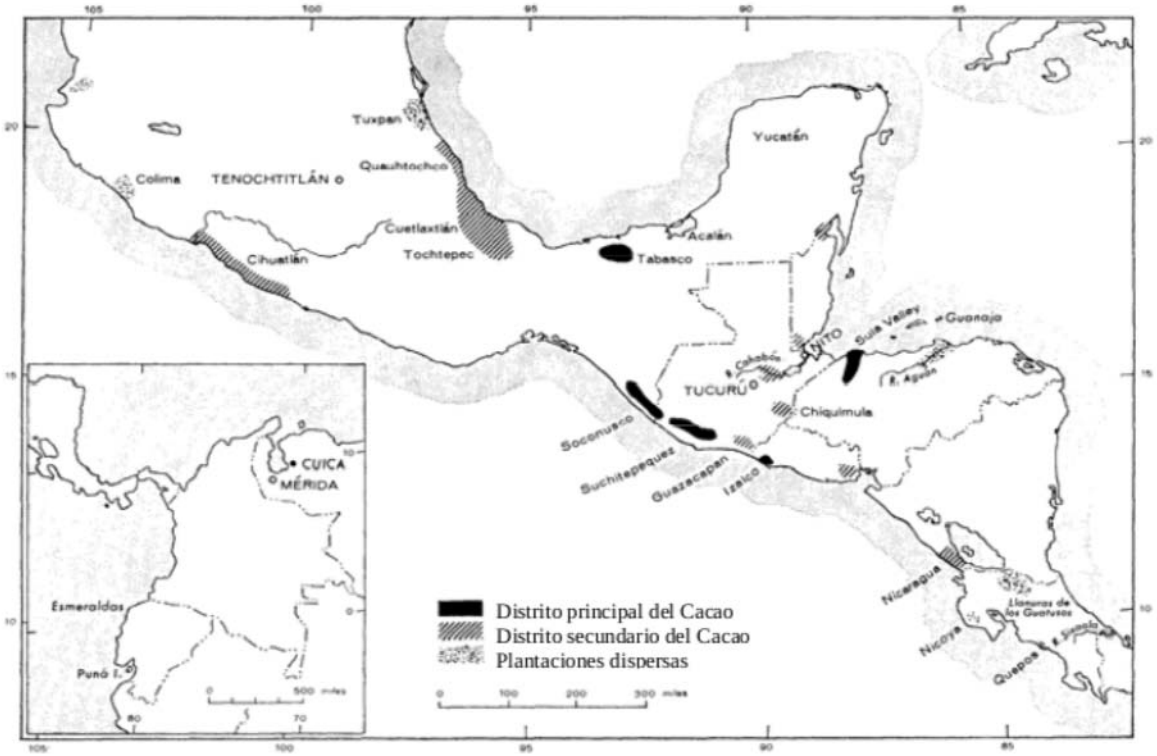


*Illustration 5: Distribution of pre-columbian cacao cultivating areas (BERGMANN 1969)*

7 Microsatellites, or Simple Sequence Repeats (SSRs), are repeating sequences of 2–6 base pairs of DNA, used as molecular markers in genetics; RFLP (restriction fragment length polymorphism) is a technique that exploits variations in homologous DNA sequences.

According to LOPEZ MENDOZA 1987 there is a link between the distribution of cocoa and the distribution of ancient civilizations as the Maya or Nahua, because within the ecological conditions the cacao-plant requires, distribution was probably also depended on the scale of social development (LOPEZ MENDOZA 1987).

In Tabasco, the principal area of cacao cultivation was found at the Rio Chacalapa (today known as the Rio Cunduacán) where a great part of the Tabascan Maya population (*Chontales*) lived and all *Nahuátl* speakers were concentrated. In contrast, at the Teapa and Tacotalpa regions with similar ecological conditions but then with other population profile (such as the ethnic group of the *Zoques* who lived here), no cacao plots were found. In the *Nahoa* Mythology, cacao trees of many colors were one of the treasures of the god Quetzalcóatl who transformed them into *Mesquite*-Trees (Genus: *Prosopis*, Fabaceae) when he went from Tulla to Tlapallan. In Mayan tradition, cocoa seeds were one of the main offerings to the rain god *Ek Chuah* (also the god of Cocoa and of Mayan merchandisers) and part of rain ceremonies (LOPEZ MENDOZA 1987).

The cacao variety cultivated back then in Tabasco was a nowadays known as *Criollo* cacao variety with white seeds. Tools in the plots are thought to be very limited (stones [called *hachas*] and wood [*macana*]) as first metallurgy of the Maya was found from the 6$^{th}$ or 7$^{th}$ century AD mainly with an ornamental focus. Limited tools used for cacao cultivation could also explain the reasons for low documented harvest of about 81 tons of cacao per year before the Spaniards arrived (LOPEZ MENDOZA 1987).

Cocoa was mainly used as currency and to create chocolate drinks. There were more forms of currency but cocoa beans were the most common. Chocolate was manufactured in many different ways – one was to mill it in the *metate* (a kind of mill also used for maize), grind and mix it with maize paste (*masa de maiz*) as a basis for a beverage with water. This highly nutritious drink called *Pozol* is still found in Tabasco and was in former times more common in Tabasco than, for instance in the rest of Mexico, the tortilla was a basic part of the diet. Sometimes vanilla, pepper or honey were added and the traditional “glass” was a cascade of *jícara* (*Crescentia cujete*: Bignoniaceae), today sold as artesania as a traditional Tabascan handcraft. Various celebrations in the Mayan culture, such as marriages, required this chocolate as a main part of the ceremony. The demand of the Mayan and Aztec upper classes was enough to stimulate production in the Mesoamerican tropical lowlands that delivered cocoa to the Mexican Highlands and the Peninsula of Yucatan (which for its long dry periods and little water reservoirs had certain limitations for cocoa cultivation). Given that neither the wheel, iron nor carrying animals were used in transport, transportation was difficult over longer distances. Tabasco and Honduras covered the demand for cocoa of the Yucatan peninsula, whereas Tabasco, together with the Socunosco region in Chiapas, also delivered cocoa to the Altiplanos in Central Mexico (LOPEZ MENDOZA 1987).

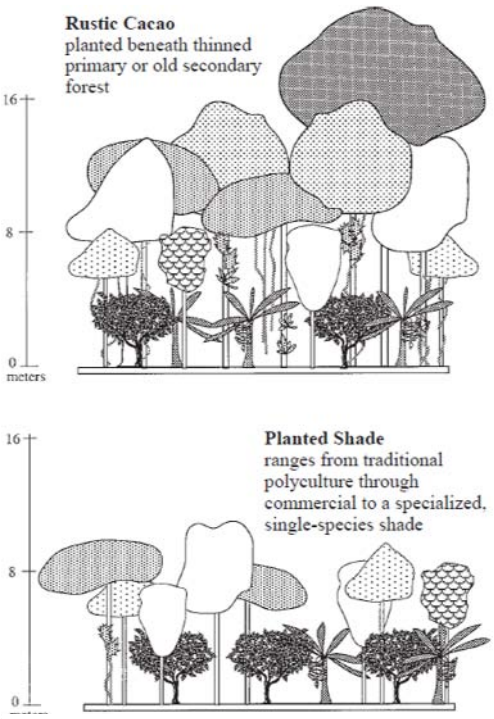


*Illustration 6: Cacao shade management systems (RICE and GREENBERG 2000)*

With the arrival of the Conquistadores in 1498 until the middle of the 16th century the cacao plots remained the same size and production was at a standstill. With the diseases and the violence brought by the Spanish which decreased 90% of the indigenous population by 1579 (LOPEZ MENDOZA 1987), the structure of society altered: the upper classes of Mayan and Aztec society were greatly disturbed by the Conquista and the demand for cocoa sank remarkably.

At the time just after the Spanish arrival, Chontalpa was the only region in Tabasco still producing cocoa and its products were still used for export, money and tribute-paying within the indigenous American population. By 1550 the Spaniards began to mix chocolate with sugar which led to the export of cocoa to the Iberian Peninsula and also to *Nueva España*. This stimulated production and prices rose once again. With the higher prices, the cocoa-producing regions in South America expanded to Trinidad and the Caribbean Islands. This rise of cocoa production for the 'old world' changed the situation in Tabasco in various ways (according to LOPEZ MENDOZA 1987):

- The property of the plots: the indigenous production was not enough to fulfill the newly arisen demand and the Spaniards began to buy or simply take already existing plots and made new ones, too. In Tabasco it was possible to legalize land titles by 1643 very cheap. This was one rea son why the Spanish had big properties in Tabasco and most of the cocoa production lay in their hands;

- the kind of hand labor changed (slavery of indigenous people was abolished in 1550, labor in the plots was done by the owners, *mestizos*, *mulatos* and by African slaves, indebted farmers and Chinese workers);

- the expansion of the plots within Tabasco to Teapa, Tacotalpa and Macuspana (until the end of the 16th century);

- and the technical revolution of production systems (the natural shade of the rain forest was changed for shade tree systems with less shade that augmented the production (Illustration 6); iron as a working material was introduced, axes and machetes now helped to control weeds).

From 1640–1800 onwards, cocoa consumption became popular in France, Germany, Italy and the Netherlands. This created new markets which led to a further expansion of production in South America (Venezuela, Colombia, Ecuador, Jamaica and Haiti). The Dutch brought cacao in 1686 to Surinam, the French in 1661 to the Martinique Islands and other colonial powers brought cacao to south-east Asia. In Tabasco the population suffered an exodus from the end of the 16th century onward because of numerous pirate attacks. Pirate attacks were the reason why the Chontalpa region became less productive and the Sierra region of Teapa, Tacotalpa and Macuspana were more focused on cocoa production. With all the altered production, the price began to fall again and by 1650 there were signs of less production in Tabasco while Ecuador and Venezuela became the new players on the cocoa market. The crisis of Tabascan cacao led to the introduction of sugar cane by the middle of the 18th century and its intensification. This led again to a decline of cacao production.

From the 17th to the 18th century, cacao plots were scaled as follows: large 6000–10000 trees, (equal to 10–15 ha) and there were haciendas that possessed approx. 114 hectares. Labor was provided by slaves and indigenous indebted farmers. As for exportation, cacao was sent from the Tabascan capital of Villahermosa (former called San Juan Bautista de Tabasco) by ship to Veracruz and from there to Spain or the City of Mexico. By 1800 production in Tabasco rose from 175 tons to 300 in less than 10 years (1802–1811) to approx. 324 tons in 1825 because of less pirate activity which led to a repopulation of the Chontalpa region. Pirate activity was successfully combated by redirecting the River Mezcalpa in 1765 as the ships could no longer enter the river any more and this measure resulted in less inundations by redundant water. The now dried riverbed became known as Rio Seco and had fertile soil that attracted cultivators. As piracies in the Gulf of Mexico itself began to fall, exporting cocoa again became to be easier and cheaper.

During the time period known as Independence (1821–1860), cocoa prices were more or less at a high level. The population in the Chontalpa region started rising again, the government helped to plant cacao and the export volumes of dried cocoa beans grew. Despite the changes in the Independence period, land titles and land concentration in Tabasco remained as they were in the colonial period. This also happened with labor forces except that slaves were declared free in 1829. However, the labor system that forced indebted farmers to endure due to the miserable payment in the plots went on. From the middle of the 19th century to the 1930s Tabascan cocoa production fell from 5177 tons to 295.5 tons in 1933. Many plots were abandoned because of floods, droughts and a focus on more profitable productions like sugar cane and its processing (which competed with cacao, as well as the cultivation of green bananas, for working labor and capital). In Tabasco, a small epoch of coffee cultivation led many cacao cultivators to abandon their plots.

Competition arose, especially with the African cocoa exports. At this time the cacao cultivating African countries such as Ghana and Ivory Coast were colonies of European powers. The dependence on the

USA for most cocoa exporting countries made cocoa exports more difficult, too. For the high quantities available, the price fell again between 1926 and 1932 (LOPEZ MENDOZA 1987). Western Africa's leading role in cocoa production when the demand for chocolate grew in the so-called developed world in the first 20 years of the 20th century, the area dedicated to grow cacao by smallholders increased very rapidly in West Africa (RYAN 2011). In 1900, only 20% of all cocoa beans came from outside the Americas (PLOETZ 2007).

By the end of the 19th century land concentration in Tabasco was highest. Because of several laws that were introduced, land could be taken irregularly and fallow as well as national land passed into private property. Indigenous communal land was transformed into individual and later on into foreign property. So, in 1895 about 80% (2,000,000 ha) of Tabasco's surface was property of 1400 haciendas and 4100 ranchos[8] (WEST et al. 1987). By 1914 the system of debt-slavery was forbidden by law and debts declared canceled, a minimum wage of 1 peso was installed and a working day of 8 hours[9]. This changed the situation dramatically for workers as well as feudal hacienda owners depending on cheap labor.

Regarding cocoa commercialization, at the beginning of the 20th century, Tabasco's cacao farmers sold their product directly to local merchants but this was not very competitive in the international markets, especially not against the rising African cocoa production. This can be regarded as the main reason why, in 1934, the first cacao-producing organization *Central de Cooperativas de Productores de Cacao de Tabasco SCL* was formed. But intermediate sellers and buyers were still in control to decide over the prices for cocoa beans. To overcome them, Tabasco's Government installed a system to control cocoa production in the state. Taxes were fixed and the UNPC, the National Union of Cocoa Producers, was established and began to work in 1963 (LOPEZ MENDOZA 1987). At the same time, the traditional *Criollo* cacao varieties were substituted with *Forastero* and *Trinitarian* cacao trees, mainly because of the UNPC's advice and programs. The UNPC was controlled by the state of Tabasco and

8 The difference between *hacienda* and *rancho* is that a *hacienda* was a production unit of Nueva España in the 17th and 18th century, a *rancho* was private property. The , were owned by a few administrators of the Spanish Crown and some privates, all Spanish or *Criollos* (descendants of Spanish colonists). Characteristic was combined livestock keeping (cattle, pigs, poultry and turkey), cacao cultivation, timber, grain and vegetable production as well as horticulture together with fishing and hunting to form semi-independent economic units that could be more self-sufficient. Even the cacao *haciendas* in Tabasco never reached the prosperity of other *haciendas* in Nueva-España they were quite wealthy and important for people's sustentation (RUIZ 1994).

9 The current (October 2012) ongoing debate on the Mexican Labor Law reform (*reforma laboral*) tries to alter this federal law to achieve greater flexibility for employers (but most probably not for employees) by changing crucial paragraphs.

aimed to serve for a more direct commercialization to the national and international markets for cacao farmers. Cacao farmers were now able to get credits and to finance the cost of commercialization (LOPEZ MENDOZA 1987). The UNPC received great amounts of money from the state that allowed the organization to accumulate power (MARTÌNEZ ARBOLEYA 2007) – a chocolate factory was build and shops for selling their products, airplanes for fertilizations, trucks and other things were bought. The UNPC gained the economic possibilities to accumulate large amounts of cacao beans from different local associations. But the resources from the state implied a larger control over the Tabascan cacao farmers for political reasons and the hegemonic leading political party PRI in the 70s and 80s gained great influence. There was also a great deal of corruption (MARTINEZ ARBOLEYA 2007): Union leaders took more than their share and used the UNPC as a political platform which led to some arrests as well as to successful careers in politics and business (MARTÌNEZ ARBOLEYA 2007).

In the last years, Tabascan cacao business evolved in two steps: From 1973 to 1989 the National Commission of Cacao (CONADECA) regulated commercialization. From 1990 on there has been a state deregulation, an opening of the markets and a fall of international cocoa prices[10] (MARTÌNEZ ARBOLEYA 2007). Various semi-technologized programs were developed and carried out with the aim to increase yields. These attempts were unsuccessful and because of the higher costs for the agrochemicals as well as the low international cocoa prices many plots were abandoned. Land use change towards other activities, especially sugarcane cultivation and cattle keeping increased (MARTÌNEZ ARBOLEYA 2007).

The Cocoa market in Mexico is dominated by Nestle, Barry Callebaut AG, ANCO and others (MARTÌNEZ ARBOLEYA 2007). There is a certain percentage of Tabascan Cocoa destined for the local and national market which is processed into various products like chocolate bars, drinking chocolate, *pozol* (as stated above a traditional beverage made of cooked maize and dried cacao-beans with water) or *mole* (a traditional sauce with various ingredients including cacao).

## 2.6. Organic, Integrated Pest Management and low input agriculture

Farming systems do influence farmers' way of dealing with pests and therefore may influence pest perception (SEGURA et al. 2004). Conventional farming, Integrated Pest Management (IPM) and organic farming are the three mainstream classification systems often used to describe different levels of an 'intensification' scale in agriculture that is of course far more diverse and differentiated (TJAMOS et al. 2010).

10 In 1994, the controversial North American Free Trade Agreement (NAFTA) was signed by Canada, Mexico and the USA to create a trade block between the three countries. Liberalization of markets changed, among other sectors, the agricultural market in Mexico tremendously and aggravated the cocoa farmers'.

Organic agriculture is a way of farming that became more wide spread through the last 20 years. There are various forms of "organic": The official certified organic production according to guidelines made by, for example, the European Union (which is primarily meant to protect consumer interests), voluntarily certified organic production which can be certified beyond the legal "basic organic" by private associations like Demeter and of course there are farmers who produce in a traditional "low input way" sometimes very similar to organic standards but that are not certified. Basic principles of organic farming are a more holistic way of using resources (but this aim is not really specified), a raised use of certain farming techniques like green manure, crop rotation, compost, biological pest control and an abstinence of most synthetic fertilizers and synthetic pesticides (WILLER 2010).

IPM (Integrated pest management) is a farming system that tries to use synthetic agrochemical input in a more efficient way. Its aims are to reduce economical means, environmental pollution and human intoxication together with optimizing or stabilizing yields. One concept of IPM is the economic threshold principle that argues that combating a pest or disease is only profitable if the expected losses in yield are higher than the expected costs for pest control. IPM does include a whole range of divers control measures like natural enemies, botanical pesticides, cultural methods as well as synthetic pesticides. Knowledge of the pest organism is required to optimize the treatment, for example to know in which state of development of an insect pest or a disease, development control measures can be applied successfully (SHERWOOD 1997).

So-called conventional agriculture is regulated by national and international standards (for example for pesticide use or animal welfare) and as well as any special standards of label the farmer's product may participate.

### 2.6.1. Organic agriculture in Mexico and in Tabasco

In the year 1998, in Mexico 28,000 organic farmers cultivated 54,000 ha organically which corresponded to 0.05 % agricultural used area. 85 % of all produced organic goods were exported (WILLER et al. 2000). Ten years later it was shown that the organic sector grew very rapidly since then: In 2005 there were already about 310,000 ha managed organically and two years later in 2007 this figure even increased to 393,461 ha (WILLER 2010). According to GOMÈZ TOVAR et al. (2005), from 1996 to 2004 Mexico had an annual growth rate in the organic sector of 34% (Illustration 7). This area was cultivated by about 129,000 organic farms and approximately 90% of all organic goods were exported while domestic market remained small. According to WILLER et al. (2008) about 10 % of produced organic products that are not exported are sold as conventional products whereas GOMÈZ TOVAR et al. (2005) state that approximately 15 % of certified organic production is destined for internal markets and only 5 % is sold as organic.

Organic exports were valued at around 430 million US Dollars in 2007. The main producer states are Chiapas, Oaxaca, Guerrero, Michoacán, Chihuahua, Jalisco and Veracruz (WILLER et al. 2008).

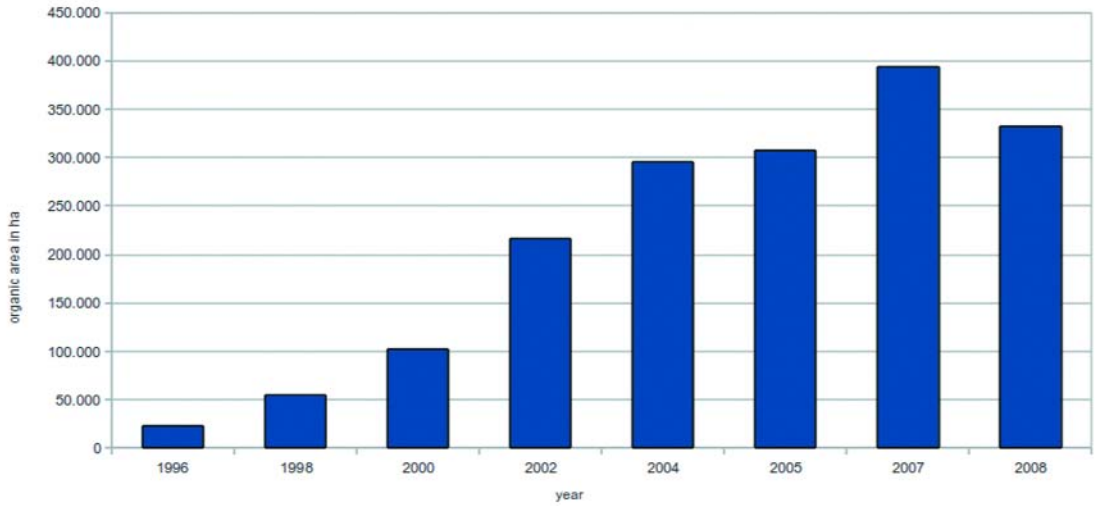


*Illustration 7: Organic area (ha) in Mexico (WILLER 2004; WILLER et al. 2008; WILLER 2012, combined)*

A biodynamic coffee farm (*finca*) owned by a German in Chiapas became Mexico's first organic operation with official certification status. In the 1980s, one coffee producers cooperative (*Union de Comunidades Indigenas de la Region del Istmo* or UCIRI) began to shift to organic production, initiated by the influence of Liberation theology on some cooperatives' members. The first certified organic operation in Northern Mexico was a cooperative of small-scale vegetable producers in Baja California Sur, certified in 1985. The Mexican state had little involvement in organic production at this time; the main actors were NGOs, export-oriented businesses and religious groups (WILLER 2009). The Mexican state itself did not support organic small-scale production of coffee but changed its position after seeing its succeeding and now refers to organic agriculture as a "model export strategy" (GOMEZ TOVAR and GOMEZ CRUZ 2004). The state of Mexico has viewed certified organic agriculture as a short-term solution to export and foreign exchange concerns. As such, the Mexican state has not developed a national strategy like for example EU states (GÒMEZ TOVAR et al. 2005). NGOs advised on how to achieve certification and enter the export market. The adopting of smallholder cooperations to the requirements of certification did have impacts on the internal functioning and structure of farming communities (GONZÀLES et al. 2005). The success of this strategy was contributed on the one hand to the factor that organic-coffee farmers who worked poor and marginal mountain land were less pressured during the 1970s and 1980s to join the IMECAFE programs that aimed to modernize coffee production (GONZÀLES et al. 2005) and still use traditional agroforestry methods. On the other hand indigenous communities still have a huge social capital.

In Mexico, there is still a very large gap between large-scale and small-scale producers. According to WILLER (2012), 99.95 percent of a total of 128,862 organic producers in 2008 were small-scale farmers that cultivate less than two hectares. While large-scale producers and enterprises (the term large-scale refers to producers with more than 100 ha organic certified land) are found in the north of the country, in the south organic producers tend to be clearly smaller. Organic small-scale producers in

Mexico are mainly low income producers, consisting of peasant and indigenous farmers often working together in groups, networks and cooperatives (WILLER et al. 2008). One problem about these structural differences in Mexican organic agriculture is that certification privileges large farmers and agribusiness-style organic cultivation because of the high bureaucratic requirements and certification costs. Large producers do have easier access to capital, international corporate expertise and security arrangements (GOMÈZ TOVAR et al. 2005). Smallholder certifications are much more complicated processes as they require internal and external control measures (including labor-intensive communal land inspections), are document-based, process-oriented and use regional networks and associations of farmers (GOMÈZ TOVAR et al. 2005). There is a difference in what large and small-scale farmers produce: Coffee, hibiscus and cacao are produced by using locally produced inputs by small-scale farming groups while for example organic greens, mangoes and winter vegetables are produced input-intensive and labor-exploiting mainly for the U.S. Market (GOMÈZ TOVAR et al. 2005). In 2000, small, peasant and indigenous farmers organized in producer groups represented over 98 % of total organic producer zones, cultivated 84 % of organic land on an average plot size of 2.6 ha and generated about 69 % of the economic returns (GOMÈZ TOVAR et al. 2005). According to GOMÈZ TOVAR et al. 2005 plot size difference between large and small units is associated with significant variations in mechanical technology use, inputs, attitudes toward environmental impacts and the use of labor. Another dimension, stated by WILLER 2012, is that organic production in Mexico mainly takes place in areas that are characterized by both poverty and high biodiversity.

The main product of organic agriculture in Mexico is coffee. 56% of the organic certified land is dedicated to organic coffee production which corresponds to 30% of the total Mexican coffee growing area (WILLER 2012). Mexico was the largest producer of organic coffee worldwide with 150,043 ha cultivated in 2006 (WILLER et al. 2008). Organic coffee is mostly grown by indigenous smallholder cooperatives in the states of Oaxaca, Guerrero and Chiapas and it is exported to Europe and the USA (GONZALES and NIGH 2005).

Despite general the Mexican agricultural sector crisis[11], the organically certified area was growing steadily until 2007 with a slight depression in 2008 (Illustration 8).

