

Managing Pest and Disease Pressures – Cocoa Farmers' Perspective

Introduction

Worldwide it is estimated that approximately 30 to 40% of all potential cocoa production is lost to diseases and pests. In localities with exceptional disease and/or pest infestation, losses can exceed 80%. In dollar terms, annual losses total approximately \$2 billion. While these losses have an impact throughout the supply chain, it is the cocoa farmer that feels the most immediate and direct impact on family income. Depending on tree variety and region, cocoa farmers can face a variety of fungal diseases and insect pests that attack the leaves, stems, trunks, or pods of their cocoa trees. This paper highlights three major fungal diseases (black pod, witches' broom and frosty pod) and two pests (cocoa pod borer and brown cocoa mirid) and tells the stories of farmers affected by them.

Fungal Diseases

Black Pod Rot (caused by *Phytophthora spp.*)

Many of the world's most devastating crop diseases are caused by fungi in the genus *Phytophthora*; for example, the Irish Potato Famine was the result of such a disease. In cocoa, three species of *Phytophthora* cause diseases commonly referred to as black pod rot, and account for approximately 450,000 MT of losses worldwide. *Phytophthora* species are found in all three growing regions, but the most aggressive and fast moving is *P.megakarya* which is found in West Africa.

The first sign of the disease is small spots on the cocoa pod. Farmers may miss this initial sign, particularly in areas where other diseases are prevalent. But the farmer will notice when the spots grow and darken and the pod turns black and rotten. Although infection of the pod is the most common, the pathogen can also infect the trunk and branches with cankers (known as trunk or stem cancer) and cause root rot. Infection of the pods can result in significant losses of the crop, but infection of the trunk and branches could cause the death of the tree. As a soil borne disease that thrives in the humid, rainy conditions common in the tropics, black pod is very difficult for farmers to control.



Figure 1 Pods infected with black pod rot (left) and a normal pod (right).



Figure 2 Farmers breaking pods. Note the large number of pods infected with black pod.

Learning about Diseases – Black Pod

In Côte d'Ivoire, Roger Zongo and his neighbors were familiar with black pod and its devastating effects. “Like many farmers of my village, I thought that black pod was a curse cast on farmers by enemies,” said Mr. Zongo. To protect his trees, Mr. Zongo performed traditional rites to ward off evil and improve the soil such as “baptizing” his trees and placing black pods in a circle around the base of the tree. Disappointed with results and concerned about his dwindling production, Mr. Zongo enrolled in a farmer field school where he learned more about black pod. “Now I know that black pod is a disease which is caused by a fungus and which spreads rapidly under wet and dense environmental conditions,” he said. Mr. Zongo also learned that some of his practices were actually spreading the disease; for example, he learned that “the fact of putting together healthy and spoilt pods rather contributed to the spread of the disease on my farm.” Implementing the techniques he learned, he has noticed a considerable decrease in level of black pod on his farm. Since he started the farmer field school in June 2008, Mr. Zongo has seen his 2.5 ha farm increase production from 12 bags (65 kg each) to 18 bags of cocoa beans.

Witches’ Broom (caused by *Moniliophthora perniciosa*)

While black pod causes the greatest losses on a global scale, in Latin America the two most devastating fungal diseases are witches’ broom (caused by *M. perniciosa*) and frosty pod (caused by *M. roreni*). Witches’ broom is native to the Amazon and is found in South America and a few Caribbean islands. Annually, it causes 250,000 MT in losses.

The first subtle sign of witches’ broom is that the flowers on the cocoa tree are abnormal – the stems are thicker and wilted, brown flowers do not fall off the tree. Other early signs of disease are swelling on stems and pods and the rapid appearance of many new buds. But, for most farmers, the first sign they see is strange looking branches – resembling a witch’s broom – beginning to grow from the flowers or the ends of infected branches. At this point, the tree has already been infected for over 30 days. The pods become infected and destroyed at 12 weeks of age. Then the farmer observes the infected branches slowly die from the tip back toward the trunk and small mushrooms form on the dead branches and pods. These

mushrooms release spores into the wind that infect the farmer's other trees and the cycle begins again.



Figure 3 Broom like growth around a flower cushion.



Figure 4 Dead brooms on an infected tree



Figure 5 Mushrooms growing on an infected pod.

Witches' Broom in Brazil

Before witches' broom arrived in Bahia, Brazil in 1987, Brazil was the world's second largest cocoa producer with production at over 400,000 MT. Within 10 years, overall yields had dropped by 75% and farmers in some areas lost 90% of their crop. The cocoa sector has not recovered to its pre-witches' broom levels (in 2008/2009 production was at 160,000 MT) and 3 million people in Brazil continue to be affected by the consequences of the outbreak.

Frosty Pod (caused by *Moniliophthora roreri*)

In comparison to black pod and witches' broom, losses to frosty pod may seem small – 30,000 MT per year. However, frosty pod has the potential to become more significant. Its spores are more resistant to environmental factors (such as dry air