Organic certification has to be viewed critically, too: As GONZALES and NIGH (2005) explain, standards applied to certify smallholders' production systems tend to be developed with regard to first world consumer interests and imposed in a top-down fashion by certification agencies and intermediaries, with little or no farmer participation. As a result, mainstream organic certification can be viewed as a means of increasing dependency of Southern countries on the rich nations of the North; a process that can be referred to as 'biocolonialism' (NELSON et al. 2010).

11 Most prominent was the "Tortilla crisis" in 2008

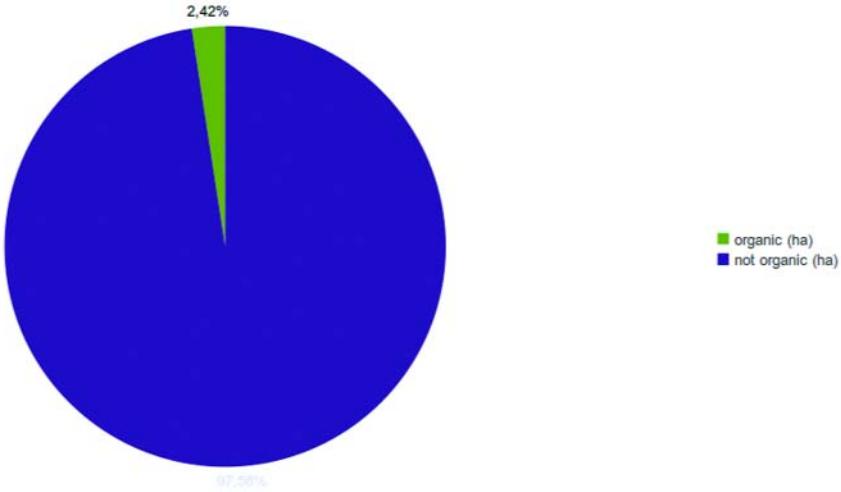


*Illustration 8: Proportion of certified organic area to conventional agricultural area in Mexico 2008 (WILLER 2012)*

### 2.6.2. Organic cacao cultivation in Tabasco

According to WILLER 2006, 2005 there were about 73,000 hectares of certified organic cacao plots worldwide with Mexico as second largest producer with 17,314 hectares (and a volume of almost 9,500 tons), mainly produced in Tabasco. For example, in 2005 a small Tabascan farmers' initiative called *Integradora Organicos de Chontalpa* had 2,336 hectares certified and 636 hectares in conversion. In their agroforestry systems, *Organicos de Chontalpa* were producing cacao with different varieties like the *Guayaquil*, *Ceylan* and *Criollo*. Its processing capacity totaled 2,400 tons annually, both for the national and the export market (WILLER 2006).

Beginning in 2001/2002, Tabasco's Government had started, with an investment of about 17 million pesos (approx. € 2 million at this time) in federal, state and regional resources, the conversion of conventional cacao plot into organic ones. By 2005 there were officially 10,982 ha of organic land cultivated by 6,475 producers (SEDAFOP 2006). Clear goals were defined by the organic promoters but difficulties arose about organic production, commercialization and organization. The stakeholders involved in developing the organic program took advantage of the low economic status of farmers who were not used to use much chemical input, therefore making certification easier. Most farmers participated for the subsidies or for a better product price. Other advantages of organic cultivation, for example the environment or human health, were not promoted, neither much technical assistance offered (MARTINEZ ARBOLEYA 2007).

The absence of technicians and a lack of resources in knowledge and actors of the organic net may have been one reason for the failure of this program, another top-down approach by the Government. There

is doubt the certification agencies have done enough to have the right to hand out certification to the farmers without teaching them about organic production. MARTINEZ ARBOLEYA 2007 uses the term *proceso de certificacion comprado* (bought certification process) that was necessary to enter into organic commercialization of cocoa because most organic farmers did not know the measures recommended for organic cacao production. As the technicians have not fulfilled their duty of monitoring and evaluating the project, many farmers started operating with agrochemicals again. There was little knowledge found about organic agriculture by MARTINEZ ARBOLEYA 2007, which is considered one of the most important factors of successful organic agriculture (see CRUCEFIX 1998: "Organic agriculture is more intensive in knowledge than conventional agriculture").

There is little confidence about the integrity of certification and the program of organic agriculture as such. Organic agriculture is believed as the absence of agrochemicals (but not giving input with other means). Another factor was the lack of a better price for organic cacao: In 2007, the price for one kilo of *cacao en baba* (cacao with pulp) was 5 pesos [12], for organic cacao it was 5.5 pesos [13] (MARTINEZ ARBOLEYA 2007). But the farmers expected a price of about 15 pesos [14] due to higher expectations by the certification agency who then argued that the extra price was not paid because of a lack of buyers in the international market.

# 3. Approach of this thesis

## 3.1. Problem statement

Reports about organic cocoa production are contradicting: while official figures indicate a high level of organic cocoa production, local stakeholders reported of a failed governmental measure and fraud. Another issue to address is to ensure that measures against pests and diseases taken by cacao farmers or other stakeholders often reveal a lack of knowledge regarding for example life cycles and habits of biotic pest organisms and synthetic products used against them. Especially with new diseases emerging in the last years (*Moniliophthora roreri*) and most probably in the future (*Moniliophthora perniciosa*) as well as changing pest populations in Tabasco's cacao orchards, building farmers' capacity could be a necessary measure.

12 5 Mexican pesos were worth about € 0.34 (01.03.2007) according to OANDA 2013

13 5.5 Mexican pesos were worth about € 0.37 (01.03.2007) according to OANDA 2013

14 About € 0,9 (01.01.2011) according to OANDA 2013

## 3.2. Research questions

- What are the properties of a pest-organism as defined by the interview-partners? What makes an organism a potential threat on cacao plots? What are the differences in perception of these organisms by high-input and by low-input cacao farmers?
- How can the relationship between the interviewed farmers and pests as well as diseases be described?
- What are the pests and diseases (as defined by the interview-partners) that are the most undesired? Why is that so? What are the measures taken against them by the interviewed farmers?
- What sources of information about pests and diseases are accessible to cacao farmers?

## 3.3. Objectives

This thesis aims at describing characteristics of cocoa production systems in Tabasco, especially regarding qualitative differences in 'pest-perception' between low-input/organic and high-input cacao farmers in the same region. The goal is to explore what are the differences between the two farming systems as far as it concerns farmers' perception of pest organisms and define how the concept "pest" or "disease" is described by the interviewees. Another objective is to highlight what kind of knowledge about pests and diseases exist.

# 4. Methods

## 4.1. Research region

The fieldwork was carried out in 18 different villages in Tabasco, a southern Mexican state. Seventeen of the villages were situated in four districts of the Chontalpa-subregion (Cárdenas, Cunduacán, Comalcalco and Huimanguillo) and one in Pichucalco, Chiapas, very close to Tabasco's border. The region was chosen because of its long cacao cultivating tradition and because it is the main cacao producing state in Mexico. Initial contacts were made through Dr. José Armando Alayón Gamboa and Rodimiro Ramos Reyes, both Co-supervisors of this thesis. The sampling method used was a mixture of snowball sampling (some interview-partners referred to others that were asked to be interviewed) and "accidental sampling" (cacao farmers who's cacao plots were observable from the main bus roads were asked if I can interview them).

### 4.1.1. Geography

The state of Tabasco is located between the Mexican states of Veracruz, Chiapas and Campeche and borders Guatemala. Geographically Tabasco is situated between 17°15' N and 18°39' N latitude 91°00' W and 94°07' W longitude. It is divided into 17 districts or municipios altogether with a total area of 24,738 km$^2$ and a total population of 2,238,603 people (INEGI 2012). These 17 *municipios* form 5 sub regions (Centro, Chontalpa, Sierra, Ríos y Pantanos) and 2 regions, called like their main rivers, Grijalva y Usumacinta (Illustration 9).

Most cacao plots visited are situated in the sub-region called *La Chontalpa* in Western Tabasco. According to the INEGI (2012) statistics of 2000 the Chontalpa region consists of 5 districts that make up together 31% of Tabasco's land area (7,606 km$^2$) and 38% of the population.

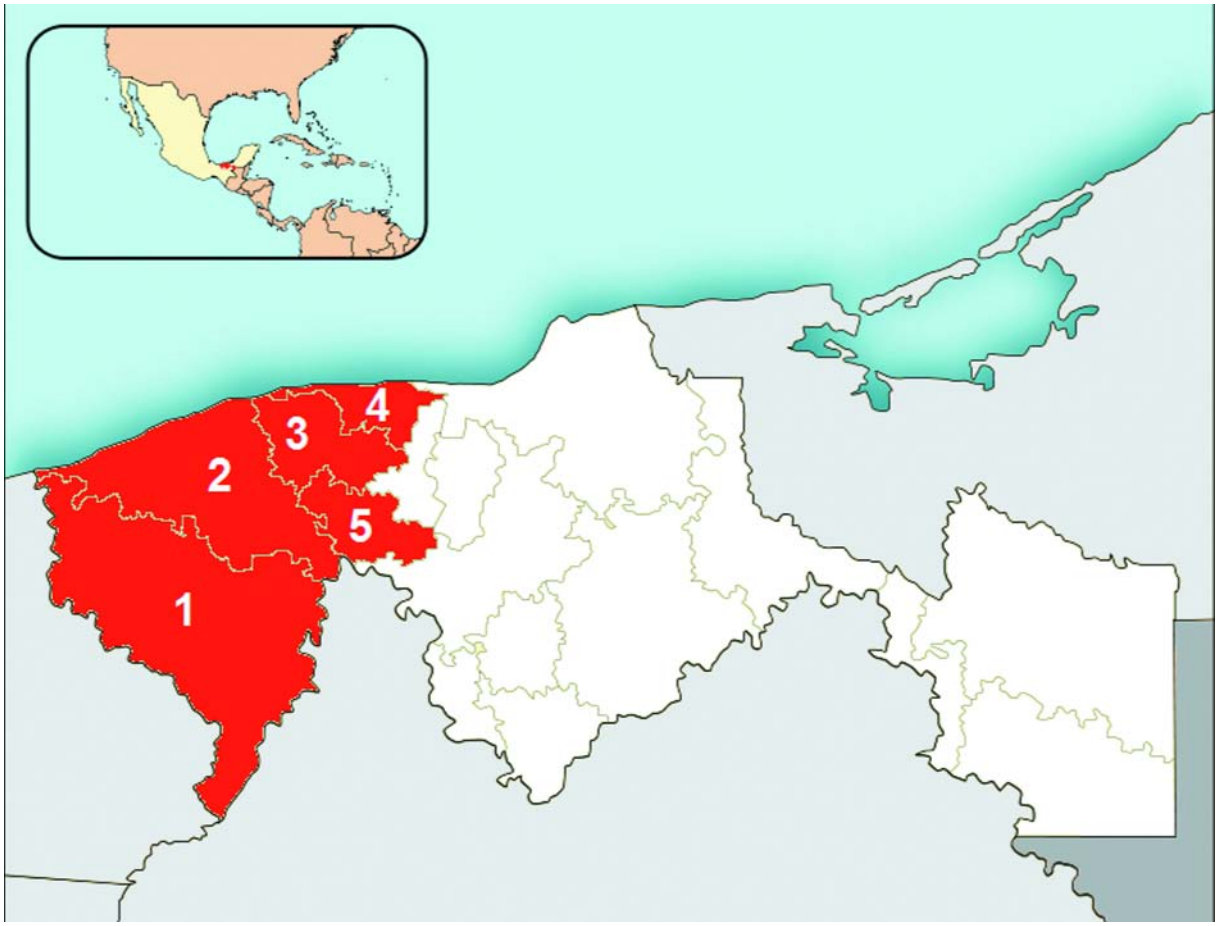


*Illustration 9: Map of the Subregion "Chontalpa" within the state of Tabasco, consisting of the districts Huimanguillo (1), Cárdenas (2), Comalcalco (3), Paraíso (4) and Cunduacán (5). (WIKIPEDIA 2012, licenced under Creative Commons 2012)*

### 4.1.2. Geology and Geomorphology

The major parts of the relief in the Chontalpa subregion are plains and lowlands; only in the border regions to Chiapas some elevations can be found. The area is characterized by depressions that are swampy and at risk of inundations because of the overpassing streams as well as for waters coming from heavy rainfalls and cyclonic perturbations (GOBIERNO DE TABASCO 2012).

### 4.1.3. Climate

Tabasco is located in a tropical zone where sun rays enter with a high intensity. This leads to a high temperature (around 26ºC as annual mean): the maximum is temperature of 42ºC. The climate is hot and humid with maritime influences form the Mexican Golf.

It is raining most time of the year, especially from June to March. The rainfalls are more intensive in summer while in autumn and winter the climate is characterized by the *nortes*. *Nortes* (or *el norte*) are thunderstorms with heavy winds from the Mexican Golfs – this is the season when inundations and floods are most likely. These storms are unimpeded by the low flat plain, with the elevations near the Chiapas border forming geologically the first barrier. Average precipitation sums up to 2170 mm per year (MARTINEZ BECARRA 2005). Generally, the dry season lasts from April to May, 2 months.

### 4.1.4. Soil conditions

Soils in the Chontalpa region are mainly Vertisols and Fluvisols, sometimes Gleysols and Cambisols as well as Acrisols and Regosols (CORDOVA AVALOS et al. 2010).

### 4.1.5. Hydrology

The average annual rainfall in Cárdenas sums up to 2240mm and the relative humidity measured is above 80% (OSORIO ARCE and SEGURA CORREA 2006). There are regions in Tabasco, especially near the border to Chiapas, where rainfalls sum up to 4000mm a year.

Tabasco is known as the State of "river people". The two main streams are the Rio Usumacinta with the highest water carrying capacity and the Rio Grijalva, the second largest river regarding the amount of water. These two rivers divide the Tabascan state into two regions. Through them and their affluents, water is carried to the Mexican Golf. Not part of this stream system are only a few rivers near the border to Veracruz in Western Huimanguillo, the small rivers in the Chontalpa region (which are feed by excess rainwater of the swamps) and the González river, a river channel separated of the Mezcalapa in the 19$^{th}$ century that drains to the sea through Chiltepec in the North of Tabasco.

The availability of water is based in the low basin of the rivers Usumacinta and Grijalva that accumulate water of numerous streams. The mean annual volume of water brought to the sea is 125.000.000.000 m$^3$ which represents 35 % of all Mexican currents. This results in wide river channels that inundate large areas and lead to the formation of shallow lagoons in the lower zones of the state.

The river courses were changed various times, the Grijalva River in 1675, 1882 and 1902 (SCHERR 1985), this led to migration into the affected regions, also because of less piracy attacks that affected the population before. The old Grijalva dried riverbed is today known as *Rio Seco* (Dry River), a region north of Cárdenas to where people (especially of the "Old Chontalpa" region) immigrated

because of its fertile soils. The Towns of Comalcalco (settled in 1827) and Paráiso (settled 1823) were right in the old riverbed. The region became prosperous and full of cacao by 1854 (SCHERR 1985).

In addition to rivers, the abundant rainfall produces and feeds large areas of lakes, marshes and other wetlands like lagoons. The flat areas of the region are highly susceptible to flooding, including the 2007 Tabascan flood. This flood was caused by unusually heavy rain in October, brought by multiple cold fronts – a record of 1,054 mm of rain in the region in only three days was recorded. However, significant flooding is relatively frequent with major events occurring in 2008, 2009 and 2011, especially in the months of September and November (GOBIERNO DE TABASCO 2012).

### 4.1.6. Vegetation

In Tabasco, there are six types of vegetation associations, inhabited by a total of 3766 known plant species (CAPELLO GARCIA et al. 2010):

1. The tropical rainforest (*la selva tropical lluviosa*);
2. the tropical savanna (*sabana tropical*);
3. the lower rainforest (*selva mediana y baja*);
4. the lower formations of the beach (*formaciones bajas propias de la playa*);
5. the Mangrove rainforest (*selva de mangles*);
6. and the swamp vegetation (*vegetación de pantano*).

In the research region the autochthon vegetation types are the evergreen tropical rainforest, the tropical Savannah and, to a lower extent, the lower rainforest and wetlands. The tropical rainforest is characterized by the abundant vegetation that prevents most of the sunlight from penetrating down to the soil. There are abundant rainfalls and very diverse vegetation. Tropical rainforest in Tabasco has been widely destroyed by humans for plant cultivation, grazing land for cattle or forest exploitation. Small parts can still be found in the *municipios* of Tenosique, Balancán, Macuspana, Teapa, Tacotalpa, Cárdenas y Huimanguillo, in the alluvial cones of the deltas and the riparian zones of the rivers. Common trees that can be found in the Tabascan rainforest are Mahogany or *caoba* (*Swietenia macrophylla*), the Cigar-box cedar or *cedro* (*Cedrela odorata*), royal palm or *palma real* (*Roystonea regia*), *jobo* (*Spondias mombin*), *macuilís* (*Tabebuia rosea)*, *ceiba* (*Ceiba pentandra*), *tatúan* (*Colubrina arborescens*), rubber tree or *árbol de hule* (*Castilla elástica*) and many more. There are shrubs and herbs like *capulín* (*Prunus virginiana*), Araceaes, ferns and orchids.

The tropical Savannah can be seen as the continuation of the rainforest and its typical used by humans for cattle grazing. It is characterized by extensive, open terrain where the dominant vegetation consists of herbs and pastures. This vegetation type can be found in the South of Tabasco, located in the plains

where the rivers flow together. Typical plants are palm trees, Brazilian pawpaw or *anona* (*Annona muricata*), savanna serrette or *nance* (*Byrsonima crassifolia*), the calabash tree or *jícaro* (*Crescentia cujete*), vines and climbing plants. This plant association is less compact as the rainforest vegetation but does also include a lot of species. The lower rainforest in Tabasco has suffered many invasions by humans: use for agriculture like slash and burn cultivation for pastures or forest clearing, especially for timber species. There still exist some small areas of lower rainforest near the coast, around the dry and sandy lands that border the beach. Typical elements of this vegetation are, among others, the coco palm (*Cocos nucifera*), royal palm (*Roystonea regia*), *guácimo* (*Guazuma ulmifolia*) and *jobo* (*Spondias mombin*) (GOBIERNO DE TABASCO 2012).

### 4.1.7. Fauna

The Tabascan Fauna can be grouped into nine association types according to the ecological zones: the tropical rainforest, *acahual*[15], Savannah, Swamp, herbaceous landscapes, fresh water, the Swamps of Shrubs, the Mangrove Swamps and salt water Lagoons.

There are 1612 animal species described in Tabasco of which 33,4% are birds (CAPELLO GARCIA et al. 2010). In the Chontalpa region the fauna consists, according to the vegetation types, of animals of the tropical rainforest, pastures, *acahuales* and the wetlands (due to the weak drainage of some areas). Mammals like the Virginia Opposum or *tlacuache* (*Didelphis virginiana*), ferret or *hurón* (*Mustela putorius furo*), raccoons or *mapache* (family Procyonidae), the ring-tailed cat or *cacomixtle* (a felidae of the genus *Bassariscus*), *armadillos* (family Dasypodidae), rabbits (family Leporidae), Pocket gopher or *tuza* (rodent of the family of Geomyidae), spider monkeys (genus Ateles) and the mantled howler or *sarahuato* (*Alouatta palliata*) are native here. Various species of wild birds can be still found, e.g. the sparrow-hawk or *gavilán* (family of Accipitridae), true parrots or *loros* (superfamily Psittacoidea), *cotorro* (family Psittacidae), woodpecker or *carpintero* (family Picidae), mockingbirds or *cenzontle* (family Mimidae) and hummingbirds or *colibrís* (family Trochilidae).

Snakes, turtles and iguana lizards are common as well as a wide range of insects like ants, butterflies and wild bees (GOBIERNO DE TABASCO 2012).The biodiversity in Tabasco is, despite its intensive way of land use, still quite diverse even though human activities like deforestation, expansion of the intensive cattle ranching, intensification of agricultural activities, urbanization and petrol exploration do have severe impacts on the habitats and therefore carry the danger of extinction to some species (GARCIA et al. 2010).

15 The "*acahual*" is a type of fallow vegetation that consists of plants with high and thick stems. They are areas of tropical ssecondary vegetation where rainforests have been cleared to gain land for agriculture.

### 4.1.8. Population

The total population of Tabasco, according to INEGI (2012), the *Instituto Nacional de Estadística y Geografía* (National Institute of Statistic and Geography), was 2,238,603 persons in the year 2010. Population density is with 91 people per $km^2$ much denser than the national average of Mexico with 57 persons per $km^2$. 17.95% of the working population is occupied in the primary sector whereat this figure consists of 24.4% of all occupied Tabascan men and only 3.29% of all occupied Tabascan women. There are slightly more women in Tabasco's population (96.7 men to 100 women).

### 4.1.9. Economy

Tabasco, especially the western part, is a so-called *zona petrolera*, a petroleum rich zone that suffers a great exploitation of its crude oil reservoirs. The Tabascan GDP is fed mainly by secondary activities (63.8%), over all mining of oil, gas and Sulfur. The oil and gas mining is performed by PEMEX (*Petroleros Mexicanos*), a parastatal institution. The primary sector makes only a very small share of the state's income, 1.6% (INEGI 2012).

### 4.1.10. Land use and cacao cultivation

Cacao is mainly cultivated in the districts of Comalcalco, Cárdenas, Cunduacán, Huimaguillo, Jalpa de Mendez and Paraíso (Table 3). The cacao production of these six districts in 2007 totaled 97% of Tabasco's total cocoa Production (INEGI 2012). In the Tabascan State official figures indicate that there are 40,833 ha of cacao, on which 31,139 families do depend. They are distributed in 368 villages in the regions of "La Chontalpa" and "La Sierra" (CESVETAB 2012).

*Table 3: ha of cacao in Tabasco (CESVETAB 2012)*

| Municipio | ha of cacao |
|---|---|
| Cárdenas | 10654 |
| Centro | 306 |
| Comalcalco | 10894 |
| Cunduacán | 8740 |
| Huimanguillo | 5495 |
| Jalpa de Méndez | 2812 |
| Nacajuca | 37 |
| Paraíso | 1465 |
| Tacotalpa | 167 |
| Teapa | 263 |
| **Total** | **40833** |

Other important agricultural sectors in the Chontalpa region are extensive cattle ranching and the cultivation of sugarcane and plantain.

## 4.2. Data collection

Data was obtained via semi-structured interviews (BERNARD 2011:228), free lists (BERNARD 2011:319) and seasonal calendars (CATLEY et al. 2002). Semi-structured interviews with closed and open-ended questions in a questionnaire were used to obtain qualitative data, free listing for relevant cacao pests and diseases in general (according to QUINLAN (2005) "freelists are more efficient for generalized topics"). For free-listing, the interview-partners were asked to state all pests and diseases of cacao in the region. In the first interview, I tried to get two different freelists, one for pests and one for diseases but as they got mixed up by the respondents, these two aspects were combined from the second interview on. Seasonal calendars were valuable tools to place the different activities in the cacao plots to a certain time in the year as well as for social interactions as most of my interview-partners stated that they liked visualizing their tasks (Table 4).

*Table 4: Data obtained from the interview-partners*

| Method | n performed | n used for analyzes | Interview-partners |
|---|---|---|---|
| Semi-structured interviews | 32 | 31 | All (P1-P32) except P3 |
| of which were transcribed | 25 | 25 | All except P3, P7, P11, P14, P15, P20, P24 that were not recorded but analysis based on written notes and questionnaire |
| Group interviews | 2 | 0 | Not included (P33-P40) |
| freelists | 29 | 29 | All except P3,P22,P27 (not performed) |
| Seasonal calendars | 20 | 19 | All except P3, P4, P10, P11 P12, P15, P23, P25, P26, P27, P30, P31, P32 (not performed) |

## 4.3. Language

I had doubt about using the word *plaga* (pest) in the questionnaires as this (technical) term already implies something negative. I finally decided to use *plaga* (instead of describing e.g. animals that disturb production) after I spoke to my first interview-partner who assured me that *plaga* is a widely used word among cacao farmers and is the one used when farmers speak among each other.

All interview-partners used Spanish as their first language so interviews were held and transcribed in Spanish by me. Even though my Spanish skills are quite good, the possibility of errors due to language cannot be entirely excluded.

Commonly used terms as *plaga* (pest) and *enfermedad* (disease) were embedded into the text. When it was unclear to what plants, animals or diseases a local name referred, I had help of MsC. Ramos Reyes and the interviewed farmers themselves who helped me to specify the organism. I could then search in literature for the scientific names (WEST et al. 1985, SANCHEZ SOTO 1992, MARTINEZ ARBOLEYA 2007 and CORDOVA AVALOS et al. 2010).

## 4.4. Data storage

Data was stored on the laptops internal and external hard disks as well as on the audio recorder and notes I took during the interviews, together with the filled questionnaires. Calendars were photographed and left with the interview-partners.

## 4.5. Data analysis

The interviews were transcribed using the free software F4 (DRESING and PEHL 2011) and coded with Atlas.ti Version 5.7.1. (FRIESE 2012). Codes were developed due to the research questions and hypotheses made before, potential quotes of the interview-partners highlighted. Statistical analysis of quantitative data was conducted with the open-source program GnuPSPP with, if not stated otherwise, a confidence interval of 95%. Tests used for quantitative parametric data were the Independent Sample T-test and the Paired Samples T-test to compare means, for nonparametric quantitative data the Fisher's Exact Test and the Likelihood-Ratio (BERNARD 2011).

To evaluate free-lists Anthropac (BORGATTI 1996) was used. Free listing can be used as tool to define a certain Cultural Domain. Cultural domain analysis is used to investigate how a culture understands its environment (KRAUSE et al. 2010). The cultural or cognitive domain of interest in this thesis is pests and diseases. The domain is defined by what people in a given culture consider as pest or disease. There are more tools for analyzing cultural domains in depth, like triad tests, pile sorts or paired comparison that were not used in the investigation – freelists seemed as an appropriate tool to get an overview of the different items grouped into the cultural domain "Pests and Diseases in Cacao in Tabasco" For that purpose 29 of my interview-partners were asked to name all pests and diseases (both combined in one list) in cacao plots they could think of. The freelists were then analyzed with Anthropac to obtain frequencies (how often a certain item is named), ranks (in which order) and salience, a variable that combines rank and frequency (Illustration 10). In theory, items that make up the "core set" of the cultural domain will be named first and more often (BORGATTI 1996). After obtaining the freelists, open-ended questions in the interview followed. One open-ended question asked

was “What pests and diseases do you have in your cacao plot?” which should led to more specific information about pests and diseases in this one plot whereas the freelisting should carve out the whole spectrum of pests and diseases in the region. Before analyzing the freelists, synonyms and unclear items were cleared.

The question “What is a pest?” led to various answers. The question itself was interpreted differently by the interview-partners. Some started to list the various pests and diseases they consider *plagas* like they did before in the freelist, others were not sure what to answer as the question itself was, by default, not very explicit. I tried to design the questionnaire in a way that throughout the interview more chances were given to shape the personal meaning for the interview-partner of the word pest.

For the section “Attitude towards pests, diseases and agrochemical input”, statements of the interviewed farmers were analyzed with the aim to detect common or distinctive perspectives towards certain topics (AREAL et al. 2011). Thereby it has to be mentioned that results that refer to ‘attitudes’ as well as ‘perceptions’ of the interview-partners, terms that are used frequently in this thesis, are only based on statements given by the interview-partners in the one interview that was performed with each respondent.

$$s_j = 1 \ \frac{r_j 1}{n 1}$$

$$s_j = \frac{n \, r_j}{n 1}$$

*Illustration 10: Saliency index used by Anthropac, where rj = position of item j in the list, and n = number of items in the list (BORGATTI 1996)*

## 4.6. Material and Equipment

Recorder, camera, pencils, prepared empty calendars and paper were used in the field as well as a laptop to process data.

## 4.7. Permission

No permissions from any authority were needed. The interview-partners were asked for their cooperation, time and knowledge and decided if they wanted to be interviewed or not.

## 4.8. Consideration of ethics issues

It is a common problem that knowledge that is “taken away” does not contribute to people’s live in the research region. This should be avoided by sharing the results of this thesis with at least two research institutions located in Tabasco: The EcoSur Unit in Villahermosa as well as the Colpos (*Colegio de los Posgrados*)

in Cárdenas. The interview-partners were given my email address and telephone number to contact me if they are interested in the results and of the ones that handed me their email a copy of this thesis will be sent.

## 4.9. Difficulties

There were some difficulties to overcome during my research in Mexico. One major problem was the search for organic cacao cultivators as the organic cacao sector is in general not well perceived in Tabasco. My questions for organic farmers often lead to the answer that it does not exist anymore (the problems concerning organic cacao in Tabasco will be explained later in this thesis). My presence, being an obvious foreigner may have been perceived ambivalent: on the one hand, there was sometimes obvious suspicion that I may be from the government or another organization and some cacao farmers may have doubted my intentions. On the other hand I was welcomed very hospitably and people seemed very open when I explained my research. Another obstacle was the insecure safety situation in Mexico in general and in Tabasco. During most of my stay in Tabasco there was military curfew at night and various incidents related to the so-called *narcos*[16] that led to a tense atmosphere, especially in Cárdenas and its surrounding areas where according to rumors the Zeta cartel and the Golf cartel struggled for power.

## 4.10. Data management

To analyze the interviews two groups were compared: One group is formed of farmers who use agro-chemical pesticides and synthetic fertilizers on a regular basis, I will call them "G_highinput". This group is relatively homogeneous even though their reasons for pesticide use may differ from farmer to farmer.

The other group is called "G_lowinput/organic". This group is far more diverse as it includes so-called traditional farmers without pesticide use, certified and non-certified[17] organic farmers as well as farmers that simply cannot afford the agrochemical input but would apply it if given the financial means. The two farmers P28 and P30 were included in this group because, even though they used insecticides in the season 2010/2011, they joined an organic program just a few days before interviewing them.

16 *narcos* is the Mexican term used to describe drug cartels that influence Mexican society on all levels and are known to be very violent. The "war on narcos", initiated by President Felipe Calderón in 2006, has led to more than 50,000 official victims by 2012.

17 The difference between traditional and non-certified organic farmers (as defined in this thesis) that non-certified organic farmers are more or less aware of the organic principles of cacao cultivation and work along these rules but are not certified by an internal or external organic inspector.

## 4.11. The cacao producers (research partners)

### 4.11.1. Attempt to characterize the interview-partners (G_lowinput/organic)

#### 4.11.1.1. P1

P1 is a 42-year-old teacher who cultivates 11 ha of cacao. He lives together with his family in Cárdenas and his cacao plots are situated out of the city in the Rio Seco area at his parents' house. He studied Agronomy and obtained a Bachelor's degree. His bachelors thesis, that he finished in 2008, was about the disease Frosty pod. He is very concerned about pollution and pesticides and believes them to provoke cancer which he considers a serious problem in Tabasco. Even though he cultivates his cacao organically he is not eager to certify his product because there are no better prices to achieve as a result.

#### 4.11.1.2. P2

P2 is a 65-year-old female plot owner. She inherited 2 ha of cacao from her mother. She leaves most of the cultivation details to her daughter as well as her workers; she says that they know much about the cacao plant and its cultivation. On her plot no insecticides are applied since her mother's death 20 years ago because they are too expensive.

#### 4.11.1.3. P5

P5 may be the "economically most successful" cacao plot owner as she cultivates *neo-criollo* cacao that is exported to the USA, Canada and Europe. She inherited the cacao plot from her father, together with already existing export partners. She is used to visitors, scientists and facilitation workers that ask her about her special breed (*Carmelo*) or investigate on her cacao plots. She already won prizes for her cacao, has the most technologized cultivation (tractor, irrigation) and performs value-adding processes on her farm together with ten all-year-round hired workers (harvest, fermenting, drying, packaging for export as well as chocolate producing for the local market). In addition to 13 ha of certified organic cacao she cultivates conventional sugarcane. She states that for the market, organic production is important, but more significant is the breed.

#### 4.11.1.4. P11

P11 is a 59-year-old female farmer who owns 1.5 ha of cacao. She stated that some years ago, she and her husband cultivated 7.5 ha but due to economic reasons and Frosty pod they decided to reduce the cacao cultivating area. What is left is not cultivated intensely anymore, and except for weeding and pruning once a year no further tasks are performed.

#### 4.11.1.5. P12

P12 is 52-year-old male farmer and has 1 ha of very old cacao trees (50 years) that he inherited. He works as a *jornalero* in different jobs and does not cultivate his trees intensely anymore. Apart

from cacao he owns 0.25 ha of beans and maize for self-consumption as well as cattle which is the family's main income.

#### 4.11.1.6. P19

P19 is a 58-year-old male farmer with 10 ha of cacao who cultivates sugarcane, as well as maize for self-consumption. He has about 50 turkeys and chicken that run in and around the cacao plots near his home. He is convinced that the petrol-related pollution causes acid rains that harm his trees and joined the organic farmers in his village. He stated that he has not used insecticides for more than 20 years.

#### 4.11.1.7. P21

P21 is a 65-year-old male farmer who cultivates 5 ha of cacao. He is a member of a local organic group but he is not convinced anymore, as, in spite of the promise of a better income, prices for organic cacao remained the same or even less. He is very religious and it is important to him to work with, not against, nature.

#### 4.11.1.8. P22

P22 is a 75-year-old female farmer who is active in a local organic group. Together with her husband she cultivates 5 ha of organic cacao but is disappointed about the organic program and thinks of leaving the group, mainly because of not receiving any better prices.

#### 4.11.1.9. P23

P23 is a 73-year-old male farmer who has cultivated cacao all his life. He is secretary of the organic organization in his hometown and fond of the organic idea, although it had not brought him any economic advantages. He is very religious, is concerned about the environment and stated that he had various accidents with pesticides in the past that caused him to have a permanent headache. He has no potential successor for his cacao plots, a fact that bothers him.

#### 4.11.1.10. P25

P25 is a 72-year-old male farmer and is the brother-in-law of P19, both members of the same organic group. P25 and his wife seemed very relaxed during the interview, lying in a hammock between two cacao-trees next to the house. Both of them have cacao and cultivate it together, assuring that both of them make decisions together. While he is more a technically-interested farmer that tries out new measures against Frosty pod like antagonistic fungi, his wife likes to intercrop the cacao trees with many different vegetables, fruits and flowers.

#### 4.11.1.11. P26

P26 is the only Chiapanec farmer I interviewed for this thesis. He is 66, very active and showed me his cacao with pride. He would like to use pesticides but for years he did not have the economic means to do so. In the village next to where he lives, the first Frosty pod infected Mexican cacao pod was found and identified as such in 2005.

#### 4.11.1.12. P27

P27 was interviewed when he was standing on a ladder, pruning cacao trees. He was very talkative, telling me how he started his cacao plot 20 years ago. He is not organic, but does not use insecticides anymore because he stated that they do burn the cacao flower and are expensive.

#### 4.11.1.13. P28

P28 joined the organic organization in his village just a few days ago together with P30. He is 50 years old, has a grocery shop where the families main income comes from and cultivates together with his wife 4.2 ha of cacao. He expects to get a better price (once he passes the conversion time to organic) and help from the organic promoters in the region.

#### 4.11.1.14. P29

P29 is a 75-year-old, male farmer and lives next to P28. He joined the same local organic organization 4 years ago, paying 400 pesos (about € 25) per ha per year for certification. For him, it also did not make a big difference as prices remained the same.

#### 4.11.1.15. P30

P30 joined an organic group a few days before the interview. He has 4 ha of cacao, is 82 years old and expects better prices than he is getting.

#### 4.11.1.16. P31

P31 is a 60-year-old pastoral assistant in an evangelic church who owns 16 ha of cacao. He is not certified as an organic producer but is very concerned about the environment as he sees nature as a gift of God that has to be taken care of. He refuses to use insecticides and talks about problems with petrol-related contamination. He reads a lot about cacao cultivation.

### 4.11.2. Attempt to characterize the interview-partners (G_highinput)

#### 4.11.2.1. P3

P3 is a 74-year-old plot owner who also produces chocolate products that she sells on her farm and in a small shop in Villahermosa (managed by her daughter-in-law). Interviewing her was, even though very interesting, though difficult – so this interview was excluded from the data analysis.

#### 4.11.2.2. P4

P4 is a 55-year-old farmer who has worked as a facilitation agent for the SAGARPA[18] until going into pension last year. He knows very well about pesticides in cacao as it has been his job to teach farmers

18 The SAGARPA (*Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*) is an official Mexican institution responsible for agriculture, livestock, fishery, alimentation and rural development (can be regarded as the Mexican agriculture ministry).

about them. When I met him, he complained about headaches because of the use of insecticides in the last days and that he should be more careful. He cultivates 2 ha of cacao.

#### 4.11.2.3. P6

P6 is a 95-year-old male farmer but despite his advanced age very active. He still works as much as he can in the 4.5 ha of cacao, which he cultivates with the help of his family, especially his sons.

#### 4.11.2.4. P7

The interview with P7 (male, 47 years old) was a little difficult for me. I fixed a date and time but when I came he was not there. So I spoke with his son and a worker who were drying fermented cacao beans with gas until he arrived one and a half hours later. The family owns 5.5 ha of cacao and buys cacao *en baba* (wet cacao) from other farmers, processes it and sells the fermented and dried beans to the UNPC.

#### 4.11.2.5. P8

P8 is a 40-year-old female farmer who owns 1.5 ha of cacao. Her husband works and she is at home, looking after the children and takes care of the cacao and fruit trees. She has help from her sons and brother-in-law.

#### 4.11.2.6. P9

P9 is a 73-year-old male farmer who lives together with his family next to 1.5 ha of cacao. Normally he cultivates the plot alone but in times of harvest or weeding, the whole family is helping.

#### 4.11.2.7. P10

P10 is a 40 year-old construction worker that cultivates together with his wife 0.5 ha of cacao, next to his house. He states that his wife does most of the work together with her brother (who owns a big plot himself). The brother-in-law is in charge of pest control.

#### 4.11.2.8. P13

P13 is a very active, 71-year-old male farmer who had a lot to say about politics and cacao cultivation practice. He showed me his plot and explained a lot about the shade trees and weeds on his property.

#### 4.11.2.9. P14

P14 is a 63-year-old, very open-minded farmer. He was not surprised by my question for an interview but stated that as his plot is next to the main street, people (researchers, technicians and, as he proudly stated, once even an Italian tourist) come quite often to him and wanted to talk about his cacao orchard.

#### 4.11.2.10. P15

This 58-year-old male farmer who has participated in an organic group but decided to leave the group because “it did not give me results nor higher prices”.

#### 4.11.2.11. P16

P16 is a 58-year-old male farmer who cultivates 7.5 ha of cacao and processes cacao-beans of other farmers. He is very concerned about the high criminality and fears kidnappers and robbery.

#### 4.11.2.12. P17

P17 is a 47-year-old male farmer who started cacao cultivation on 3 ha ten years ago. Additionally he has maize and poultry for self-consumption. He and his wife were part of a local organic group but became soon deeply disappointed because, as he stated: “we paid a lot of money for nothing”. He now returned using pesticides and fertilizers.

#### 4.11.2.13. P18

He is a 78-year old cacao and sugarcane farmer. As he has health problems his sons have to help him in the field but he still likes to go there. He laments governmental and Union corruption which is a severe problem in his view.

#### 4.11.2.14. P20

P20 (a 34-year-old male) was the youngest farmer interviewed. The family’s main income comes from his working in the cacao plots of his neighbor, but the family does own 1 ha of cacao which he and his wife cultivate together with the advice of his uncle.

#### 4.11.2.15. P24

P24 is a 67-year-old, very active woman who owns 6 ha of cacao trees and buys and processes cacao from other farmers. Additionally, she runs a well-going fish (*Mojarra*) business. She, her daughter and her son share responsibility for the different enterprises.

#### 4.11.2.16. P32

P32 is a 50-year-old male cacao farmer (with 1.5 ha of cacao), who sells cacao saplings and cultivates sugarcane. He likes to cultivate cacao but is unhappy with the UNPC and its price policy.

## 4.12. Socioeconomic factors

The average age of the interview-partners ($n=31$) is 61 years. At the time of the interviews, the youngest cacao farmer (P20) was 34, the oldest (P6) was 95 years old. Within the two groups there is no significant ($p_{(T\text{-}test)}=0.21$) difference in age: the average age of G_highinput is 57.9 years, the average age of G_lowinput/organic is 64.5 years (Table 5).

*Table 5: Individual socioeconomic factors for G_highinput (A, n=15) and G_highinput (B, n=16) cacao farmers*

| Factor | A | B | Statistical test |
|---|---|---|---|
| **Sex** | | | |
| female | 2 | 4 | Fisher's Exact Test: df=1, p=0,36[a] |
| male | 13 | 12 | |
| **Age in years** | | | |
| Arithmetic mean | **57.93** | **64.31** | T-test: df=29, p=0,21[a] |
| whereby: | | | |
| <40 years old | 1 | 0 | |
| 40 to 60 years old | 8 | 6 | |
| 61 to 80 years old | 5 | 9 | |
| >80 years old | 1 | 1 | |
| **Marital Status** | | | |
| married | 12 | 14 | Fisher's Exact Test: df=1, p=0,47[a] |
| widowed | 3 | 2 | |
| **Householdsize** | | | |
| Arithmetic mean | **4.67** | **3.77** | T-test: df=26, p=0,98[a] |
| whereby | | | |
| 1 to 4 persons | 6 | 4 | |
| >4 persons | 9 | 9 | |
| Missing answers | 0 | 3 | |
| **Householdmembers working outside agriculture** | | | |
| yes | 9 | 8 | Likelihood Ratio: df=1, p=0,88[a] |
| no | 5 | 5 | |
| Missing answers | 1 | 3 | |
| **Cacao as principal source of income** | | | |
| yes | 7 | 3 | Fisher's Exact Test: df=1, p=0,18[a] |
| no | 5 | 7 | |
| Missing answers | 3 | 6 | |
| **Experience in cacao cultivation** | | | |
| since childhood | 7 | 12 | Fisher's Exact Test: df=1, p=0,06[a] |
| Cacao started as a new business | 8 | 3 | |
| Arithmetic mean (years ago when started as a new business) | **19** | **23.33** | T-test: df=9, p=0,59[a] |
| Missing answers | 0 | 1 | |

[a] Difference not statistically significant on an α=0,05 Level

Of the 31 interviews, six were carried out with women. This is not sex-balanced but even though I may have already been biased to interview more women, most of the cacao farmers I met were men. The women interviewed all had male (paid or non-paid) manpower for at least some tasks in the cacao plots. Two of the female farmers are placed in G_highinput, four into G_lowinput/organic. There is no significant difference regarding sex ratio between the groups ($p_{(Fisher's\ Exact\ Test)}$=0.68). The average

household size of all my interview-partners was 4.25 persons. There was no significant difference in household size between the groups (G_highinput: 4.7 persons; G_lowinput/organic: 3.77 persons, $p_{(T\text{-}test)} = 0.98$) and it ranged from 1 to 9 persons. All of the interview-partners were married or widowed (no significant difference between the groups, $p_{(Fisher's\ Exact\ Test)} = 0.57$) and all of them had children. The question: "Do you or anybody of your household work outside your home or your plots?" was aimed to get an idea of how much time the interview-partners and their families spend in other activities and if cacao cultivation alone allows them to earn a living. Between the G_highinput and G_lowinput/organic there was no significant difference ($p_{(Likelihood\ Ratio)} = 0.88$). Ten interview-partners' households did not have an additional income from wage labor, from four respondents I did not obtain an answer. From the interview-partners that do have at least one household member earning a salary (17 answers), seven do work themselves, five have working spouses and ten had children who contribute to the household's income (multiple answers were possible). Cacao was stated as the principle source of income for seven farmers of G_highinput and only three of G_lowinput/organic (showed no significant difference between the groups, $p_{(Fisher's\ Exact\ Test)} = 0{,}18$) whereby pensions and financial support from family members was most prominent. Income from cacao cultivation alone would not provide for a living for six G_highinput and eight G_lowinput/organic farmers (no statistically significant difference $p_{(Fisher's\ Exact\ Test)} = 0{,}10$).

# 5. Results

## 5.1. Appearance of the cacao plots

### 5.1.1. Size

The cacao plots' size of the 31 interview-partners ranged from 0.5 ha to 16 ha and had an overall average size of 5 hectares. It is important to mention that the question asked "How many hectares of cacao do you have?" included property and *ejidos*[19] where cacao trees were present as the main crop, whether they were cultivated, newly-planted or abandoned plots. There is a significant difference ($p_{(T\text{-}test)} = 0.03$) in size between the plots of G_lowinput/organic and G_highinput: the average size of the cacao plots of the G_lowinput/organic farmers is 5.92 ha, of G_highinput 3.43 ha (Table 6).

### 5.1.2. Age of cacao trees and renovation

The age structure of cacao trees varies from newly-planted plots to trees that are over 60 years old in some plots. One interview-partner (P1) confirmed that cacao trees can be cultivated until they are 70 years old but the most productivity is reached with trees around 20 years old and declines when trees reach the age of forty. Most of the cacao farmers do have plots with mixed aged trees; dead or weak

19 The *ejido* is an area of communal land used for agriculture. Each member of an *ejido* community possesses and cultivates individually a parcel of land.

*Table 6: Factors concerning the appearance of cacao plots of the farmers of G_highinput (A, n=15) and G_lowinput/organic (B, n=16)*

| Factor | A | B | Statistical test |
|---|---|---|---|
| **Land property** | | | |
| hectares (arithmetic mean) | **3.43** | **5.92** | T-test: df=29, p=0.03* |
| **Age of the cacao trees (years)** | | | |
| arithmetic mean (years) | **27.33** | **27.79** | T-test: df=27, p=0.37[a] |
| Missing answers | 0 | 2 | |
| **Variety of cacao (number)** | | | |
| 1 variety | 2 | 2 | Fisher's Exact Test: df=2, p=0.91[a] |
| 2 to 3 varieties | 7 | 9 | |
| more than 3 | 1 | 2 | |
| missing/no clear answer | 5 | 3 | |
| **Crops grown in cacao plantation for self consumption** | | | |
| yes | 11 | 10 | Fisher's Exact Test: df=1, p=0.92[a] |
| no | 2 | 2 | |
| Missing answers | 2 | 4 | |
| **Number of species of trees in cacao plantations (except cacao)** | | | |
| number species (arithmetic mean) | **5.4** | **7.13** | T-test: df=28, p=0.40[a] |
| Missing answers | 0 | 1 | |
| **Cultivated species in cacaotal (except cacao)** | | | |
| number species (arithmetic mean) | 6.33 | 7.87 | T-test: df=28, p=0.28[a] |
| Missing answers | 0 | 1 | |

[a] Difference not statistically significant on an $\alpha = 0{,}05$ Level
* Difference statistically significant on an $\alpha = 0{,}05$ Level

trees are replaced with young ones if possible. I asked for the age of the majority of cacao trees in their plots and if possible an average was made. The overall age average of my interview-partners' cacao trees was 27 years but this figure is more a rough estimate as many farmers were not sure about the age of their trees and many had various plots with trees of different ages. There was no significant difference between the groups ($p_{(T\text{-}test)} = 0.37$).

### 5.1.3. Varieties of the cacao trees

The interview-partners were asked to state of which varieties their cacao trees are (multiple answers possible). The most popular variety was *Guayaquil*, a breed of Forastero cacao that was introduced into Tabasco in the 70s. *Injerto* is a new Forastero type that is propagated mainly by the INIFAP[20] and they tried to combine high yields with resistance against *M. roreri*. *Ceylan* and *Patastillo* are Forastero types while the *Criollo* is an indigenous Tabasco breed but not widely cultivated any more (except by one

20 *Instituto Nacional de Investigaciones Forestales y Agropecuarias*, is an official Mexican research and facilitation institution.

farmer (P5) who specializes in this variety and further developed it [*Neo-Criollo*]). Plots are often mixed with different varieties of cacao-trees.

### 5.1.4. Shade trees and vegetation

In total, 44 different tree species growing in their cacao plots were mentioned by all interview-partners and 24 species mentioned at least by two different interview-partners (Table 7). I did not record the shade trees on the plots directly, but asked my interview-partners; so it is very probable that there are even more different species within the cacao plots.

*Table 7: Shade trees, mentioned in at least two interviews, growing in the interview-partners' plots according to the interview-partners' information. Only those species mentioned > 2 times, i.e. by at least 2 respondents are mentioned here (G_highinput: A,n=15 and G_lowinput/organic:B,n=16).*

| Spanish name | *Latin name* | Familiy | Use | A | B | total |
|---|---|---|---|---|---|---|
| Cedro | *Cedrela odorata* | Meliaceae | Timber | 9 | 9 | 18 |
| Cocohíte | *Gliricidia sepium* | Fabaceae | Fertilization | 7 | 10 | 17 |
| Chipilcohite | *Diphysa robinioides* | Fabaceae | Fertilization | 7 | 9 | 16 |
| Moté | *Erythrina americana* | Fabaceae | Fertilization | 8 | 6 | 14 |
| Plantano | *Musa sp. (M. acuminata)* | Musaceae | Fruit | 7 | 6 | 13 |
| Caoba | *Swietenia macrophylla* | Meliaceae | Timber | 4 | 7 | 11 |
| Maculís | *Tabebuia rosea* | Bignoniaceae | Timber/Ornamental | 5 | 5 | 10 |
| Aguacate | *Persea americana* | Lauraceae | Fruit | 5 | 5 | 10 |
| Naranja | *Citrus sinensis* | Rutaceae | Fruit | 5 | 5 | 10 |
| Mango | *Mangifera indica* | Anacardiaceae | Fruit | 3 | 5 | 8 |
| Tatuán | *Colubrina arborescens* | Rhamnaceae | Timber | 3 | 4 | 7 |
| Chinin | *Persea schiedeana* | Lauraceae | Fruit | 1 | 6 | 7 |
| Zapote | *Pouteria sapota* | Sapotaceae | Fruit | 3 | 2 | 5 |
| Guanabana | *Annona muricata* | Annonaceae | Fruit | 1 | 3 | 4 |
| Castaña | *Artocarpus altilis* | Moraceae | Fruit | 1 | 3 | 4 |
| Limón | *Citrus limonia* | Rutaceae | Fruit | 2 | 2 | 4 |
| Coco | *Cocus nucifera* | Arecaceae | Fruit | 2 | 1 | 3 |
| Nance | *Byronima crassifolia* | Malpighiaceae | Fruit | 2 | 1 | 3 |
| Pan de sopa | *Artocarpus camanis* | Moraceae | Fruit | 1 | 2 | 3 |
| Pataxte | *Theobroma bicolor* | Malvaceae | Fruit | 2 | 1 | 3 |
| Guayaba | *Psidium guajaba* | Myrtaceae | Fruit | 0 | 3 | 3 |
| Ciruela | *Spondias sp.* | Anacardiaceae | Fruit | 1 | 2 | 3 |
| Quninquil | *Inga jinicuil* | Fabaceae | Fertilization | 0 | 3 | 3 |
| Palma real | *Roystonea regia* | Arecaceae | Ornamental | 2 | 0 | 2 |
| Saman | *Pithecelobium saman* | Fabaceae | Fertilization | 1 | 1 | 2 |
| Caimito | *Chrysophyllum caimito* | Sapotaceae | Fruit | 0 | 2 | 2 |

In addition to shade trees, other plants cultivated in the cacao plots were mentioned, most of them used for food or spices, but also for ornamental flowers or orchids. These herbaceous plants (except weeds) were mentioned only by female interview-partners. Regarding economics, most interview-partners sold the cacao harvested and from time to time, especially when bigger investments had to be made, timber. Fruits, vegetables and spices were used for self-consumption or given to farm workers in addition to their salary.

### 5.1.5. Location of the cacao plots

The plots' distances from the houses where the interview-partners lived do vary. The greatest distance found was about 7 kilometers but most of the plots were close to the house or at least reachable on foot.

### 5.1.6. Tools used for cacao cultivation

*Illustration 11: Farmer with machete (Photo taken by the author 2011)*

Tools that are typically used in the *cacaotal* are basic. Only one interview-partner (P5) owned a tractor that was also used for irrigation in cacao, but mainly used for sugarcane cultivation. All of the interview-partners worked with the so-called *luco* and the machete. The machete is used in the plots to cut off branches while pruning, to harvest the cacao pods and for weeding (Illustration 11). The *luco* is basically a stick with a blade on one end and is used like a machete in the upper parts of the cacao and shade trees to prune and harvest. Additionally ladders, knives, files (*limas*), nets, buckets and shovels (for drains) are used. Most interview-partners mentioned that they have a *bomba*, a manual or motorized pump for the application of water, liquid fertilizers and pesticides. One interview-partner (P12) mentioned that he sometimes still uses a very traditional wooden tube called *toya* to wash the cacao beans from the pulp.

### 5.1.7. Motives of cacao cultivation

Nineteen of my interview-partners stated that have "always" (*siempre*) cultivated cacao because their parents already cultivated cacao. For 11 of my interview-partners it was a new business they started 10 to 30 years ago when they were aged between 20 and 81. From one of my interview-partners (P27) I did not obtain an answer. Of the 19 interview-partners that did always cultivate cacao, seven belonged

to G_highinput, 12 to G_lowinput/organic (Table 8). There is no statistical significant difference between the groups ($p_{(Fisher's\ Exact\ Test)} = 0.06$). Only one certified organic farmer (P21) did not take over cacao cultivation from his parents.

> *A mi, porqué pa nosotros es una costumbre desde la descendencia de nuestros padres. Nos enseñaron, como lo se hacer. Entonces era lo unico de que viviamos en este lugar. Entonces lo agaraba y así y esta muy bonita la sombra de los árboles cuando hay mucho sol, allá uno anda tranquilo. Por eso.* (P23) [21]

When hypothetical asked if the interview-partners would like to have more land for cacao cultivation, farmers of the G_highinput did rather affirm to appreciate more area whether most farmers of G_low-input/organic answered in the negative (statistical significant difference $p_{(Fisher's\ Exact\ Test)} = 0.00$).

*Table 8: Experience in cacao farming for G_highinput (A, n=15) and G_lowinput/organic (B, n=16) cacao farmers*

| **Do you like to have more land for cacao cultivation?** | **A** | **B** | **Statistical Test** |
|---|---|---|---|
| yes | 12 | 3 | Fisher's Exact Test: df=1, p=0,00*** |
| no | 3 | 10 | |
| missing | 0 | 3 | |
| **Experience in cacao cultivation** | | | |
| since childhood | 7 | 12 | Fisher's Exact Test: df=1, p=0,06[a] |
| cacao started as new business | 8 | 3 | |
| arithmetic mean (years in cacao business when new) | 19 | 23,33 | T-test: df=9, p=0,59[a] |
| missing | 0 | 1 | |

[a] Difference not statistically significant on an α=0,05 Level
*** Difference statistically significant on an α=0,05 Level

> *Que va a quedar al dueño, no le queda nada. Por eso están tirando. Se han tirado miles de plantaciones. La gente ya no quiere al campo. Quieren ser doctores, ingeneros, algo, pero no el campo. Y francamente el campo no da, no rinde, no esta rindiendo. Antes cualquiera estaba comprando lugares. Ahorita cualquiera vende lugares y nadie esta comprando, por eso mismo. Porqué ya no rinde.* (P1) [22]

21 "For me, [cacao cultivation] it is a tradition since our fathers times. They taught us, that's how I understand it. So, it was they only thing that we lived off the land in this place, that's why they did it. And the shade from the trees when there is a lot of sun is very nice; there one can be quiet, for that."

22 "What is left for the [plot-] owner, actually nothing is left. That's why many have left their plots. They have abandoned thousands of plots. The people do not like [to live in] the country side. They want to be doctors, engineers, something, but not in agriculture. And honestly, agriculture doesn't give you anything, it does not pay. In former times everybody bought land. Now everybody is selling land and nobody is buying. Because it does not pay off."

## 5.2. Tasks in the cacao plots

Nineteen interview-partners completed a seasonal calendar in which they arranged weather conditions, activities in the cacao plot as well as pests and diseases were arranged according to the time in the year (Illustration 12).

*Illustration 12: Examples for seasonal calendars: the outside circle shows climate conditions around the year; the second circle cultures and measures in the cacao orchards; the third is the occurrence of pests and diseases and the core circle actions taken against pests and diseases (Photos taken by the author 2011)*

The main task in the cacao plots is harvesting in the main harvest period from November to February and in the time of the so-called *alegrón* (second harvest period from March to June). The *alegrón* harvest does not take place every year and depends on cacao variety and weather conditions. Fungicide spraying, mainly against Black pod disease, took place from September to March. Insecticide spraying against various targets was performed from February to August. Weeding was mainly performed once a year from April to August, pruning from February to September. In February, March, May or June cacao tree fertilization was performed by some interview-partners (Illustration 13).

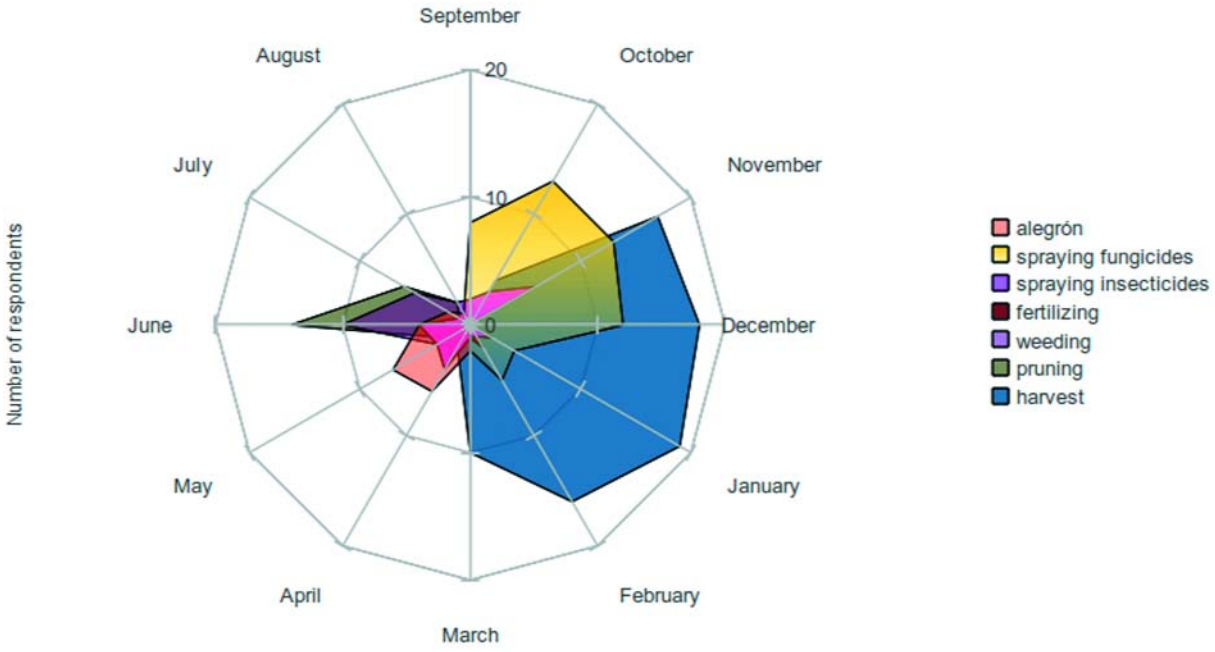


*Illustration 13: Tasks in the cacao plot according to the seasonal calendars (n=29)*

### 5.2.1. Who performs the tasks in the cacao plot?

Most tasks are performed by men in the cacao plots. Hired labor (*jornaleros*) is very common, especially at harvest season. 24 interview-partners (12 G_highinput, 12 G_lowinput/organic) stated that they do employ *jornaleros* at least at labor peaks like harvest, weeding or pruning, six interview-partners did not employ hired labor but had help from their families (1 answer missing). All interview-partners that employed *jornaleros* stated that they pay them 100 *pesos*[23] a day.

### 5.2.2. Weeding

Main time of weeding (*la jílea*) is in or shortly after the dry season (May, June) when the cacao tree starts flowering. The most common weed in the cacao plots is *lengua de vaca* (*Phylodendron hederaceum*) (Illustration 14). It grows about 40cm in height and covers the soil under the trees if not removed. It climbs up trees' trunks and can cause serious losses. Even though it is considered undesirable because of its competition for water and minerals, some farmers did mention its property of keeping water in the soil in times of drought. Usually once a year weeding is performed with the machete. The biomass is left within the plots and serves as fertilizer.

Another weed that was mentioned is the so-called *caballera* (*Phoradendron quadrangulare*). This plant, an epiphyte, affects shade trees as a parasite, especially the *cocoíte* (*Gliricidia sepium*) and *chipilcohíte* (*Diphysa robinioides*) trees, and to a lesser extent, also the cacao tree. It is cut off with the *luco* or the *machete* but as it grows in the trees crown, the removal can be difficult. Also mentioned were the *bejuco loco* (*Cissus sicyoides*), a kind of vine, the "tree-killer" or *matapalo* (*Ficus sp.*), a tree that is a parasite to other trees, and *pitahaya* (*Hylocereus undatus*), growing typically high up in the crown (Table 9).

*Table 9: Herbaceous plants cultivated in cacao plots*

| Spanish name | *Latin name* | Familiy | Use |
|---|---|---|---|
| Lengua de Vaca | *Dieffenbachia seguine* | Araceae | weed |
| Matapalo | *Ficus sp.* | Moraceae | weed |
| Caballera | *Phoradendron quadrangulare* | Santalaceae | weed |
| Pitahaya | *Hylocereus undatus* | Cactaceae | weed/fruit |
| Bejuco Loco | *Cissus sicyoides* | Vitaceae | weed |

23 about € 7.2 (01.01.2011) according to OANDA 2013

### 5.2.3. Pruning

Pruning is a task mainly performed in times of May to June. Various Spanish expressions (*podar; desmamonar; quitar rajitas, chupones or gajos*) describe the parts of the cacao or shade trees that are removed-entire branches, dead wood or young shoots. Especially shade trees are pruned because of shade reduction, recommended by facilitation workers to regulate humidity in the cacao orchards. The cacao trees, as well as the shade trees, require pruning for maintaining as well as, in the case of the cacao trees, to keep them at a reachable high for harvesting. It was mentioned various times that all types of pruning should be performed in times of waning moon as than the plant needs less energy and the regrows slower. Nine interview-partners (4 G_highinput, 5 G_lowinput/organic) performed pruning in waning moon, fifteen said they do not mind lunar phases and of seven farmers I did not obtain an answer.

*Illustration 14: Farmer with lengua vaca (Photo taken by the author 2011)*

### 5.2.4. Harvest

Main harvest season is in time of the so-called *frio* (cold), from November to January. Depending on the cacao varieties cultivated there may be a second harvest season with less pods in March called *alegrón* (seven interview-partners stated that they have an *alegrón*), but not every year. The amount of cacao-beans harvested per hectare and year in the season 2010/2011 did vary heavily from farmer to farmer: Answers were given for dried (*seco*) or fresh cacao (*en baba*). When answers were given for dried cacao, the figures were converted with the factor 0.33 (1000 kg of fresh cacao result in approximately 333 kg of dried cocoa beans) to compare them. Most farmers did give an estimate as they did not know the exact figures, so the results should be regarded as a conservative estimation. The average (n = 28) was 879 kg of fresh cocoa beans per hectare with a minimum of 120 kg (P12) and a maximum of 6,000 kg (P5). Due to these extreme differences standard deviation is quite high (1,103). There is no significant difference ($p_{(T\text{-}test)} = 0.32$) between the average harvest of G_highinput (n = 13; 723 kg) and G_lowinput/organic (n = 15; 1.014 kg).

## 5.3. Input into the cacao plots

### 5.3.1. Fertilization

Fertilization was frequently mentioned during most of the interviews as a basic concept for improving the plots. The majority of farmers talked about the importance of organic matter input in form

of leaves from the various trees in the cacao ecosystem and the lack of additional fertilization due to financial reasons.

The G_lowinput/organic farmers reported not using synthetic fertilizers in cacao (at least in the last two seasons 2010/2011 and 2009/2010) except P28 (in conversion to organic since 2011) who used synthetic fertilizer before joining an organic group in 2011 (Table 10). Cattle Manure was mentioned various times, bat guano once, but most farmers did not use any kind of additional fertilization expect leaving the residues of the cacao pods in the plots to rot. Some interview-partners did make compost out of harvest residues even though asked if they do so, the answer was 'no' in at least one observed case (P13). Only one interview-partner (P1) stated that he does use compost and another one said that it is planned to try compost in one plot (P5).

> *Tampoco (uso composta). Todo es hoja de cacao, la lengua vaca que entra en descomposición, las hojas que caigan ahí o madera, la cascara de cacao – todo lo que se va dejando de resid-uo de allí como composta. La hoja de cacao tarda 6 meses para desintegrarse y proporcionarle al suelo materia organica- igual la rama de cacao y la cascara tardan como 6, 7 meses.* (P1)[24]

*Table 10: Agrochemical input of G_highinput (A, n=15) and G_lowinput/organic (B, n=16) as reported by the interview-partners*

| Reported agrochemical input | A | B | Statistical test |
|---|---|---|---|
| **Synthetic fertilizer use** | | | |
| yes | 13 | 1 | Fisher's Test: df=1, p=0,00*** |
| no | 2 | 15 | |
| **Fungicide use** | | | |
| yes | 14 | 8 | Fisher's Test: df=1, p=0,01** |
| no | 1 | 8 | |
| **Synthetic insecticide use** | | | |
| yes | 15 | 2 | Fisher's Test: df=1, p=0,00*** |
| no | 0 | 14 | |
| **Herbicide use** | | | |
| yes | 1 | 0 | Fisher's Test: df=1, p=0,48[a] |
| no | 14 | 16 | |

[a] *Difference not statistically significant on an α =0,05 level*
** *Difference statistically significant on an α =0,01 level*
*** *Difference statistically significant on an α =0,001 level*

24 "I do not use compost. Everything is cacao leaf, *lengua vaca* [Phylodendron hederaceum] that enters decomposition, leaves that fall or wood, cacao pods – everything that is left of the residues there [in the plot] as compost. The cacao leaf takes 6 months to break down and to come into the soil as organic matter, same as the branches of the cacao tree and the pods need 6 to 7 months."

When asked if they use synthetic fertilizers 13 interview-partners (all G_highinput) stated yes. Synthetic products mentioned were "Triple 17" (N17 P17 K17) (7 answers) and urea[25] (6 answers). Two interview-partners stated that they use foliar fertilizers when cacao trees are in flower (products mentioned were "Floren", "Nutrisol", "BioGreen" and "Activol"– the last contains Gibberellic acid 40% to stimulate florification). Usually fertilizers were applied once (5 answers) or twice (3 answers) a year whereby the dosage ranged from about 400g to 1kg of "Triple 17"[26] per tree . Urea was said to stimulate growth in young cacao trees, for better fructification "Triple 17" was preferred. Prices for fertilizers are relatively high compared to the interview-partners income: one *saco* (a bag of 50kg) was said to cost between 300 and 500 pesos (approximately € 18 to € 30).

> *Si le hace falta. La planta es como uno, tiene que comer diario. Si a la planta se pone fertilizante dos veces al año, todavia quiere mas … a lo menos una vez al año, dos veces mejor. Pero sale caro, tanto el producto como el trabajo. No se avanza mucho en el día.* (P13)[27]

### 5.3.2. Fungicides

Fourteen interview-partners of the highinput group did report to use copper-based products against fungal diseases, especially *Phytophthora palmivora*. In the lowinput/organic group 8 farmers reported using copper-based products (that are permitted according to the organic standards), 8 farmers did not apply them according to their statements. The most common copper-based product was coppersulphate mixed with lime in water. But also copper-oxychlorid products like Cupravit© (Bayer) and Oxicu© (Agristar) were mentioned by G_highinput farmers. Copper-based products are applied usually every 15 or 20 days in times of *el frio*, from October or November to January or February when the cacao pods ripen.

### 5.3.3. Insecticides

For synthetic insecticides, farmers of G_lowinput/organic did report not using any, except the two newly-converted organic farmers in conversion P28 and P30.

All farmers of the G_highinput reported using various synthetic insecticide products, mainly the so-called *metilico* (actually Parathion Methyl, products mention were *Folidol* or simply *Metilico*), mentioned by 8 farmers. Another product applied by 3 farmers was *Nuvacron*© (active ingredient

25 Urea is used as a nitrogen-releasing fertilizer

26 There is an average of 500 to 700 trees per hectare in Tabasco.

27 "There is a lack [of fertilization for the cacao trees]. The plant is like oneself, it needs to eat every day. If you put fertilizer on the plant twice a year, it still wants more … at least once a year, better is twice. But it is expensive, the product as well as the labor. One does not advance much in the day."

Monocrotophos) as well as *Vancron*©, a highly toxic substance applied as a liquid solution in water. Also mentioned were products like *Foley*, *Carioca* and *Tamaron 600*, unsystematic organophosphates.

### 5.3.4. Herbicides

Herbicides are not used by the farmers interviewed according to their statements. This is due to the sensitive root system of the cacao tree that makes herbicide application not advisable according to the interviewed farmers and therefore manual weeding with the machete is preferred. Only one farmer (P9) did apply synthetic herbicides (*matamonte*) from time to time in the cacao plot.

### 5.3.5. Organic pest and disease control

To control pests in certified organic cacao cultivation, a mixture, called *caldo orgánico* was mentioned by 10 (all of them organic or former organic) interview-partners. Most of them did apply this mixture only once, when introduced by organic-farming promoting workshops and not use it since that time (except P5, who that she uses this mixture regularly). The mixture contains chili, onions, garlic, allspice, cloves and leaves of herbs or trees like *chinin* (*Persea schiedeana*), *epazote* (*Chenopodium ambrosioides*) or others. Some interview-partners also mentioned that they added lime, cow or chicken manure, cascade of pineapples, ash and/or leaves of the neem tree (*Azadirachta indica*). These ingredients were mixed, then reduced into small pieces, filtered, fermented and finally sprayed on the cacao tree's leaves, flowers and pods. The other farmers of lowinput/organic group did not mention these mixtures as none of the G_highinput except P16 and P17, who were formerly organic cacao producers. The reasons given for not applying this bio-insecticide after the initial demonstration were the following: the absence of further instructions (2 answers), a general disappointment in the organic project (3 answers), the mixture was considered not to be working (2 answers) and one interview-partner did not want to kill beneficial insects (P22). P5 stated that she additionally uses soap against ants in her plots and one farmer (P1) mentioned he uses a brew of chili peppers to remove weeds, a method which he started using at the time I interviewed him.

## 5.4. Perception of organic cacao cultivation in Tabasco

Organic cacao cultivation was perceived very ambivalent by my interview-partners. The main reason for joining organic agriculture was the promise of higher prices for their product, made by promoters of organic farming. As this promise was not fulfilled by the time of my interviews, a certain disappointment was noticed during almost all interviews. At the beginning of the organic promotion in Tabasco (in about 2003) financial aids for conversion were given to farmers willing to participate. As payments and other support like workshops, organization and materials were stopped after a new governor was elected in 2005, organic farming did not offer any advantages anymore according to most interview-partners:

*No, no, hace falta [la organisación]. Al principio creamos todo eso que iban a organizar, que hicimos una asociacion que incluye el permiso para la exportación del cacao organico. Pero repito nos abandonaron y ya. Todo eso se ha ido. Habian dicho que van a dar los costales donde se corta el cacao en las plantas de fermentación. No de eso hubo, por eso la gente se desanimo, se desorganizo. El otro problema que tuvimos fue eso de la enfermedad, la moniliasis. Nos ha pegado muy fuerte en los ultimos años y hasta ahorita pues no había un producto para combatir la moniliasis.* (P21) [28]

For most of the organic farmers interviewed, organic agriculture was identical with no input (except copper-sulphate with lime) to the cacao-plots at all. Except P5, none of the organic farmers had an individual official document of certification and only cacao cultivation was certified: the two farmers certified for organic cacao that were also cultivating sugarcane (P5, P21) did apply synthetic fertilizers and pesticides in sugarcane.

*El orgánico es que ese cacao no le podemos hechar de esas medicinas que venden en la veterinaria. Aquí nada de eso porqué es tóxico. No mas aquí lo fumigamos, cuando hay cosecha de cacao y empieza a mancharse la mazorca, se fumiga con sulfato y cal. Eso nada mas. Pero no nos admiten que le hechamos esas medicinas de la veterinaria.*(P29) [29]

## 5.5. Cacao and its market

### 5.5.1. Own consumption

Fourteen interview-partners did consume some of their cacao harvest in their households; five interview-partners did use all their harvest for self-consumption. Cacao is mainly used to prepare *Pozol* (19 answers), chocolate (7 answers), *polvillo* (3 answers) and *agua de cacao* (4 answers). *Pozol* is a beverage made from ground cacao, corn dough and water in contrast to *polvillo* that also contains ground cacao and water, but additionally toasted ground corn instead of cooked corn. *Pozol* as well as *polvillo* are common Tabascan beverages. *Agua de cacao* is a beverage prepared with water and fresh cacao pulp but not as commonly found as the other two cocoa-based beverages.

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28 "No, no, there is a lack [of organization]. At the beginning we believed that they will organize it, that we will form an association that includes the permit for organic cacao exportation. But I repeat, they abandoned us and that was that. All this has gone. They said that they will give us the bags where one cuts the cacao in the fermenting sites. But none of this happened, that is why people got demoralized and disorganize. The other problem we had was that with the disease, the Moniliasis. It hit us very hard in the last years and until now there is no product to treat it."

29 "Organic means that we can not apply the medicine they sell in the agricultural shops. We don't use it here because it is toxic. We just spray when there is harvest, when the cacao pod is ripe and starts to get dots, then we spray with [copper-] sulphate and lime. Just this. They don't allow us to use the medicine sold in the agricultural shops."

### 5.5.2. Sale channels

Most of the interviewed cacao producers (Table 11) did sell their harvest without processing (*en baba*, fresh cacao beans including the pulp) to associations and/or intermediaries (usually called *coyote*). The farmers then ferment and dry the cocoa beans and usually sell them to the national cocoa producers' union (UNPC – *Union Nacional de los Productores de Cacao*) or to private buyers:

> *En baba quiere decir que nosotros cortamos y quebramos el cacao, sacamos el fruto y así en el agua se lleva a la asociacion. Ellos , para hacer un fermetado, tienen que meterlo en caja durante 8 dias, dandole vueltas, de una caja a otras, se deja 8 dias tapado, el calor la mejor fermentación agara un color obscuro de acuerdo tira unas planchas que le meten un vapor 720 grados de vapor y lo estan viendo cada 2 horas para secar. Eso ya es otro proceso. De ahi lo mandan a la chocolatera y ahi lo hacen chocolate y sacan lo que es la manteca, la cocoa que es lo que se vende principalmente aqui en Tabasco para el mundo.* (P1)[30]

P5 is an exception: she ferments and dries her harvest on the farm and exports the dried cocoa beans directly to buyers in Canada, Belgium and France that use her neo-criollo cacao variety for special blend chocolates. She gets a much higher price of about 126 Mexican pesos[31] per kg of dried cocoa beans while all other interview-partners stated that the price for dried cocoa-beans was about 45 pesos[32] in the harvest season 2010/2011. The price for fresh cacao for farmers varies during the harvest season and it makes a difference to whom farmers sell: intermediaries are said to pay better and immediately, associations often pay less and delayed because of limited financial liquidity. Also, one part of the payment is paid to the members only after the association sold the processed bean, the so-called *remanente*. Intermediaries also have the advantage that they move around with pick-ups and collect the fresh cacao directly at the farm, a service most associations cannot afford. However, intermediaries are not always seen as positive: "*Queremos una medicina para combatir coyote.*" (P32) [33]

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30 "'En baba' means that we cut and open the cacao pods, take out the fruits and wet as they are we take them to the associations. To ferment, they have to put (the beans with the pulp) into boxes for 8 days, turn them around from one box into another and leave them (the boxes) closed for 8 days too. The heat improves the fermentation and gives the beans a dark color. After that the beans are put onto a roast to dry with hot vapor for 2 hours. This is already another process. From there they send it to the chocolate factory where they make chocolate, extract the cocoa butter and the cocoa, what is mainly sold from Tabascan Cacao on a global scale."

31 126 Mexican pesos corresponded to about € 7.6 (01.01.2011) according to OANDA 2013

32 45 Mexican pesos corresponded to about € 2.7 (01.01.2011) according to OANDA 2013

33 "We want some medicine to fight the 'coyote' ".

Critical points for farmers were the insecurity of prices paid and the dependence of farmers on the money from the main harvest.

> *Y ahorita ya termino la cosecha, hay cacao poquitito pero solo el coyote (compra) – como vienen 10 coyotes, esos pagan mejor, pagan 15.5 hasta 17 Pero nosotros para sostener esa compra la tiene como ejido ahi porqué aqui somos como 800 productores de cacao. Entonces si alla se deja de comprar y ahorita viene el coyote y paga bajisimo el cacao, por pagar hasta diez, ocho pesos. Y éste es el contrapeso que tenemos. Si hubiera funcionado bien porqué el grupo [asociación organica en Huimanguillo] se compro un terreno y ya habia remanente y de verdad un compañero, un directivo, ha trabajando bien. Y eso es el motivo porque todavía está. Ahora si que seguimos con el cacao orgánico, sin tirarle nada pues. Ya tenemos como 10 años sin tirarle ningun insecticida, sin nada, lo hemos dejado todo, lo natural pues todo, lo hemos sabido. En grupo nos hemos reunidos, en equipo así, los tecnicos no, ya no, no nos enseñaron. Pero tenemos todos los materiales, aquí lo tenemos. Pero a veces nos descontrolamos porqué los precios estan bien. Hasta ahora.* (P23)[34]

The interview-partners stated that the price for fresh cacao ranged from 7 to 18 pesos[35] in the harvest season 2010/2011, better than it was during previous years.

> *Bueno … (el precio) esta bien. Bueno, no esta bien. no esta bien. Pero mira, hace dos años el kilo de cacao estaba a 2 pesos. A 2 pesos nos pagaban el kilo de cacao. El caso de que muchas veces no alcanzó para la jilea, lo que se llama la jilea, ni para poner trabajo al campo. A veces el mismo que te contaba y cobraba cacao te cobraba bolsa, y te decia: mirame, 100 pesos por saco. Y lleva 70 kg el saco entonces por 2 son 140 pesos. Eso fue otra de los cuales para muchos de los campesinos tenian que tumbar su hacienda porque estaba a dos pesos el kilo de cacao. Si ahora ya subio a 14 pesos. Porqué? Porqué no habia mucho producto- ahi se dice esta la ley de la oferta y de la demanda. No habia mucho producto – subio el precio. Todos los*

34 "And now the harvest is over and there is only a small amount of cacao that the coyote buys – there are 10 coyotes coming, they pay better, up to 17 to 15.5 pesos. But in order to achieve good sales one has to work together as ejido, in this region we are 800 producers. Because if they stop to buy there, then the coyote comes and buys the cacao at a very cheap price, for ten, eight pesos. And this counterbalance is what we have. If it would functioned much better, because the group [of the organic association in Huimanguillo] bought land and they already [would have paid us] for the remnant and honestly, one companero, a directive. He worked good. This is the reason they are still there, we still go on with the organic cacao, without treating it. Now it is 10 years without insecticides, without anything, we stopped everything, just natural, we knew it, well. In [the past] we joined in groups, in teams, but the facilitators no longer taught us anything. But we have [all the knowledge,] all the materials, here we have them. But sometimes we cannot control this when the prices are good. Until now."

35 Corresponded to € 0.42and € 1.1 (01.01.2011) according to OANDA 2013

*que tumbaron su hacienda ahora tienen que volver a sembrar. Fue en el 2008, 2009 que pagaban a 2 pesos el kilo de cacao. Muchos productores ni viviamos de eso.* (P1)[36]

*Table 11: Hired labor and harvest of G_highinput (A, n=15) and G_lowinput/organic(B, n=16)*

| Variable | A | B | Statistical test |
|---|---|---|---|
| **Seasonal Labor** | | | |
| Number of workers hired last year according to interview-partners (arithmetic mean) | 2,58 | 3,58 | T-test: df=22, p=0,58[a] |
| no labor force employed (number of answers) | 3 | 3 | |
| Missing answers | 0 | 1 | |
| **Harvest 2010/11** | | | |
| According to interview- partners in kg/ha fresh (arithmetic mean) | 723,7 | 1014 | T-test: df=26, p=0,32[a] |
| Missing answers | 2 | 1 | |
| **Perception of the harvest season 2010/11** | | | |
| Good (number of answers) | 2 | 4 | Likelihood Ratio: df=2, p=0,34[a] |
| Medium (number of answers) | 5 | 2 | |
| Bad (number of answers) | 7 | 4 | |
| Missing answers | 1 | 6 | |
| **What would be a good harvest season?** | | | |
| Anserws in kg/ha (arithmetic mean) | 1647,58 | 2551,1 | T-test: df=18, p=0,68[a] |
| Missing answers | 3 | 6 | |

[a] Difference not statistically significant on an α = 0,05 Level

As most farmers do not process their harvest and lack the infrastructure to do so properly, they need to sell their fresh cacao-beans quickly. The lack of further processing was lamented by one farmer.

36 "Well, [the price] is good. Well, it is not good, it is not. But look, two years ago one kilo of cacao sold for two pesos. They paid us two pesos for one kilo of cacao. It happened that often it did not cover the costs for weeding, what is called jilea, not for putting work in the field. Sometimes the same person that counted and paid you, paid per bag and said to you: Look, it is 100 pesos per bag. And one bag weights 70 kg so two bags are 140 pesos. This was another [reason] why so many many farmers dumbed their *haciendas*, because the price was at two pesos per kilo. Now it rose to 14 pesos per kilo. Why? Because there was less product available – there is the law of supply and demand. There was not much product [on the market] so the prices rose. All who have dumped their hacienda now have to seed again. That was in 2008, 2009 that they paid two pesos for one kilo of cacao. Many producers could not live on that."

*El productor no [procesa]. En verdad antes si se proceseba pero es que aqui el sindicalismo es muy fuerte. Se decia: Es que me vendes a mi, la union, o tu cacao no sale. Te retienen, te roban el producto, te comerzializan el producto … ya perdiste todo. por que? por parte de la Union. Dice la Union: véndemelo a mi, yo te compro y no hay bronca- tu quieres comercializarlo por a fuera te lo quito. Es el problema. Nosotros teniamos una secadora. (…) Pero ya no [secamos] porqué hubo mucho problemas por lo que de decía. Habia mucha bronca.* (P1)[37]

Certified organic cacao was, except for the harvest of P5, sold conventionally to associations and coyotes. This lack of a better price was lamented by all certified organic farmers except P5.

# 5.6. What is a pest?

### 5.6.1. Freelists

Twenty-nine freelists were made and analyzed with Anthropac. Of the 29 freelists obtained during the interviews, frequency and saliency were analyzed. After eradicating synonyms and misspellings, 42 different items remained in the cultural domain "Pests and Diseases of Cacao in Tabasco". Lists were rather short (6 items overall average with 3 items in the shortest list and 11 in the longest) and only 20 items were at least mentioned by two different interview-partners (Illustration 15).

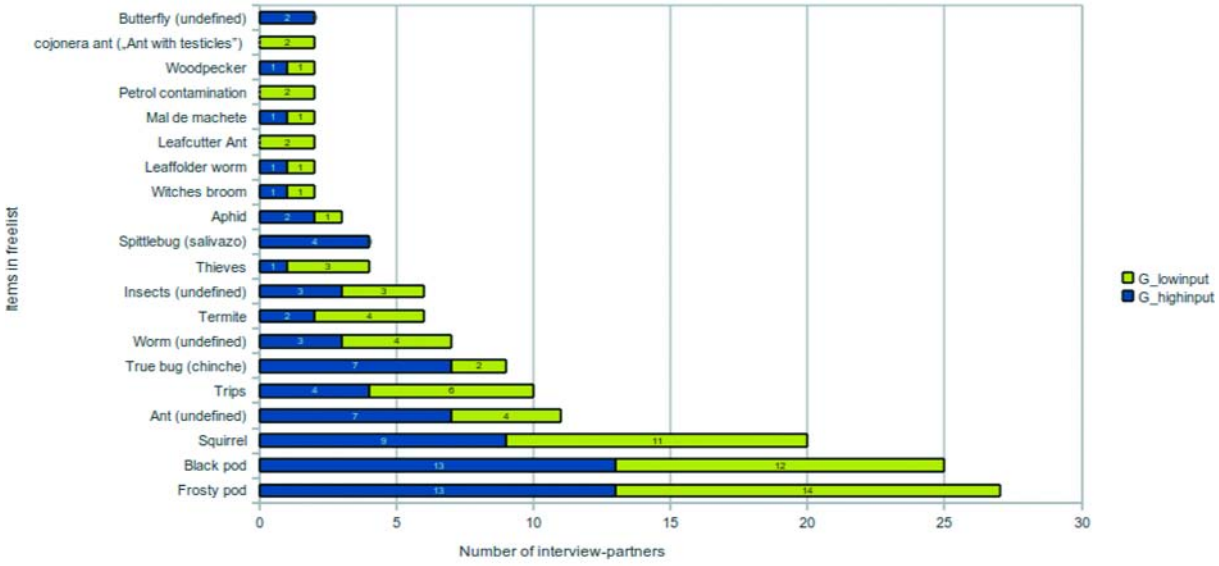


*Illustration 15: Items mentioned at least by two different interview-partners in freelists of G_highinput (A,n=15) and G_lowinput/organic (B,n=14)*

37 "The producer does not [process his/her produce]. In former times [cacao] was processed [by the farmers] but the syndicalism is very strong here. It was said: You sell to me, the Union, or your cacao will not be sold. They detain you, they steal the product, they commercialize the product … you have already lost everything. Why? Because of the Union. The Union says: Sell it to me, I buy your product and there won't be any problems. If you want to sell it to others, I will take it from you. That is the problem. We had a drying machine … But now [we don't dry the beans] any more because we had stress, because there of the many problems because of what I told you about. A lot of stress."

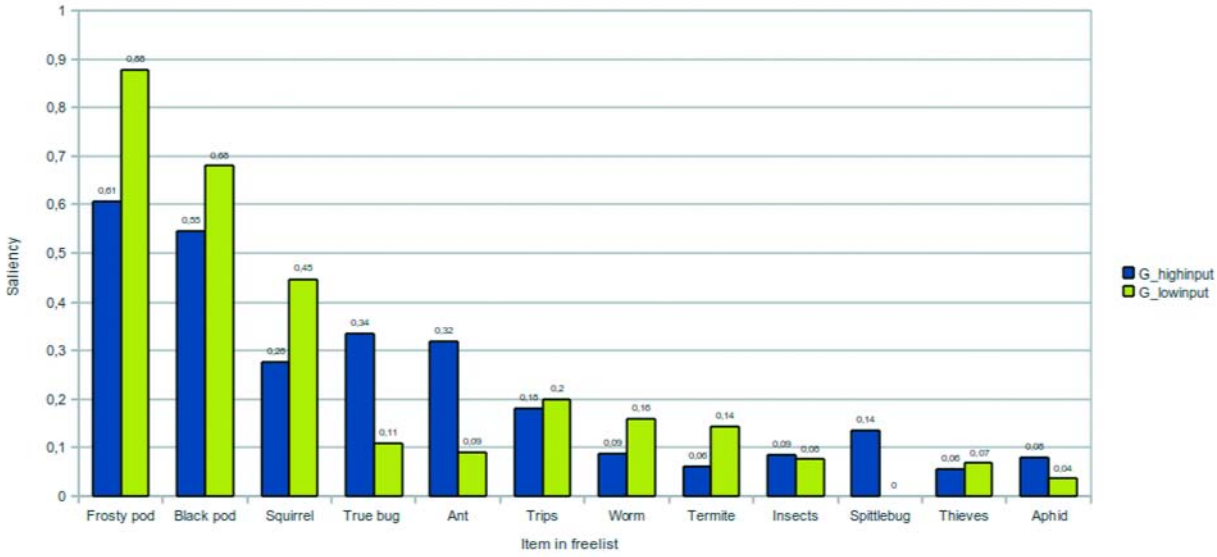


*Illustration 16: The twelve items with the highest saliencies in the cultural domain "Pests and diseases in cacao in Tabasco" mentioned by farmers of G_highinput (A,n=15) and G_lowinput/organic (B,n=14)*

Most frequently mentioned were Frosty pod (*M. roreri*, synonym to *moniliasis*, *mancha amarilla*, *monilia*, *el hongo* and *media luna*), Black pod (*P. palmivora*, synonym to *mancha negra*, *mancha morena* and *pudrición negra*), squirrels, ants, true bugs and so-called *gusanos* which means "worms" (but are mainly caterpillars of the Lepidoptera order).

A paired samples T-test to compare saliencies of the two groups (Illustration 16) high_input and low_input resulted in no statistical difference between the two groups ($p_{(2\text{-tailed t-test})} = 0{,}55$), the comparison of frequencies however showed that G_lowinput/organic farmers do mention items more frequently ($p_{(2\text{-tailed t-test})} = 0{,}02$).

All items were grouped into 4 mutually-exclusive categories (diseases, animal pests, abiotic and weeds) and their saliencies were analyzed (Illustration 17). Diseases (6 items) are the most relevant category regarding their frequencies and ranks (saliency: 0.652) because Frosty pod and Black pod disease were most prominent in the freelists. Animal pests were by far the most numerous category (30 items) but their relative importance is less (saliency: 0.507). Abiotic items named in the freelist (4 items) had a saliency of 0.138 and weeds, as only named by one interview-partner, were least named (saliency: 0.01).

### 5.6.2. Characteristics of a pest

The dimension of the concept 'pest' (and in succession 'disease') for my interview-partners included various aspects. Economic aspects include smaller or damaged harvests, more financial input to hire workers and costs for agrochemicals.

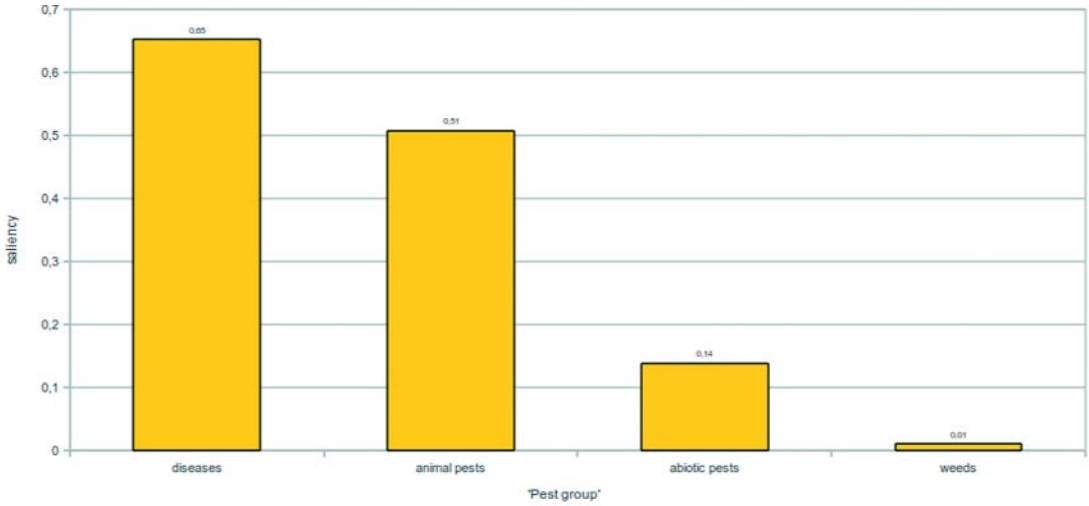


*Illustration 17: Saliencies of grouped answers of all free-listing interview-partners (n=29)*

> *Mira, se dice que es una plaga cuando economicamente te daña a tu bolsillo, que te daña tu patrimonio. Ya se dice que es una plaga. Es cuando se dice que es una plaga. Por eso digo que es una plaga: porque me afecta mi bolsillo.* (P1)[38]

Pests and diseases are perceived as part of a cacao farmer's everyday life. Economic disadvantages caused by them were the main factor why these animals and micro-organisms were considered undesirable (Table 12):

*Table 12: Estimated losses because of pests and diseases G_highinput (A,n=15) and G_lowinput/organic(B,n=16)*

| **Losses because of pest and diseases** | **A** | **B** | **Statistical test** |
|---|---|---|---|
| Estimation of interviewpartners of losses due to pest and diseases (0= no loss to 1=complete loss) | 0.55 | 0.44 | T-test: df=21, p=0.51[a] |
| Missing answers | 3 | 5 | |

a Difference not statistically significant on an α = 0,05 Level

> *Todo regular, todo esta normal. Así esta la situacion. Por eso lo llamamos plaga porqué andan de un lado al otro lado … . Plaga son animalitos. Pues todo es relativo: Si dañan al árbol, el árbol ya no produce lo que debe producir. No produce y entonces la inversion,*

38 "Look, one says that it is a pest when it economically damages you, your purse, your heritage. Then you say it is a pest. [Indeed] that is when you say it's a pest."

*el gasto que se hizo para el cultivo ya no se recompensa y éste es el aspecto economico también.* (P21)[39]

Sometimes the (cacao-) plant was included in the definitions, sometimes only the producer.

*Es así: Es una molestia para la planta. Y para el productor también. Porqué? Mira, recursos, menos recursos para el productor y la planta.* (P4)[40]

Some definitions were rather vague.

*… pués lo que decimos plagas – no se decirlo. Porqué hacen daño. Daña.* (P19)[41]

*Pués una plaga es una plaga. Es una cosa que te merma la cosecha. Es una enfermedad que trae mala cosecha.* (P5)[42]

*Porqué te tira la planta. Porqué te tiró la planta.* (P8)[43]

The ecological aspect mentioned by the farmers covered animals and microorganisms seen as actors in an anthropomorphic ecosystem like cacao orchards and that do, among other factors, alter these ecosystems.

*Yo considero que la plaga es todo insecto, los animales que dañan al árbol, al fruto. Para mi eso es la plaga.* (P28)[44]

Some interview-partners' definitions did not distinguish between (animal) pests and diseases and considered both as *plagas*.

*Es plaga cuando le cae algún mircobio a la mata. Nosotros lo llamamos plaga si nos afecta, así sea para el mango, el cacao, la naranja, también le caye. Son malas las plagas que lo afectan.* (P25)[45]

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39 "Everything is normal (in my plot). That is the situation. We call these (animals) pests because they wander from one place to another … . Pests are (small) animals. But everything is relative: If they harm the tree, the tree does not produce as much as it should. It doesn't produce and then the inversion, the costs for the crop do not pay off and this is the economic aspect, too."

40 "It is like that: It is uncomfortable for the plant. And for the producer, too. Why? Look, resources, less resources for the producer and the plant."

41 "… well, what we call pest – I don't know. Because they cause damage. It damages."

42 "Well, a pest is a pest. It is a thing that lowers your harvest. It is a disease that gives you a bad harvest."

43 "Because ruins your plant. [Simply put] because it ruins your plant."

44 "I consider as a pest every insect, every animal that damages the tree, the fruit. For me that is a pest."

45 "It is a pest when some microbe gets on the tree. We call it a pest when it affects us, no matter if mango, cacao or orange, they get them [they attack them], too. Bad pests do affect them."

When the causal agent of a disease was known, it was usually also considered a pest.

> *Quién sabe que sea una plaga? También sera como el polvo blanco en la hoja. Tiene que ser plaga. Porqué la hoja se pone blanca – debe ser una plaga. El polvillo, ¿Cómo se llamara pues? Es una mala plaga, como un animalito que esta en la hoja, una plaga pues.* (P9) [46]

Weeds were called pests twice during the interviews (P1, P13).

> *También los árboles de sombra tienen plagas. Hay un piquito que se llama caballera, eso es bejuquito y se va estrellando, estrellando hasta que cubre toda la planta y se muere. La caballera, lo pusieron, no se porqué se llama así. Son plantas parásitas. también hay el bejuco loco, éste también mata a las plantas- asi o llaman los viejos, bejuco loco. Son las plagas que afectan los árboles de sombra. También atacan al cacao.* (P13) [47]

### 5.6.3. Characteristics of a plant disease

There was no clear difference between the terms *plaga* (pest) and *enfermedad* (disease) throughout all the interviews. Some interview-partners stated that they do differentiate diseases from pests but most did not.

> *Moniliasis también, esta de vuelta con la mancha negra; son dos plagas que salen igualitas. Eso es lo que nos perjudica. Todos los productores de cacao se estan quejando- porqué cortan bastante pero no les rinde nada. Porqué ni queda la mitad.* (P17) [48]

Causal agents of the two mayor diseases Black pod and Frosty pod were often correctly called *hongos* (fungi), probably due to intense information campaigns about *M. roreri* in the last years.

> *Primero la humedad produce mucha enfermedad, cómo es la moniliasis y la mancha morena. Dicen que es un hongo pero quien sabe si es cierto. eso dicen los ingeneros que*

46 "Who knows what ought to be a pest? It can also be the white powder on the leaves. It must be a pest. Because the leaf turns white – it has to be a pest. The powder, what is it called? It is a bad pest, like a small animal that is on the leaves, therefore, a pest."

47 "The shade trees do have pests, too. There is one that is called *caballera* (engl.: female horse-rider), it is a vine and it stretches, stretches until it covers the whole plant and it dies. *Caballera* it is called, I do not know why. These are parasitic plants. There is also the *bejuco loco* (engl.: crazy vine), it also kills the plants – *bejuco loco*, that's how the elders call it. These are pests that affect the shade trees. They also attack the cacao tree."

48 "Frosty pod too, it is together with Black pod Rot: they are two pests that are similar. This is what affects us. All cacao producers are complaining- because they affect a lot. All our work does not pay off, because not even half [the crop] is left."

*es un hongo que produce la moniliasis y la mancha morena. Y yo digo que son las unicas plagas, el cacao no es de plaga.* (P13)[49]

Other cacao diseases were mentioned rarely, their existence not known or they were not considered important. Even though there are only these two major diseases, they affect farmers a lot.

*Pues, como dicen toda la enfermedad sera habia plaga pero yo no la conozco. Cada dia llega otra enfermedad, cada dia diferente.* (P6) [50]

Two interview-partners mentioned the existence of Witches' broom disease in the freelist. Infections with witches' broom (*M. perniciosa*) in Mexico have not been verified by now but there is concern that the disease may spread there stated one interview-partner (P1). One interview-partner (P8) stated to have witches broom infected pods in her plot but was not able to describe the symptoms or to show the pod – probably she confused the disease with Black pod Rot (which she did not mention during the whole interview).

Other interesting characteristics of pests and diseases are the attributes "hot" and "cold". *El frio* is a term used to describe the time of the year from October/November to December/January when temperatures are lower and heavy winds can enter from the Golf of Mexico (*los nortes*). But *el frio* also describes meteorological events that causes unspecific damage on the temperature-sensitive cacao trees and was also named in one freelist as a pest. Diseases are usually, but not always, considered "cold". Animal pests were considered hot by at two interview-partners during the interviews.

*No lo se decir, de verdad. Una plaga pues, como la chinche. (…) No lo sé, si me comentan que pone amarilla la planta por el calor de la plaga pues.* (P10)[51]

"Hot" and "cold" are two properties that can interact – something "hot" can help against the "cold". Fungicides are considered "hot": the more concentrated, the "hotter" they get. When too much is applied, it "burns" the tree. Black pod disease is also known as *mancha frialdad* (spot of cold).

*Ya creo que son plagas (las enfermedades). Otro bichito también que es cómo un escarabajo que me dicen que es caliente. Se pone eso, la manchita se muere y así se va también.* (P30)[52]

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49 "First the humidity causes a lot of disease, like Frosty pod and Black pod Rot. They say that it is a fungus but who knows if it is true, the engineers say it is a fungus that produces Frosty pod and Black pod Rot. I already said these are the only pests, the cacao (tree) is not likely to have pests."

50 "Well, like they say all diseases is having pests but I don't know them. Every day there comes another disease, every day another one."

51 "I do not know, really. Well, a pest, like the bug. (…) I do not know (why it is a pest), they tell me that it colors the plant yellow because of the heat of the pest, then."

52 "Now I think that (the diseases) are pests. Another vermin, too, it is like a beetle, they say it is 'hot'. When it comes, the spot dies. And it is gone, too."

I also explicitly asked for expressions, phrases or sayings that include cacao cultivation, especially pests and diseases of cacao, but all interview-partners denied knowing any. The only common expression stated by five interview-partners was that *quien toma pozol se queda en Tabasco*[53].

## 5.7. Types of pests and diseases mentioned

Squirrels, birds, ants and various other insects were most prominent as animal pests in the interviews, freelists and calendars (Illustration 18). Animal 'pest' pressure was seen highest from squirrels.

### 5.7.1. Squirrels, Birds and other vertebrate-pests

"*La ardilla es muy bonita también, pero, por Dios, hay que atacarla.*" (P6)[54] The squirrel (*ardilla*) seems to be a relatively new problem for cacao farmers in the Chontalpa region. Even though some squirrels were always present according to interview-partners, they only recently (about 3 to 15 years ago, the answers varied) became a major problem. One farmer stated:

> *La ardilla es una plaga que nos llego y nos daña pues cantidades. La ardilla nos ha dañando mucho cacao en las temporadas. No sé de donde, nunca habia ardilla por aqui. Y de 4 años para aca vino la ardilla que nos ha dado fuerte. Nunca habia, ni uno. Y ahora uno va a la hacienda y dos, tres mazorcas, cinco, comidas. No mas las cascaras tumba éste animal.* (P16)[55]

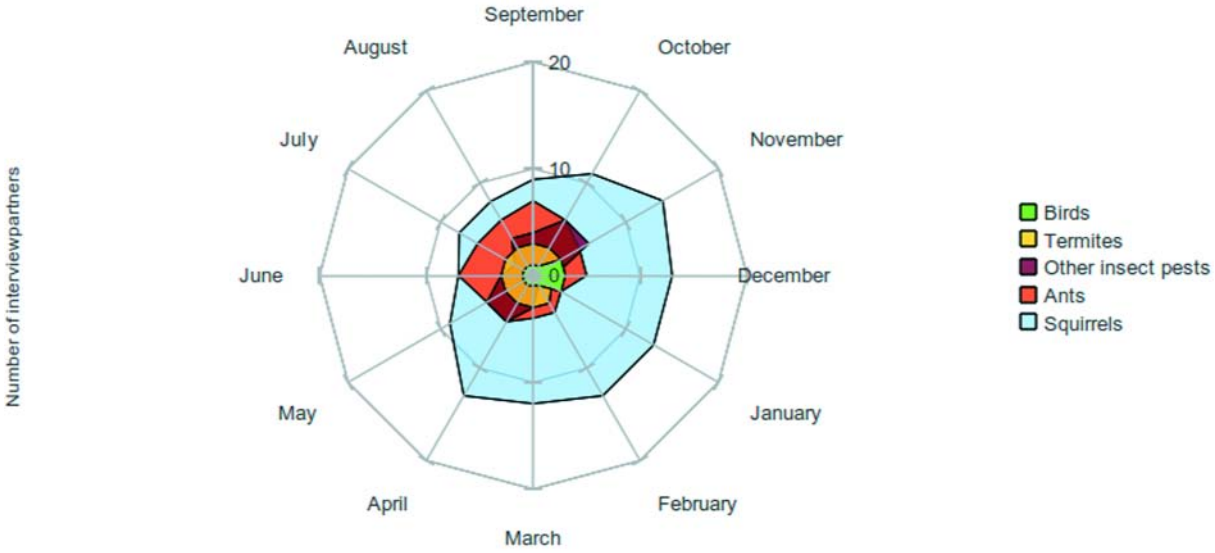


*Illustration 18: Animal pests mentioned by the interview-partners to occur during the year in the seasonal calendar (n=19)*

53 "Who drinks Pozol will stay in Tabasco."

54 "The squirrel is very beautiful too, but, for God's sake, we have to attack it."

55 "The squirrel is a pest that came to us and damages a lot. The squirrel has damaged a lot of cacao pods in the seasons. I don't know where they came from, before, there were no squirrels around here. And 4 years ago the squirrel came here – and gave us a hard time. There were none before, not even one. And now if you go into the haciendas and two three cacao pods are eaten. Just the cascade is not eaten by this animal."

The reason for the reported invasion of squirrels does not seem quite clear; populations grew tremendously according to different interview-partners statements. Some farmers mentioned that the squirrels came from the coast of Paraíso in Tabasco's North, where due to now reduced coco palm cultivation, the squirrels did not find enough to eat.

> *La ardilla, hace unos 12 años no habia ardilla aqui. Pero hace unos 12 o 15 años empezo a llegar. Dicen que en la costa habia mucho y que algunos lo agarraban y por gusto de ellos se fueron de ahí, quien sabe.* (P13)[56]

Other farmers mentioned that PEMEX[57] or the Government could be responsible for the occurrence of squirrels but did not explain further in which sense.

> *Ni cuenta nos dimos cuando aparecio. Vino de la nada. Dicen que el gobierno lo trajo para acabar con el cacao. Quien sabe, no se sabe bien. Se come hasta el cacao tierno. Hace 2, 3 años que esta aqui. No sabemos que hacer, que veneno ponerle, que cosa darle. Son animales que estan en los arboles altos.* (P18)[58]

I did not find any scientific paper that underlines or negates any of these arguments or that deals with squirrel populations in Tabasco. According to most interview-partners, the squirrels became a problem at about the same time or a little earlier than Frosty pod entered the Tabascan Cacao plots. All speculation about the squirrels' migration to the cacao-cultivating regions included a human component.

> *Aquí lo trajeron [la ardilla] porqué habia una pajaro que le llaman aqui tordo, "el sanate" lo llaman aqui. En el parque hay muchisimo que se reprodujeron muy rapido- y trajeron la ardilla para que se coma los huevos. Ya se pude imaginar que ahora es plaga para el cacaotero. Si realmente este es uno de los principales [problemas] – combatir la plaga. (P1)*[59]

Some interview-partners complained about red and black squirrels that open the cacao pods and remove the cacao beans to eat them. Some farmers estimated that one squirrel is responsible for 3 to 5 damaged pods a day. Three interviewed farmers (P22, P26, and P28) distinguished between red and

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56 "Twelve years ago there were no squirrels here. But 12 or 15 years ago they started coming. It is said that at the coast there were many and some took them and because of them they left [from there], who knows."

57 PEMEX (Petróleros Mexicanos) is the state-owned petroleum company of Mexico, exploring petroleum resources in Tabasco and other Mexican states

58 "We didn't even notice when it (the squirrel) appeared. It came out of the blue. They say that the government took them here to finish cacao (cultivation). Who knows, one doesn't know. It eats the green cacao too. Two or three years it is here now. We don't know what to do, what poison to put, what thing. They are animals that are up in the trees."

59 "They brought the squirrel here because there was a bird, a thrush; here they call it *sanaje*. In the park, there are lots of it and they reproduce very fast – they brought the squirrels so that it should eat the eggs. Now one can imagine that it is a pest in the cacao orchards. Yes, it is really one of the main problems – fight the pest."

black squirrels, though most did not. The squirrel is, however, perceived as the major animal threat to the cacao plots by most interview-partners.

To combat the squirrel population, some farmers do shoot them with guns, some with slingshot: "*Matándolo. Mis nietos aqui se van con varios tiradores y eso le ponen, jeje.*" (P29) [60] It was also reported that some bigger plot owners do pay up to 50 pesos [61] for each dead squirrel brought to them (half the daily income of a *jornalero*):

*Illustration 19: Damage on cacao pods caused by squirrels (Photo taken by the author 2011)*

> *En la temporada de cacao se mata como ocho animales en la semana. La ardilla ve una mazorca y la daña y así daña tres, cuatro mazorcas en el día. Come como a las nueve, a las cuatro de la tarde vuelve a comer.* (P26) [62]

The squirrel is present all around the year and said to eat the 'best' cacao pods, leaving the ones infected with *Moniliophthora roreri* on the trees (Illustration 19).

> *Sigue, sigue, la mazorca que esta buena lo come la ardilla. Hay que matarla. Si no come todo. Porqué la que esta enferma no la toca, no la come – sabe que esta enferma.* (P26) [63]

Most interview-partners considered squirrels pests, but not all:

> *Ya le decia pues esas todavia no son plagas. Pero más si el problema continua porqué se dice que la ardilla es semejante la rata, que se multiplica cada 2 o 3 meses. Así es.* (P21) [64]

60 "Killing it. My grandchildren here target them with catapults and they do it, te-hee."

61 About € 3,6 (01.01.2011) according to OANDA 2013

62 "When there is harvest one kills about eight squirrels a week. The squirrel sees a cacao pod and damages it, and like that it damages three, four a day. It eats at around nine in the morning and at four at the afternoon it eats again."

63 "It goes on, the pods that are good are eaten by the squirrel. Because the diseased ones it doesn't touch, it does not eat it the squirrel knows that [the plant] is sick."

64 "I already told you that they are not pests by now. But if this problem continues, probably, because it is said that squirrels are like rats, they reproduce and every two or three months and their numbers multiply. That's it."

Birds were mentioned in seven interviews as a pest (P26, P17, P21, P2, and P5). There were five mentions of the woodpecker (in Spanish called by three different names: *cheje*, *chojo* or *carpintero*) that picks a hole in the ripe cacao pods and takes out some cacao beans. One interview-partner (P30) mentioned the *cotorra* (green parrot) as a pest that damages the pods and two interview-partners stated that they do have *peas* (most probably Brown Jays) in their cacao orchards, one considering it a pest (P30); another stated that he liked it (P19). No control measures against birds were mentioned.

Other vertebrate-pests do not seem very important; in the freelists snakes, but *iguanas*, monkeys (all mentioned by P31) and opossums (P20) were mentioned once each.

### 5.7.2. Insect and arthropod pests

Ants (*hormigas*) are the insect pests mentioned by 11 interview-partners (n=29) in the freelists and have therefore the highest frequency of all mentioned insect-pests. In 19 interviews ants are mentioned. Ants are considered a problem because they are said to damage the cacao flower and/or to dry the young cacao fruits (*chilillos*). Three types of ants were mentioned: the *cojonera*, the *arriera* and the *jardinera*. When talking about ants in general, interview-partners usually referred to the *cojonera* ant (Illustration 20).

> *Y también la cojonera, la hormiga también sube al cacao, también lo perjudica. Es un hormigón, cuando se accomada perjudica y también se accomoda en el cocohite. Eso también matamos con el medicamento, fumigamos y se muere. Tienen bastante plaga las arboles madres de cacao. En todo el cocohite hay cojonera casi, si hace daño.* (P16)[65]

The *arriera* ant (leaf-cutter ant) was mentioned twice in the interviews (P25, P26), the *jardinera* once (P25).

> *La hormiga, también lo afecta. Hay una hormiga que lleva como un panal, lo trae así, esta mal. Esa se combate con el Foley.* (P26)[66]

Ants (and termites) were the main targets of the insecticides used by G_highinput farmers. Especially Parathion Metlico was said to be used against ants and termites. In the lowinput/organic group only one interview-partner (P5) combats ants with soap. One farmer (P23) stated that ants can play a role in biological control of other pests.

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65 "And also the *cojonera* ant, it rises the cacao tree and damages it. It is a big ant, when it settles it causes damage and it also settles in the *cocohite*. We kill it with the medicaments (agrochemicals), we spray and they die. The shade trees have a lot of pests. Especially in almost all *cocohite* tree there is *cojonera*, it really causes damages."

66 "The ant affects (the trees), too. There is one ant that carries something like a roof, like that it takes it, it is bad. This one is combated with Foley."

*Aparentemente la hormiga es mala porqué la hormiga se sube arriba y va a perjudicar la florcita del cacao. Pero éste animal se come a otros animalitos. nos ayuda asi, y asi se mata. también hay otro animalito, una hormiga que se llama arriera, es grande y roja. Esa hace su nido, va cortando una mata de cacao, de mango, a cualquier arbol que se sube, miles de animales. Y este animal tiene una tijerita asi, con eso lo poda y cada arriera va trayendo al nido un pedacito. Pero como son miles de animales que forman el nido, por arriba de la tierra y abajo.* (P23)[67]

Termites were mentioned by six interview-partners in the freelist and in 9 interviews. Two types were differentiated: the *comejen de la bola* (nest-termites) and the *comejen de la raiz* (termites nest at the root system).

*Illustration 20: Cojonera ants with associated aphids on cacao flowers (Photo taken by the author 2011)*

Insects other than ants and termites were mentioned frequently but their importance as pest organisms seemed less – their damages were not considered very important during the interviews. The term *gusano* (*engl.* worm) was mentioned in twelve transcribed interviews (P1, P4, P8, P9, P16, P17, P22, P23, P25, P27, P28, P30). Two interview-partners (P16, P23) differentiated into *gusano medidor* and *gusano barrenador* (P1, P4) and one interview-partner (P4) mentioned the *gusano lagarto*. They are all said to eat the leaves and young cacao pods. *Gusanos* are also mentioned as targets for insecticides.

*El gusano medidor que come el chilillo y si no le fumiga uno – pfft tumba al cacao. Es un gusano negro que agarra y empieza a comer la mazorca y la come toda cuando esta chica. Come tal gusano y cae asi. Este hay que fumigarlo. Cuando hay gusano es un problema- brinca y brinca pero lo fumiga uno y se muere pues. Esa es una plaga.* (P16)[68]

67 "Obviously the ant is bad because it goes up [the tree] and damages the cacao-flower. But this animal eats other animals and helps usby killing them. There is another animal, an ant that is called *arriera*, it is big and red. It builds it's nest, goes cutting one cacao tree, mango tree, every tree that it goes up, thousands of animals. And this animal has a scissor, it prunes (the trees) and every *arriera* brings a piece to the nest. But because thousands of ants [are needed to] form a nest, on and under the ground."

68 "The *gusano mediador* that eats the young cacao fruits and if one does not spray it – "pfft", it brings the cacao down. It is a worm that takes the cacao pod and starts to eat it and when it is a small pod the worm eats it whole. The pods are eaten by the worm and fall down. One has to spray it, when there is *gusano* it is a problem – it hops and hops (from fruit to fruit) but one sprays it and it dies. This is a pest."

True bugs (*la chinche*) were mentioned as pests by nine interview-partners (P1, P4, P6, P8, P9, P10, P16, P17, and P23). The true bugs are, besides ants and the *gusano*, G_highinput farmer's main target when using pesticides. The product mentioned most to combat *chinches* is Nuvacron.

> *La chinche, cuando esta floreando el cacao, se acomoda en los pétalos de la flor o del chilli to y se chupa la fortaleza y ya se pone el chililllito amarillto. Pero si le pegas y le bañes con el Nuvacron o con Folimat lo mata y ahi se queda, se seca y se queda limpia la mata. Yes bueno.* (P16) [69]

Apart from *chinche*, the *salivazo* (spittlebug) was mentioned by four interview-partners (P4,P5,P19,P21). This animal is said to cover the cacao flowers in white foam that leads to the flowers death.

*El trips* was mentioned in seven transcribed interviews (P4,P5,P13,P17,P23,P26,P27) as a pest that attacks the cacao trees' leaves and "burns" them. Additionally, four interview-partners (P19, P21, P25, and P27) mentioned *el chamusco* (engl. "the scorched"), a synonym for trips that describes the visual appearance of the trips' damage but can also describe damage caused by abiotic factors. Regarding the exact nature of the trips or *chamusco* some confusion was obvious: Not much was known about the trips occurrence by most farmers. Some farmers were not aware that animals are causing the symptom called *chamuscada* (engl. Burning) and other farmers related it to other insects that were said to "cause" trips.

> *Y hay este, la chinche voladora. Este por ejemplo produce esta enfermedad: el trips. Pone un polvo a la mata, esta tirando toda la hoja y nunca hay produccion.* (P23) [70]

Aphids (*pulgónes*) were mentioned in three transcribed interviews (P21, P4, and P5). As it is the case with trips, at least one interview-partner was confused by them.

> *En verano tenemos los pulgones que producen al trips, no? Los pulgones chupan la savia de las hojas. se pegan a las hojas y se pegan a las mazorcas y los ponen color café. Pero no hacen daño a los granos. Si no hace daños a los granos no hace daño. Pero a la mata si pero le chupa la savia de las hojas. (…) Lo que produce el pulgon se llama trips, como que las mazorcas se queman y de las hojas chupa la savia.* (P5) [71]

Other insect pests, mentioned only once, were *mosquitos* (P17), horseflies (P27), wasps (P17), red spidermites (P15) and grasshoppers (P23).

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69 "When the cacao tree is in flower, the *chinche* makes itself comfortable in the petals of the flowers or the young pods and sucks the power and the young fruit turns yellow. But when you catch it and bathes it in Nuvacron© or Folimat© this kills it and there it stays, it dries and the tree stays clean."

70 "And there is his flying *chinche*, for example, it produces this disease: the trips. It puts a powder on the tree and the leaves fall off and there will never be production."

71 "In summer we have aphids that produce trips, no? The aphids suck the juice out of the leaves, they stick to the leaves and stick to the pods and turn them coffee-colored. But they do not damage the cacao-beans. When they don't damage the cacaobeans they don't damage anything. But to the tree it does damage, it sucks the juice out of the leaves. (…) What produces aphids is called trips. It eats the pods and burns them and of the leaves it sucks the juice."

### 5.7.3. Frosty pod (*Moniliasis del cacao*)

Frosty pod , also-called *Moniliasis*, *Monilia*, *el hongo* or *mancha blanca* by the interview-partners, is the plant disease most mentioned by the interviewed farmers. All interviewed farmers were unprepared and lost great parts of their harvest when its causal agent, the basidiomycete *Moniliophthora roreri*, entered Mexican cacao plots. It is still not known how it got there from Guatemala: Speculations about its introduction range from Middle-American migrants who took infected pods with them to PEMEX that could have willingly brought the disease into the country (mentioned by two interviewed farmers).

> *Si, de un dia al otro [llegó la monilia]. Para nosotros vinieron unas perforadoras de otros lados, de ahi vinieron las maquinas a perforarla tierra – ahi empezó la monilia.* (P26) [72]

*Illustration 21: Cacao pod infected with Frosty Pod (Photo taken by the author 2011)*

*Moniliasis* was mentioned as a plant health problem in all freelists except one (P20) and during all interviews except one (P20). Frosty pod caused and causes severe damages and was the most mentioned plant health problem during interviews and freelists. Most interview-partners were aware of the symptoms caused by *M. roreri* and recommendations by agro-engineers how to deal with it. As there is no fungicide available that is able to treat infected pods and cultural measures are labor and time intensive, many interview-partners considered Frosty pod the biggest threat to their production.

72 "Yes, from one day to another [came the Monilia]. They [Pemex] came to us to make perforations on other places, from there came the machines, perforating the soil – so this is how started the Monilia started."

*No hay control pues. Segun el gobernador ha dicho que hay control pero no hay. No hay, no hay control exacto. Que haya mas control, pero hasta ahora no tenemos, pero no hay. Pidimos a Dios que tengamos un poquito mas de control. Este año apliqué fertilizante al suelo y producia bastante cacao pero no me fue muy bien por la monilia vieno y le gano.* (P4)[73]

Symptoms like deformation in young pods, "white powder" and the heavier weight of ripe pods were known to most interview-partners (Illustration 21). The distinction of infected pods from healthy ones was said to be difficult, especially because not all diseased fruits show obvious symptoms.

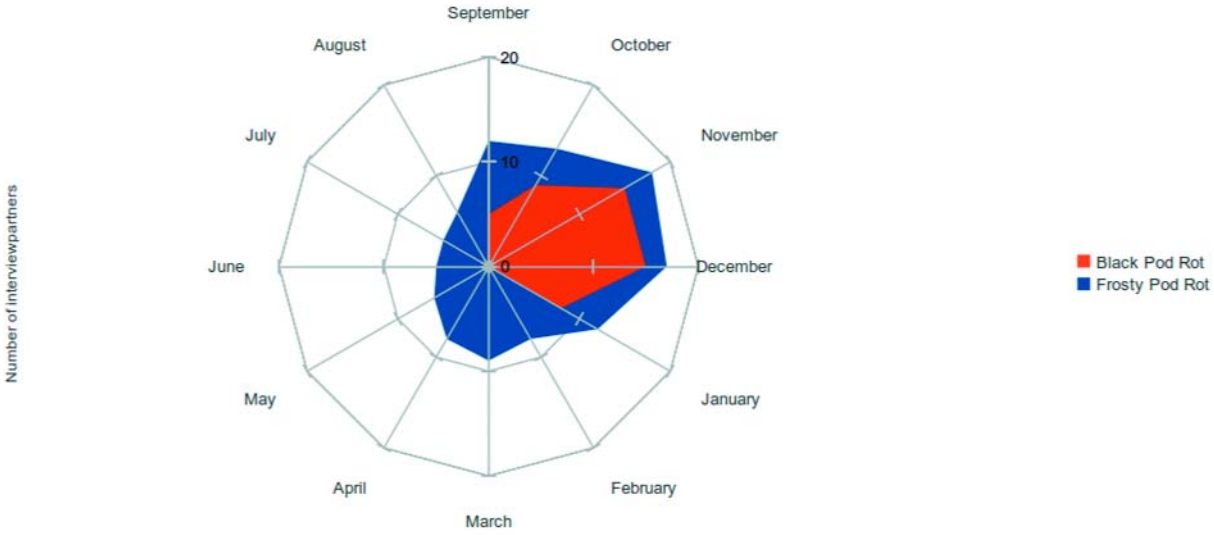


*Illustration 22: Diseases mentioned in seasonal calendar by the interview-partners (n=19)*

Cultural practices like shade reduction, the removing of infected pods and burying them far away from the cacao orchard were commonly known and some said this practices do work, some were not convinced. There is a tendency that farmers of both groups learn to live along with Frosty pod after the initial shock:

*Nosotros lo que hicimos es llevar las recomendaciones que nos dieron los tecnicos del gobierno. Mandaron por aca. Nos recomendaron escampar el arbol que entre el sol y para la sombra igual escampar y tumbar todo que va dañandose, semanal revisandolo, sacandolo y lo picandolo. Ya no sigue la enfermedad. A mi me ha dado resultado. Porqué ya no se contamina no se deja uno para que se contamina arriba. Porqué este polvo se dispersa, viene el viento, el agua y son millones, se expanden, Contamina todo. A mi lo que me*

73 "There is no control. According to the Governor, he said there is control, but there is none. It doesn't exist, there is no exact control. There should be more control, but until now we do not have it, there is none. We ask God to bring us a little more control. This year I fertilized the soil and produced lots of cacao pods – but I had no luck. The Monilia came and won."

*ha perjudicado que tengo un compañero al lado que no aplica este sistema y claro que a veces viene y siempre me contagian a las plantas. Pero si funciona éste sistema. Este año era poco de cacao, no bote mucho dañado.*(P28)[74]

The sudden impact of this disease in Tabasco had led many farmers to sell or abandon their plots, grow sugar cane or change to cattle husbandry instead. The abandoned cacao plots are not cultivated any more in any way but remain as infection herds for Frosty pod, with the infected pods not being removed from the trees, spreading spores to neighbored plants.

*No, no hay ningun medicamento par eso – solamente limpiarlo, que este bien podado y quitar le la sombra. Eso es lo que recomiendan los técnicos. Para ahorita no sabemos que va a pasar.* (P19)[75]

Frosty Pod is perceived as present all year round, but especially in the 'cold' main harvest season' from September to January (Illustration 22).

### 5.7.4. Mancha negra (Black pod disease of cacao)

*Mancha negra* (*P. palmivora*) is the second most mentioned disease (24 times in the freelists). It was called *Mancha negra* (black spot), *Mancha frialdad* (cold spot), *Mancha morena* (purple spot) or simply *Mancha* (spot). *Mancha negra* was considered the most worrisome disease in cacao before the arrival of Frosty pod. Usually different to Frosty pod, even though the pods are affected, the cacao-beans can still be harvested and due to its susceptibility to copper products losses are moderate.

*Vuelvo a repetir lo que más nos molesta es la moniliasis. Antes era la mancha morena porqué también pega fuerte esa, no digo que no pega. Pero la cosa es de que hay control – para la moniliasis no hay control. Quiero decir que si se controla pero no es por eso. Es el sistema que tenemos en el pinche cacao.* (P16)[76]

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74 "What we did was following the instructions from the governmental engineers. They were sent here. They recommended reducing the trees so that the sun can enter and for the shade trees, too, reducing and cutting back everything that is damaged, revising weekly, taking the affected parts off and chopping them. The disease does not go on, for me it brought results. Because now it doesn't contaminate if you don't leave it there to contaminate. Because this powder disperses, comes the wind, the water and there are millions expanding. Contaminates everything. What had affected me was that I have a neighbor that does not apply this system and of course sometimes they come and always they contaminate my plants. But the system functions, this year there was little cacao, I did not have to throw away many damaged pods."

75 "There is no medicine for that – just cleaning it, keep it well trimmed and take away the shade. This is what the technicians recommended. But now we don't know what will happen."

76 "I repeat – what disturbs us most is the *Moniliasis* [Frosty pod]. Before it was *Mancha morena* [Black pod disease] because it also hits hard, I don't say it doesn't hit. But the thing is that there is control, for the Moniliasis there is no control. I would like to say that there is control but not for that [but cultural measures]. It is the system we have in the damned cacao."

Black pod Rot is, as well as Frosty pod , associated with *el frio*, low temperatures and high humidity.

> *Con la mancha negra nosotros lo pasamos, siempre por lo regular la mancha negra llega a la mazorca ya madura. Y te da la oportunidad de cosechar. Cuando esta muy tierno el chililllo lo cortamos, cortamos la mazorca y igual lo enterramos. Ese siempre por lo regular es en diciembre. Hay mucha agua, hay mucho frío.* (P1)[77]

When asked, Black pod was the main reason why my interview-partners applied copper-based products. One interview-partner (P26) stated that since Frosty pod arrived, Black pod Rot had disappeared.

> *La mancha negra se combate, no es gran cosa. Desde que empezo esa enfermedad ya no hay mancha negra, se termino. Ya no combatimos porqué ya no hay – despareció. Yo digo que la mancha negra pega al chilillito cuando esta chiquitito. Tres, cuatro bañadas y ya esta maduro. Pero este ya no, viene de a dentro, el arbol ya esta contaminado.* (P26)[78]

### 5.7.5. Other diseases

Regarding diseases other than the ones caused by *M. roreri* and *P. palmivora*, little were mentioned during the interviews. Three farmers (P5, P8 and P21) did mention *escoba de bruja* two interview-partners (P5, P21) as a potential threat and one (P8) as already existing in their cacao orchards.

> *La escoba de bruja- todavia no sé cuando empieza el problema. Aqui todavia no se ha presentado éste problema.* (P21)[79]

After insisting on a description of symptoms it resulted that most probably *M. roreri* was meant by P8, because this interview-partner did not refer to Frosty pod . Other diseases mentioned in the freelists were *mal de machete* twice (P1,P4) and *el cancer* (cancer) by one farmer (P28), but both diseases do not cause severe damage and were not considered important.

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77 "With Black pod we go on, regularly the Black pod infects ripe pods. And it gives the chance to harvest. When the fruit is still young, we cut it and we cut the ripe pod and we also bury it. Usually it occurs in December. It is when there is a lot of water and cold."

78 "Black pod can be fought, it's no big deal. Since this disease [Frosty pod] started there is no Black pod anymore, it ended. We don't treat it anymore because it is not here anymore, it disappeared. I say that that Black pod hits the young fruit when it is small. Three, four baths [with fungicides] and it is ripe. But this other one not, it comes from within, the tree is contaminated."

79 "Witches broom – I don't know when this problem will arise. Here this problem was not found till now."

### 5.7.6. Abiotic 'pests'

When asked to list pests and diseases for the freelist, five interview-partners (1 G_highinput, 4 G_low-input/organic) did mention *el ratero* (*engl.* pilferer) explicitly as a pest. In the transcribed interviews theft as a problem was mentioned various times by 10 interview-partners (P1, P2, P5, P8, P17, P22, P23, P27, P28, P30). Theft of the ripe cacao pods is a common problem for cacao-farmers in Tabasco and losses are difficult to estimate. As one interview-partner (P2) stated, *la rata de dos patas* (the rat with two hands) causes her about 10 % to 20 % loss. Measures against theft are difficult to take and some farmers complained about missing authorities.

Two interview-partners (P11, P12) named pollution caused by the Mexican petroleum company PEMEX in the freelists as a pest and during the transcribed interviews contamination and the problems related were mentioned by fifteen interview-partners (8 G_highinput and 7 G_lowinput/organic). The farmers stated that they were affected by acid rain caused by burning sulfitic gas (a byproduct of oil-drilling, in large amounts), the fear of expropriation (if oil-reserves were found on their ground) and polluted air and water that affect cacao-trees.

### 5.7.7. Non-pest organisms

Biotic organisms that were stated during the interviews but not considered pests were mostly birds, especially the *pea*, iguanas and certain insects as pollinators. *Iguanas* were mentioned by four interview-partners (1 G_highinput, 3 G_lowinput/organic) because the lizard is eaten and appreciated for its taste. Birds were considered beautiful animals by 5 interview-partners (all G_lowinput/organic) and one interview-partner explicitly mentioned birds as useful against insects. Ants were mentioned by one interview-partner (P23) as both harmful and useful as they do, according to his statement, damage the cacao flowers but also eat other undesired insects. The existence of cacao-pollinating insects was only know to 8 farmers of the G_lowinput/organic who visited an organic workshop or had further interest in the topic (P1 and P31). Despite the knowledge of the existence of a so-called *mosca polinizadora* (pollinating fly), according to their statements none of the 8 interview-partners were able to identify this insect. P22 and P21 both stated that there is a decline in population of this insect, together with a general decline of biodiversity in the region and that they noticed this by less cacao pods being developed. In contrast, most farmers of G_highinput regarded all insects in their cacao plots as negatively interfering with their production.

## 5.8. Attitude towards pests, diseases and their ecosystem

### 5.8.1. Attitude towards pest and diseases

Attitude towards pests and diseases did vary among interview-partners. Attitude towards squirrels for example differed considerably among the interview-partners: most said they were a very big threat and tried to fight them.

*La ardilla lo que pasa es que agara la mazorca en cualquier tipo y tamaño, y éste, la mastica y come todos los granos y realmente si hace bastante daño. Porqué si se encuentra hasta cuatro, cinco mazorcas nada mas y eso es perdida. Si, si, si hace daño. Es una plaga. Mis compañeros no sirve de nada que lleven rifle y las matan porqué si logicamente […] A parte de eso te digo que si [hay otra medida de control]. Nosotros eramos parte de la fauna. Y era un equilibrio. Porqué nosostros teniamos un tipo de actitud como la ardilla. La contaminacion, todo yiendo, bueno.* (P1) [80]

In contrast to this, four farmers of the lowinput/organic group stated that they try to live alongside squirrels.

*Pués la gente si lo [ardilla] mata. Pero yo mi planta, no he matado ni uno. Como vuelvo a decir todos los animales tienen que comer, no se puede matar. Por ejemplo un zorro a nosotros no nos sirve pero sirve para otra cosa. a nosotros no nos sirven pero los animales asi son. son cosas que dios nos dejo, que hacemos por ejemplo como acabar con esos animales? pero el ser humano es asi, vienen unos chamacos, andan volando ahi con tirar hasta quien sabe. asi somos nosotros, asi es la gente, en todos lugares asi. yo ahorita en las noticias, en las programas se oye que hay que cuidar, que no se maten.* (P23)

Frosty pod was considered by most interview-partners more harmful than the damages caused by squirrels.

*La [ardilla] negra lo come maduro y luego la chupa, por lo menos a veces deja algunos granos y lo llevamos. Pero la moniliasis no. Y la ardilla roja esa lo come tierno, o el puro chililllo.* (P22) [81]

Farmers of G_highinput tended to complain more about insects as plagas than farmers of G_lowinput/ organic during the interviews. Ants, especially, were considered harmful.

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80 "What happens is that it (the squirrel) takes the pods of every type, every size and chews it, eats all the cocoa beans and really causes harm. Because sometimes one can find up to 4 or 5 pods, nothing more and that is lost. Yes, yes, yes it harms. It is a pest. My comrades are not worth anything, going out with rifles to kill because it is logical […] Apart from that I say yes [there is another way of control]. We did arrange ourselves with parts of the fauna. It was equilibrium. Because we had a kind of attitude, like the squirrel. The pollution, everything goes away, well."

81 "The black squirrel eats it ripe and afterwards it sucks, at least sometimes it leaves some beans and that we take. But Frosty pod doesn't. And the red squirrel, this eats it green, or the young fruits."

*Quema el chililito, la flor asi. y se sube. Ahorita que va llegar la lluvia, van a salir de la tierra y suben. Y ahi,estan chupando miel. por eso se fumiga. Pero como no quieren que le heche uno nada, esos del organico, quien sabe. si quieren eso, lo vendemos al coyote. Digo que por eso vino la moniliasis porqué lo dejamos, un tiempo en que no fumigamos nada. Si habia, de vez en cuando unas de estas palmadas así pero como se fumigaba no entraba. Pero como luego nos decian que hay que dejar las insecticidas lo dejamos. y claro que la planta estaba debil para esa enfermedad. Y sacarla no es tan facil ya.* (P27)[82]

Frosty pod was considered a destructive invader that impedes cacao cultivation; but signals of adjustment from farmers were noticed during many interviews and the disposition to adapt to the new situation. Frosty pod is now believed to stay and after the high expectations for a quick and easy solution at the beginning of it's invasion in Mexico were disappointed, the interviewed farmers try to live along and adapt: *La Monilia vino a quedarse.* (P1)[83]

### 5.8.2. Attitude toward pesticides

There was a difference in their perception about pesticides between the highinput and lowinput/organic group. Pesticides were generally perceived as useful and to be working by G_highinput. In two cases they were compared by the respondents with medicine for sick people.

*Tienes que ir poniendole todo, cómo a un ser humano, no? Cuando está enfermo tiene que medicinarlo. Así igual esta la planta.* (P8)[84]

Health hazards for the cacao producers in the highinput group were in most cases known but not considered a serious problem. The most prominent reasons not to use agrochemicals for G_lowinput/organic were the regulations of the organic certification agency, the lack of financial resources and concern for health and the environment (Illustration 23).

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82 "They burn the young fruit, the flower and it goes up. Now the rain will come and the ants will leave the ground and go up. And there they suck the honey [out of the flower], that's why they are sprayed. But as the ones from the organic don't want us to treat them, who knows, they want that we sell to the intermediary. I say that for that came Frosty pod because we did not spray for some time. Yes sometimes there were nests from time to time but as we sprayed they did not enter. But later they told us to stop spraying insecticides we stopped using them and of course the plant was weak towards this disease. And getting rid of it is not that easy."

83 "Frosty pod came to stay."

84 "You have to give it everything, like to a human being, no? When it is sick one has to treat it with medicine. The plant is the same."

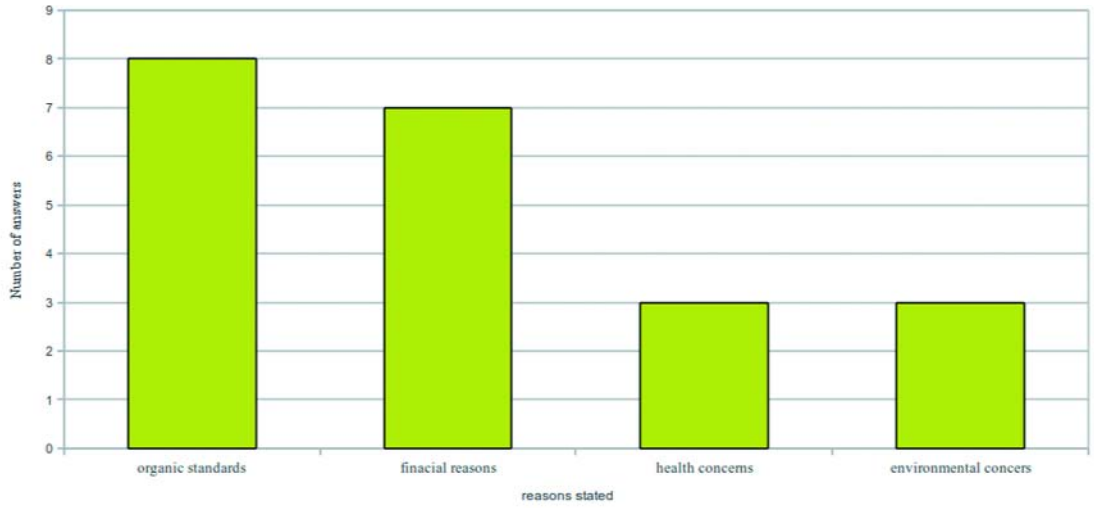


*Illustration 23: Reasons for not using pesticides of the G_lowinput/organic (n=16, multiple answers possible)*

The reported pesticide use in the cacao plots varied regarding the financial means of the interview-partners and accessible labor, personal attitude and products used. All farmers of the highinput group did use synthetic pesticides, especially insecticides, in the season 2010/2011 while in the lowinput/organic group no synthetic pest-control products were used (except P30 and P28). Among most farmers of both groups, there is awareness that agrochemicals can cause both health and environmental damage.

> *Inmediatamente se intoxica uno. Tiene que usar guantes y todo. Se han muerto ya algunos, asi los chambeadores no quieren tirar eso porqué es peligroso. Vienen unos estuches de no sé, hay que enterrarlo. Es peligroso, es delicado para el ser human, tanto para el ser humano como para todo. Lo que se llama el Metilico y el Polinol son de contacto, uno lo tira y se muere. Pero el pinche Nuvacron ahí, uno lo fumiga y sube y baja en el arbol. Sistémico. Va por las ramas, viene un animal en la noche, se pega y ahi se queda. Es sistémico. Si hoy fumigamos Nuvacron no es recomendable entrar mañana a la planta, pues sino dejarla.* (P16)[85]

Health problems due to pesticide application were reported, without explicit questioning during the interviews, from 5 interview-partners (P1, P16, P23, P27, and P28). There were many programs in the past that explicitly encouraged pesticide use in agriculture, supporting farmers with free products but not always with proper application instructions:

85 "Suddenly one is intoxicated. Gloves have to be used and everything. Some have already died, so the workers don't want to spray anymore. Because it is dangerous. There are cases of something, I don't know, one has to bury them. It is dangerous; it is difficult for humans, for humans and all others. What is called Metilico and Polinol are contact [insecticides], one does spray and they [the insects] die. But the 'fucking' Nuvacron here, one does spray it and it goes up and down in the tree. [It is] systemic. It goes through the branches and there comes an animal in the night and there it stays. It is systemic. If we would spray Nuvacron today it is not recommended to go tomorrow into the orchard, but stay away from it."

*Ya ves que para tirar insecticidas verdaderamente no hemos tenido el apoyo. Como verdaderamente tantas personas aqui se han muerto por problemas de manejar muchisimos insecticidas, mucho herbicida. Porqué cuando era colectivo se tiraba muchisimo para el platano y se mantenía sin hierba, sin nada de maleza. En la planta de cacao igual se tiraba muchísimo, se polviaba con bomba de motor y se aplicaba muchismo Nuvacron, todo esa cosa pues. La verdad, esas son cosas que vineron para proteger a la planta. De verdad tuvimos muchos problemas y muchos companeros se murieron de eso. Y muchos compañeros son alergicos que ni si quieran entrar donde hay herbicida. Pero eso es porqué no dan el apoyo que verdaderamente se necesita. Porqué que caso tiene querer solucionar el problema cuando se pudo prevenir, es como querer tapar el pozo una vez que el niño se ha muerto Eso es que aqui en el campo ha venido. en todas la cosas. Ahorita parece que se esta controlando un poco mas porqué de buena fe vienen algunas personas como los presentes ustedes y tenemos la amabilidad de placticar con ellos y mas o menos lo que queremos escuchar, ya no creemos nada. La verdad, nosotros hemos estado ahi hasta ahorita nada mas que aguantando.* (P23)[86]

Effects of pesticide use to non target organisms were mentioned only by one interview-partner explicitly (P28).

*No nos perjudican los animalitos que comen, no es rentable matarlos. Le vuelvo a decir que el tecnico dijo que si los animales por hectarea comen 50 kg, es lo mas que puedan comer. Pero si uno mata por ejemplo la mosquita, los animalitos que nos ayudan en la produccion, menos es la produccion.* (P28)[87]

86 "You see we did not really have much support for insecticide spraying. So many people died because of problems to manage so many insecticides, so many herbicides. Because when it was a collective, much was sprayed on the plantain to keep it without plants, without weeds. Also, in the cacao orchards much was sprayed, a lot of powder was applied with motorized pumps, a lot of Nuvacron, all these things. In reality, these are things that were introduced to protect the plant. Actually, we had a lot of problems and many companions died because of that. And many companions are allergic, they cannot enter [a plot] where herbicides are applied even if they want to do so. This is because we did not get the support we needed. What does it help to have this problem when there is a saying: Where the child plays, the well should be closed. This is what is happening in the countryside with everything. Now it looks like it is more controlled now because from time to time people are coming, like you, with whom we talk as a courtesy and we more or less listen to things we like, but we don't believe anything anymore. Indeed, until now we do nothing more but to abide by the regulations."

87 "The animals eating (in the cacao orchards) don't harm us; it does not pay off killing them. I repeat to tell you that the engineer said that the animals eat 50 kg per hectare, that's the maximum they can eat. But if one kills for example the mosquita (pollinating fly), the animals that help us produce, and the production is less."

### 5.8.3. Perception of environmental pollution

Pollution was a recurrent topic during the interviews. Mentioned were acid rains, pollution of air, water and soil as well as a tendency of higher temperatures in general.

> *Es que antes aqui el sol no calentaba como calienta ahorita. Los calores no eran los mismos que ahora, antes uno podria estar trabajando todo el día a mitad del sol y no se sentia tanto el sol. Y ahora cuando sale uno un rato y se mete, un fuego que le cae. La temperatura antes estaba a 30, 35 grados. Ahora tenemos temperaturas hasta de 45 grados. Las plantas también lo sienten. Las matas necesitan agua pero no llueve. Y eso es lo que mata aqui en Tabasco. Cuando llueve es una cosa que perjudica. Y cuando no llueve también perjudica porqué no hay agua. Si pasan dos meses que no llueve. Ahora hace un mes que no llovia. Estamos en Marzo. En Huimanguillo si llovia hace 3 dias creo pero aqui no.* (P13) [88]

Especially contamination caused by petroleum and gas exploration was blamed during some interviews with farmers of both groups to be responsible for damages to the cacao trees.

> *La contaminacion del PEMEX también nos ha afectado muchisimo. PEMEX nos ha acabado, eso se va afectando. Ya no produce la caña tampoco. Antes, hace unos 20 años, una hectárea daba 110, 120 toneladas de caña. Ahora el que cultiva bien cultiva 80, 90 toneladas. Ahora tiene buen precio, sale a 600 pesos y tanto mas o menos la tonelada. El cultivo de la caña al principio hay mucho trabajo pero despues ya no, se espera. En cambio el cacao tiene mucho mas trabajo: jileando, podando,desmamonando, fumigando como lo hicimos anteriormente. Ahorita ya no hay. Ahorita la verdad tienen sus plantas perdidas, abandonadas.* (P19) [89]

Environmental pollution was one factor, together with the lack of favorite political structure of cacao farming, the absence of successors for the plots and increased pest pressure, that led by some interviewpartners to a rather pessimistic view of the future and especially cacao cultivation.

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88 "Formerly, the sun did not heat like it does now. The heats were not like they are now, before one could work all day in the sun and didn't feel the sun much. And now one goes out for a moment and goes (working), a fire catches him. Temperatures were about 30, 35 degrees (Celsius). Now we temperatures up to 45 degrees. The plants do also feel it. The trees need water but it is not raining. And this is what kills here in Tabasco. When it rains it is something the harms. And when it does not rain it also harms because there is no water. There pass two months without rain. Now it is one month without rain. We have March now. In Huimanguillo it rained three days ago but here it didn't."

89 "The pollution of PEMEX has affected us severely. PEMEX had finished us, this is still affecting us. Now the sugarcane isn't producing anymore neither. Twenty years ago, one hectare gave 110 or 120 tons of sugarcane. Now if you are a good cultivator you get 80 to 90 tons. It has a good price at the moment, 600 pesos more or less for the ton. When you cultivate sugarcane, at the start you have a lot of work but then not any more, you just wait. In contrast, cacao is much more work: weeding, pruning, cutting of branches, spraying like we did before. Now it does not exist anymore. Now, to tell the truth, they have their abandoned plants, they are lost."

*El campo se va a terminar, en Tabasco dentro unos 20 o 25 años el campo va a estar en completo abandono. SOLO EL CACAO O TODO? El cacao ya esta abandonado. Me gustaria que fuera a unos ranchos que conozco. La lengua de vaca esta a 7 metros, los estolones de la lengua vaca uuuu. El que tiene una cosa que la cultiva. Pero no quieren trabajar. Quieren que uno les ayuden. El gobierno debe ayudar y a uno le toca su parte. Cada quién lo que le corresponde. Así lo entiendo.* (P13) [90]

## 5.9. Information about pests and diseases

When asked from where my interview-partners did get their information about pests and diseases, they stated one to four sources, on average two sources. There was no statistical significant difference between the two groups regarding number of information sources (df=25, $p_{(T\text{-}test)}$= 0.86). Most prominent were television and agro-engineers, followed by associations, friends/neighbors, farming stores, radio and newspapers (Illustration 24). Farmers of the lowinput/organic group additionally stated

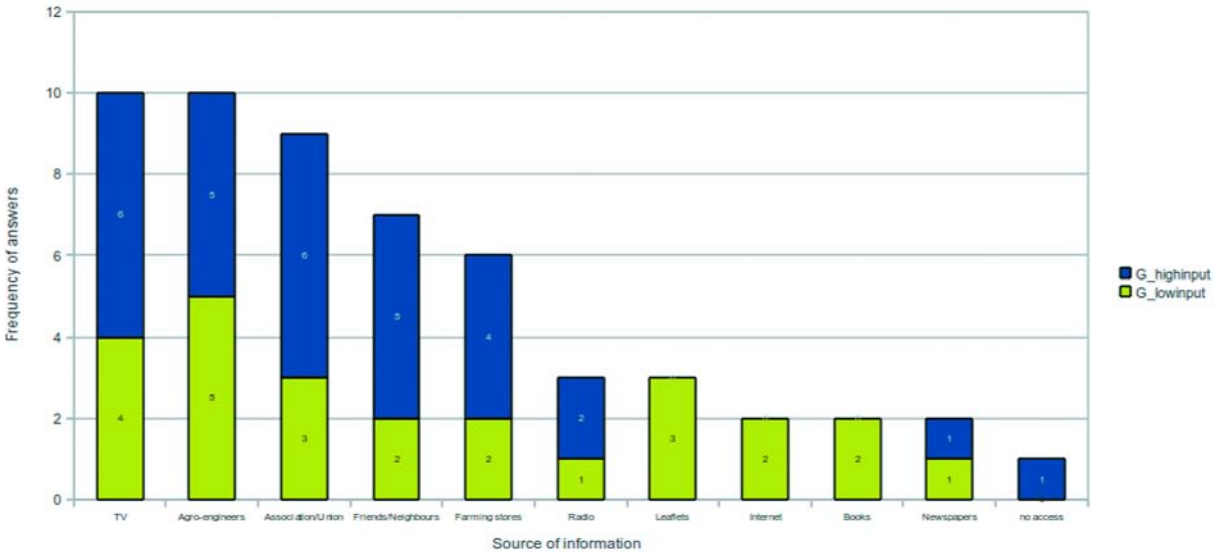


*Illustration 24: Frequency of sources of information about pests and diseases for farmers of G_highinput (n=15) and G_lowinput/organic(n=12), multiple answers possible*

leaflets, Internet and reference books where they can look up information. Information on Frosty pod was provided mainly by agro-enigneers from government institutions and most farmers reported of recommendations given to them. Notable is the fact that no interview-partner from either group mentioned workshops or presentations from organic groups.

90 "The countryside will go down, in Tabasco during the next 20 or 30 years the countryside will be completely abandoned. JUST THE CACAO OR EVERYTHING? The cacao is already abandoned. I would like you to go to some farms I know. The *lengua vaca* [a weed] is 7 meters high, the stolons of the *lengua vaca*, uuuu. Who has something should cultivate it. But they don't like to work. They want that somebody helps them. The government should help and everyone has to do his own responsibility. Everybody is responsible for his/her own part. That's how I understand it."

*Mira te voy a dar una sugerencia. Aquí los tabasqueños somos muy flojos. La solución, como ya sabemos que la moniliasis existe y ya sabemos como combatirlo, depurando depurando depurando. sabemos de la mancha negra y sabemos del sulfato que puede combatirla, con la poda, la jilea para acabar con las plagas. Noticias para seguir adelante. Pero como somos tan flojos nunca hacemos eso – por eso estamos donde estamos. Pero toda la información sobre la moniliasis lo tenemos, sobre la mancha negra la tenemos, sobre la ardilla lo tenemos y tenemos la prueba. Nada mas falta poner en práctica los conocimientos que ya tenemos. Si no lo ponemos en práctica no nos sirve.* (P1)[91]

# 6. Discussion

## 6.1. Socioeconomic background of farmers

The farmers of both highinput and lowinput/organic groups do not differ significantly regarding any socioeconomic factor covered in this thesis. Both groups tend to be advanced in age, which is consistent with the findings of MARTÌNEZ ARBOLEYA (2007) in his thesis where the average age of 28 cacao producers in Comalcalco, Tabasco was 66 years. He refers to possible problems arising of this fact: the adaption of new technologies and practices tends to be lower as well as physical fitness needed for labor necessary in the cacao orchards decreases with seniority. There may be problems with unclear inheritance of the land and fragmentation through inheritance. Cacao cultivation may not be an attractive business to start for young people (MARTINEZ ARBOLERA 2007).

There is no difference between the groups regarding sex neither. Fact is, few women were interviewed but this may reflect the actual situation in Tabasco's agricultural sector (INEGI 2012): "Typical" tasks described by women in the *cacaotales* were for example, the opening of the cacao pods (*quebrar mazorcas*) after harvesting and sometimes, if performed, the drying and preparation of the cacao beans. There are women doing field work but the interviewed female farmers were rather the *dueñas* (owners) of the cacao plots than the workers. One socioeconomic factor that may have been important was not included in this study, was education: I had the impression that farmers with a higher level of education tended to be more aware of pest organisms and other animals in their cacao plots. But as I did not collect that data, it could not be tested.

91 "Look, I will give you a suggestion. We Tabasqueños are very lazy. The solution, as we already know that Frosty pod exists and how to combat it, elaborating, elaborating elaborating we know about Black pod and we know about the copper that can fight it, the pruning and weeding to end with pests. This is news to go forward. But as we are so lazy, we don't ever do it – that's why we are where we are. But we have all the information about Frosty pod, about Black pod, about the squirrel and we have evidence. The only thing missing is implementing the knowledge we already have! If we don't implement our knowledge, it doesn't help us."

## 6.2. Appearance of and tasks in the cacao plots

Regarding the appearance of the cacao plots the groups did not differ except in size. This can probably be explained because of three interview-partners of the lowinput/organic group possessed more land Other explanation models like, for example, a link between more land resulting more probably in an input reduced cacao-cultivation, cannot be underlined with the literature. Data obtained about yield, age of cacao trees and management practices in Tabasco are consistent with findings of PRIEGO CASTILLO et al. 2009 and ALCUDIA AGUILAR et al. 2009. Striking differences between the amounts harvested were also mentioned by ALCUDIA AGUILAR et al. 2009, reporting a variance of a few kilos to 1700 kg per hectare. In their research in Comalcalco, Tabasco, the average age of cacao trees in 34 cacao plots was 38.1 years, older than the average in this thesis of 27.3 (G_highinput) and 27.8 (G_lowinput) years. As a reason for the relatively advanced age of cacao trees in Tabasco the advanced age of cacao producers has to be considered as well as economical reasons that make cacao cultivation a risky, more unattractive business compared to other agricultural activities like sugarcane or cattle grazing (MARTÌNEZ ARBOLEYA 2007).

## 6.3. Comparison of named animal pests and diseases to literature

### 6.3.1. Diseases

The fact that Black pod and Frosty pod are the most prevalent cacao diseases in Tabasco (LOPEZ ANDRADE et al. 2007) is reflected in the interviews. As it is stated by CUERVO PARRA et al. 2011, wherever on the American continent *M. roreri* has invaded, cocoa production has been severely affected: the authors estimate the fall in production of between 40% to 70% in Mexico in 2008. This is consistent with the figures obtained via the semi-structured interviews and the declaration of most interview-partners that damages by Frosty pod are less compared to previous years. *Mal de machete* (caused by *Ceratocystis fimbriata*, an ascomycet) and *el cancer* (engl. cancer, sometimes caused by *Phytophtora palmivora*) were named by my interview-partners and are present in Tabascan cacao plots. Not mentioned, however, were *antracnosis* (caused by *Colletotrichum gloeosporioides*) and the *amarillamiento de los chilillos* (yellowing of young fruits, caused by abiotic factors), also present in Tabasco according to RAMIREZ GUILLERMO and LOPEZ ANDRADE 2011 but not causing major losses.

### 6.3.2. Animal Pests

Concerning squirrels, three species are reported in Tabasco: *Sciurus aureogaster*, *Sciurus deppei* and *Sciurus yucatanensis*, whereby the first two are widely distributed within the state of Tabasco (CEBALLOS and OLIVA 2005). There are no recent studies about the populations' distribution or migration movements. Both species can damage cacao fruits but their actual importance as pests in cacao depends over all on their population size. The numerous statements of cacao farmers about squirrels' presence

in cacao and their damage demand further research. The named birds perceived as damaging cocoa production: woodpeckers (*cheje*, most probably *Melanerpes aurifrons*), *cotorras* (Bird family of Psittacidae) and *peas* (*Psilorhinus morio*). They are all common in Tabasco's agroforestry habitats, that provide space for many bird species (VAN DER WAL 2012). As in the case of birds, the compared to other, more intensive, cultures, cacao plots do provide refuge for ants, too. Ants were the most mentioned insect pests, the ones most named were the *cojonera* (*Crematogaster unispinosa*), the *arriera* (*Atta cephalotes*) and the *jardinera* (*Azteca sp.*). They are perceived as harmful and damaging although it is more probable that, except for the leafcutter ants (*Azteca sp.*), they do not harm the cacao plant but are associated with aphids. Aphids can cause sucking damage on flowers, leaves and young fruits. The aphid most common in Tabascan cacao orchards is *Toxoptera aurantii* (Hemiptera: Aphididae), and various species of ants are associated with them in mutualistic symbiosis because of the secreted honeydew (RAMIREZ GUILLERMO and LOPEZ ANDRADE 2011). The diversity of ant species in cacao orchards rises the lower the intensity of the cacao plots and they can play an important role as predators of pests (PHILPOTT and ARMBRECHT 2006). The termites (*comejen*) probably correspond to *Nasutitermes corniger*.

What is just called *gusano* or worm refers most likely to a group of different species of Lepidoptera larvae (SANCHEZ SOTO 1992) that attack young fruits (the *chilillo*). About *gusano mediador*, *gusano barrenador* and *gusano lagarto*, no literature was found that explicitly mention these terms, though it is probable due to my observations in the cacao plots that they are Lepidoptera larvae, too. The *salivazo* (spittlebug) most probably refers to *Clastoptera globosa* (Homoptera: Cercopidae), causing damage by eating young plant tissue and by covering flowers and young fruits with "spit" and thereby interfering with their development (RAMIREZ GUILLERMO and LOPEZ ANDRADE 2011). *Selenotrips rubrocinctus*, called *trips*, *piojillo* or *chamusco*, is polyphage and aliments by sucking cacao leaves and fruits and prefers little shade (RAMIREZ GUILLERMO and LOPEZ ANDRADE 2011).

The term *chinche* (mirid) probably refers to various species of mirids, for example *Shalbergella sp.*, *Distantiella sp*. and *Helopeltis sp.* (Heteroptera: Pentatomidae) (CORDOVA AVALOS et al. 2001).

## 6.4. What are the properties of a pest-organism as defined by the interview-partners? What makes an organism a potential threat on cacao plots? What are the differences in perception of these organisms by G_high-input and by G_lowinput/organic cacao farmers?

A pest organism in cacao orchards has to damage the cacao plant in some way: organisms that do not affect the cacao plant but the farmer him/herself (like *mosquitos*, snakes and horseflies) were just mentioned by one farmer as pests. Many different aspects are involved why an organism was called a *plaga* by my interview-partners. Economic reasons played the most dominant role in the definitions but also

ecological and sociological reasons were stated. Not surprisingly, the economic damage to the farmer caused by an organism does most of all define its "pest status". Diseases are considered much more important than animal pests of which squirrels and various insects were the most mentioned. Knowledge about insects seemed to be rather little and some interview-partners confused especially small insects like trips and aphids or did not state them at all. Ants were held responsible for the damage to flowers and leaves that were most probably caused by associated aphids; one possible explanation for this is that ants are easier to observe and thus better known to farmers (BENTLEY and RODRIGUEZ 2001).

As in the investigations of SEGURA et al. (2004) in Chiapas, the terms "pest" and "disease" were often used as synonyms, whereby the term *plaga* was more commonly used than *enfermedad*.

Abiotic constraints to production like pollution and theft were called pests, too. The consistent mention of terms related to temperature (*caliente, frio, mancha frialdad*) was also reported by BENTLEY 1990 and SHERWOOD 1997: BENTLEY 1990 investigated Honduran farmers that refer to plant diseases as *hielo* (ice) and differentiate between different types of diseases or *hielo*. According to him there has been a semantic extension – the term *hielo* was not only used for frozen water but also for cold rain, hail and also plant diseases. The causes of these diseases are often (but not exclusively) believed to be related with climate, especially wind that comes with heavy rainfalls (*el norte*), cold rain or excess water in the soils. SHERWOOD 1997 also describes the term *hielo* as common for fungal diseases in rural Honduras and that farmers often do not know about fungi as a causal agent. The author states that before visiting workshops, the farmers did not know about the symptoms and life cycles of disease-causing agents as they were unable to see microbes. Even though most of them were familiar with the words bacteria, fungi, nematodes and virus the actual meaning was not clear to them. The term *hielo* itself was not used during the 32 interviews but as cited by BENTLEY 1990, WILKEN 1977 noted that in South Mexico, farmers define fertilizers and certain crops as 'hot' or 'cold'. According to him, chemical fertilizers were not believed to improve the soil because of their 'cold' properties in contrast to natural fertilizers that were considered 'hot'. In this thesis, the term *caliente* (hot) was used as a property of pesticides as well as for some pest organisms, fertilizers were not explicitly mentioned.

Regarding the knowledge of pests and diseases it was expected that G_lowinput/organic farmers are better informed because of technical assistance offered to the farmers participating the organic programs. Actually this can not be stated, except a weak (because of the little number of answers) significance about the knowledge of beneficial insects could be noted. Farmers of the lowinput/organic group were vaguely informed about them while none of the highinput group did know of their existence. It is confirmed in numerous publications (SEGURA et al. 2004, BENTLEY 1989, VAN MELE et al. 2001) that farmers often have little knowledge about the existence and role of beneficial insects.

The little difference between the two groups studied in this thesis may results from the heterogeneity within the G_lowinput/organic. Another possible explanation is the fact the organic cacao farming in

Tabasco started as a top-down approach by the government with the aim to gain access to organic markets. Top down approaches make it more difficult to motivate farmers for organic farming, especially when the promised financial benefits were not fulfilled.

Insects were not mentioned more frequently or as more harmful during the interviews by G_lowinput/ organic farmers even though no control measures were taken against them. On the contrary, insects were a less important topic for farmers who did not control them in any way which suggests that the use of insecticides does not result in less perceived harm of insects. This is, however, not consistent with the findings of SEGURA et al. (2004) who claim that among nonorganic farmers, non pest-related constraints are regarded higher than among organic farmers. This suggests that the use of agrochemicals results in less concern about pests and diseases treatable with agrochemicals.

## 6.5. How can the relationship between the interviewed farmers and pests/diseases be described?

Not all farmers consider animal pests as a serious problem, especially some G_lowinput/organic farmers stated that animals do not harm their production seriously. This may results from the fact that moderate losses due to animal pests are already taken into account. But compared to the findings, for example, of MORALES and PERFECTO 2000 I was unable to find traditional expressions or sayings regarding pests or diseases of cacao (or cacao cultivation as such). Despite Tabasco's long history of cacao cultivation, it appears that little knowledge was shared over generations to the interviewed cacao-farmers. Due to their recent introduction, the presence of Frosty pod and squirrels not much knowledge among farmers was passed on, except recommendations from agricultural engineers. Generally, most interviewed farmers showed a certain resignation, resulting from pest- and disease pressure, together with environmental pollution and the perceived lack of a successful political representation.

## 6.6. What are the pests and diseases (as defined by the interview-partners) that are the most undesired? Why is that so? What are the measures taken against them by the interviewed farmers?

What I consider outstanding is the fact that the animal pest and the disease most mentioned and considered to cause most harm are both newly introduced and cannot be treated with agrochemicals: Frosty pod and the squirrel. Because of this, both groups have the same (limited) options to deal with them. As for Black pod Disease, that can be treated with copper-sulphate which is permitted by organic standards, both groups share a similar opportunities regarding agricultural measures which is also true for the dealing with the 'pests' of pollution and thieves. In accordance with ALCUDIA AGUILAR et al. (2009) nearly all interviewed farmers did remove infected pods with Frosty pod. In contrast to his study of 30 cacao farmers in Tabasco where half of the farmers applied the chemical treatment against Frosty pod, the majority of farmers interviewed by me were aware of the ineffectiveness of chemical products

against *M. roreri*. The only difference regarding pest treatments concerned insect-pests: Insects are not considered a major threat to their production by neither group although considered important enough for farmers of G_highinput to invest in both labor and financial resources to treat them with insecticides, some of them consciously taking health and environmental risks. WILSON and TISDELL 2001 offer various reasons why farmers continue to apply pesticides and state that reasons differ from region to region and countries to countries but strongly emphasize a 'lock-in' aspect of pesticide use: once a farmer starts to use pesticides it is difficult to stop.

Ecological awareness was, if included into to decision on farmer's level, sometimes an additional, but never the main factor for participating in the organic program. Uncertified organic farmers were most likely to state health and environmental reasons for not using agrochemicals (except copper-based products). As seven farmers of the lowinput/organic group mentioned that they do not use agrochemicals mainly due to financial reasons, they may not consider ecological reasons at all (at least they did not mention them).

## 6.7. What sources of information about pests and diseases are accessible to cacao farmers?

Preferred sources of information for the interviewed farmers in this thesis were television, agro-engineers, meetings in the association or Union as well as friends/neighbors/colleagues. Television, as well as radio and newspapers, offer general, often basic information about plant-health problems in the region. Agro-engineers can offer more specific and detailed information about problems concerning the individual farmer and sometimes even take a look at the situation at the plot. Farmers belonging to an association stated they have more opportunities to obtain information there via colleagues and agro-engineers on their meetings. As it was stated by DEMIRYUREK (2010), information systems for organic and conventional hazelnut producers in Turkey are different; organic hazelnut producers used more different information sources and benefited more from them. This can be neither confirmed nor rejected for the interviewed organic farmers in this thesis. Certified organic cacao farmers in Tabasco did not profit explicitly from the often one-time workshop regarding their knowledge about pests and diseases. Infrequent workshops for certified organic farmers did spread the knowledge about the existence of beneficial insects among their participants as well as the recipe for an 'organic brew'. But this knowledge remained very vague and had no detectable consequences in the reported farming practice. This probably results from the fact that in contrast to DEMIYUREK (2010), organic farmers had no higher socio-economic status in terms of producers' personal characteristics and farm structure.

# 7. Conclusions and Forecast

In this thesis it was possible to draw some conclusions from farmers' interviews about their perception of pests, diseases, agrochemical input as well as the perception of organic agriculture. The findings let me conclude that the concepts of 'pest' and 'disease' of highinput – and lowinput/organic cacao farmers do not differ *Plaga* is the dominating term for biotic as well as some abiotic factors affecting cacao production. Major plant health problems for farmers of both groups G_highinput and G_lowinput/organic are caused by two diseases (Frosty pod and to a lower extent Black pod Rot) and squirrels; measures taken against them do not differ between farming systems. Knowledge about insect pests was scare in both groups, for example the common blaming of ants for damage done by aphids, a fact that requires deeper insights into the practice and motives of inadequate agrochemical use against them. Despite the long tradition of cacao farming, little knowledge about pests and diseases was transferred over generations. Principal sources of information were television and agro-engineers, as well as associations and friends/neighbors for both groups. Farmers of G_highinput have smaller plots and are more willing to expand their area for cacao cultivation while only organic farmers of the G_lowinput/organic know about the existence of beneficial insect. Except for that no significant differences were found between the groups.

The little differences among the two test groups may result from the little differences between the groups. Certified organic farmers had nearly no advantages from their organic status, as they did not receive better prices for their product and had little support from other organic groups anyway. As organic cacao cultivation is seen among many interviewed farmers as failed and is already abandoned by many, the fact that official figures (GOBIERNO DE TABASCO 2012, WILLER and KIRCHER 2012) still indicate a high organic-cacao area in Tabasco has to be questioned. Cacao cultivation in Tabasco as such has to face many obstacles: old age of cultivators, old age of cacao-trees, lack of potential successors, a lack of reliable political representation, corruption and newly encountered plant health problems like Frosty pod and squirrels that have had a tremendous impact on production in the past eight years. The potential future invasion of Witches' broom or other not foreseeable plant health problems should be considered serious and measures developed by all stakeholders to avoid shocks as with Frosty pod are recommended.

From an outside perspective, cacao cultivation in Tabasco should be supported in a sustainable way, not only to enable cacao producers a decent livelihood but also to sustain an important branch of economy that has a long tradition in the region and offers many ecological advantages in the rather destroyed ecosystems of Tabasco.

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# 9. Index of illustrations

# 10. Index of Tables

# 11. Annex 1: Questionnaire (in Spanish)

## Cuestionario Cacaotales y Plagas/Enfermedades No__

**Fecha** ____. ____. _____

## Preguntas generales

Encuestado/a _____

Lugar _____

Edad_____ Sexo_____ Estado civil_____

Cuántos son en la casa?

¿Trabaja usted u otra persona de su familia fuera del hogar para mejorar el ingreso familiar?

Si / no

¿Quién?_____ ¿En qué trabajan?_____

## Primera Parte

**Preguntas sobre el cultivo de cacao**

- ¿Desde hace cuánto tiempo cultiva cacao?
- ¿Qué variedades de cacao cultiva?
- ¿Qué tamaño tiene su cacaotal?
- ¿Quiénes trabajan en el cacaotal? (hij@s, espos@, padres, nuera/yerno, otros familiares, otras personas-quiénes)
- Aproximadamente, ¿cuantas horas a la semana le dedica la familia al trabajo del cacaotal?
- ¿Le gustaría tener más tierra para cultivar cacao?
- ¿Cuántos años tienen los árboles de cacao en su cacaotal?
- ¿Qué especies de árboles de sombra tiene?
- ¿Hay otras plantas en el cacaotal que vende o consume en casa? Si/no
- ¿Cuales?
- ¿La familia también está cultivando otros cultivos para vender o tiene ganado? Cuáles?

- ¿Qué se puede hacer para que el árbol de cacao dé muchas mazorcas?
- ¿Qué herramientas usa en el cacaotal?
- ¿Cuántos kg de cacao cosechó el año pasado? Kg/ha
- ¿Fue una temporada buena/mala/media?
- ¿Por qué?
- ¿Cuántos kg/hectárea cosecha en un año "normal"?
- ¿Cómo vende su cacao? A) en baba B) secado C) fermentado D) pasta E) chocolate F) otro?
- ¿Vende toda su cosecha o usa algo para el consumo doméstico?
- ¿A quién le vende el cacao?
- ¿Cuánto le pagan por tonelada de cacao que vende?
- ¿Considera que su cacaotal necesita mejoras?
- ¿Cuáles?
- ¿Cuáles son los problemas que enfrenta en su cacaotal?
- ¿Cuantos % del ingreso familiar son del cultivo de cacao?
- ¿Cuantos % del ingreso familiar se gasta en el cultivo de cacao?
- ¿Usted pudria vivir solo del cultivo de cacao?
- ¿Si usted tuviera más recursos económicos para su cacaotal ¿en qué los usaría?
- ¿Como ve a su cacaotal en cinco años – ¿como va a estar?

## Orgánico/No Orgánico

- ¿Qué piensa usted sobre la producción orgánica del cacao?
- ¿Usted esta cultivando Cacao orgánicamente? Porqué si/no?
- ¿Está certificado? Porqué si/no?

# SEGUNDA PARTE

**Preguntas sobre plagas y enfermedades en general**

Por favor, ¿Puede Usted mencionarme todas las plagas y enfermedades que conoce afectan al cacaotal? FREELIST

¿De la lista que Usted señaló ¿Puede Usted agrupar las plagas y enfermedades (DE LA FREELIST) empezando con la peor (la que hace más daño) y sigiendo en orden de la menos perjudicial para el cacotal?

- ¿Cuáles son las cualidades/características que tiene un árbol de cacao sano?

| Plaga | qué cultivo | qué tipo de daño hace | Cuando ocurre | Grado de daño (poco-mediano- mucho ) | Mejor medida de con-trol que existe |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
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| | | | | | |
| | | | | | |
| | | | | | |

| Enfermedad | qué cultivo | qué tipo de daño hace | Cuando ocurre | Grado de daño (poco-mediano- mucho ) | Mejor medida de con-trol que existe |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
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| | | | | | |
| | | | | | |

- ¿Qué piensa usted de qué es una plaga?
- ¿Qué piensa usted de qué es una enfermedad del árbol?
- ¿Cuál es la diferencia entre la plaga y la enfermedad del árbol?
- ¿Cuáles son las características que tiene un árbol de cacao enfermo – que parte de árbol observa Usted?
- ¿Usted conoce cuentos o refranes en los cuáles aparecen insectos o plagas?
- ¿Hay plagas en su cacaotal?
- ¿Cuáles?
- ¿Hay animalitos que comen plantas pero no son plagas en su cacaotal?
- ¿Cuáles?
- ¿Cuáles animales o insectos que llegan al cacaotal le gustan a usted? (pajaros, mariposas, …)
- ¿Cuánto daño economico hacen las plagas a su cacaotal al año – estimacion en %?
- ¿Cuánto daño economico hacen las enfermedades a su cacaotal al año- estimacion en %?
- ¿Se ha cambiado algo al respecto de las plagas y enfermedades del árbol de cacao en los ultimos años?
- ¿Se ha cambiado algo al respecto de plagas y enfermedades del arbol de cacao desde usted esta cultivando organicamente ?
- ¿Porqué hay plagas/ no hay plagas en su cacaotal?
- ¿Cuáles son los inconvenientes de tener plagas en el cacaotal?
- ¿Hay plagas/enfermedades que solo estan en los árboles de sombra? Cuáles?
- ¿Hay enfermedades en su cacaotal? Cuáles?
- ¿Porqué hay enfermedades/ no hay enfermedades en su cacaotal?

# Preguntas sobre medidas de control para las plagas y enfermedades

1 ¿Qué prácticas en el cultivo del cacao ayudan contra las plagas y enfermedades?

| Tratamiento/ Medida | Contra cuàl plaga / Enfermedad | Frequencia de la medida | Cuándo se USA | Que ventajas tiene? | Que desventajas tiene? | Que tan efectiva es la medida? |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
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| | | | | | | |
| | | | | | | |
| | | | | | | |

2 ¿Usted usa herbicidas?

3 ¿Cuáles?

4 ¿Cuántas veces al año se usa?

5 ¿Esta satisfech@ con los resultados que tiene al usar estos herbicidas?

6 ¿Usted usa fungicidas?

7 ¿Cuáles?

8 ¿Cuántas veces al año se usa?

9 ¿Esta satisfech@ con los resultados que tiene al usar estos fungicidas ?

10 ¿Usted usa insecticidas?

11 ¿Cuáles?

12 ¿Cuántas veces al año se usa?

13 ¿Esta satisfech@ con los resultados que obtiene de usar insecticidas?

14 ¿Usted usa fertilizantes?

15 ¿Cuáles?

16 ¿Cuántas veces al año se usa?

17 ¿Esta satisfech@ con los resultados que obtiene de usar fertilizantes?

18 ¿Usted conoce algunas prácticas en las que no se usa agroquimicos para manejar las plagas y enfermedades?

19 ¿Cuáles?

20 ¿Usted usa algunas de estas prácticas?

21 ¿Qué efecto tienen en su cacaotal?

22 ¿Quién mas conoce usted que lo usa (vecinos, familia, campesin@s organic@s,...)?

23 ¿Usa Usted otras medidas de control (practicas del cultivo, plantas para repelar plagas,...)?

24 ¿Cuáles?

25 ¿Cuántas veces al año se usa?

26 ¿Esta satisfech@ con el uso?

27 ¿Usted usa algunas prácticas antes de que una plaga ocurra en su cacaotal (como preparar la tierra, sembrar al propio tiempo, podar los árboles, etc...) y como influenca a las plagas?

28 ¿Como influencian estras prácticas sobre las plagas?

29 ¿Hay ciertas costumbres o creencias (ciclos lunares, del calendario de la iglesia, …) de cuando aplicar medidas de control para plagas y enfermedades en los árboles de cacao?

30 ¿Qué más hace usted para reducir las plagas y enfermedades?

## Información sobre plagas y enfermedades

- ¿Qué oferta de informacion sobre plagas y enfermedades se comunica en la region?
- ¿Como se entera usted de las medidas que debe tomar para el control para plagas y enfermedades en su cacaotal?
- ¿En cuál de las anteriores fuentes de información confia Usted más?
- ¿Llegan técnicos para capacitar sobre las enfermedades y plagas del cacao?
- ¿Usted ha aprendido como manejar ciertas plagas/enfermedades - de quíen?
- ¿Sobre cuáles plagas/enfermedades desea más información?
- ¿Como se puede mejorar la situación de plagas/enfermedades?

# 12. Abstract

Cocoa production in Latin America is affected by various diseases that are feared to spread to other continents in the future. In this thesis, the perception of two groups of farmers (one group using much and one group is using less agrochemical input and/or is certified organic, in total 31 interview-partners) towards pests, diseases and agrochemical input in their cacao plots was investigated using semi-structured interviews, freelists, participant observation and seasonal calendars from February to June 2011 in Tabasco, Southern Mexico. The results suggest that the word *plaga* (pest) is used mainly for biotic threats to cacao harvest. Most prominent in the freelists were Frosty pod disease (*Moniliophthora roreri*) with 93% of the respondents mentioning it, Black pod disease (*Phytophthora palmivora*) with 86% and squirrels (*Scireus sp.*) with 79%. Especially the recently (2005) introduced Frosty pod (*Moniliophthora roreri*) and squirrels are considered the most harmful obstacles to cacao production, mainly because treatments are limited to time and labor intense cultural measures. Little knowledge about beneficial insects was found and only in the group lowinput/organic. Insecticides were used by farmers of the highinput group mainly against ants that probably do not cause the assumed damage but associated aphids that were not perceived as major pests. The findings also suggest that cacao cultivation in Tabasco as such is very vulnerable and especially organic cacao cultivation is hardly present at all. Preventing cacao farmers to abandon their plots or change to other, ecological problematic cultures like sugarcane cultivation or pastures for cattle ranching, should be more focused.

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Las enfermedades afectan la producción de cacao en America Latina y también puedan llegar a otros continentes en el futuro. En este tesis se investigó, mediante la aplicación de entrevistas, listados libres, observación participant y calendarios estacionales con 31 productores de cacao en Tabasco, Mexico en el año 2011, la percepción que tienen dos grupos de productores de cacao (un grupo con mucho insumo de agroquimicos, el otro con poco insumo y/o orgánico) respecto a las plagas, enfermedades y el uso de agroquimicos en los cacaotales. Los resultados indican que los productores usan la palabra '*plaga*' principalmente para referirse a las amenazas bioticas de la cosecha del cacao. Sobre todo al referirse a la 'moniliasis del cacao' (*Moniliophthora roreri*) y las ardillas (*Scireus sp.*) que son consideradas los mayores obstaculos para la producción de cacao, porque los tratamientos se limitan a labores culturales que exigen mucho tiempo y trabajo. Se encontró que existe poco conocimiento sobre insectos benéficos y fué con en el grupo que usa pocos agroquímicos. Los insecticidas usados por los agricultores que usan muchos agroquímicos fue para combatir a las hormigas y a las que se le atribuyen daños en el cultivo que probablemente son probocados por áfidos asociados y que no se consideraron como plagas que causen muchos daños. Los hallazgos sugieren que el cultivo de cacao en Tabasco esta muy vulnerable y sobre todo que el cultivo orgánico de cacao es muy limitado. Ante los problemas que enfrentan los productores de cacao se debe prevenir el abandono del cultivo o el cambio del uso del suelo hacia otros cultivos menos ecológicos como el cultivo de caña o la ganadería.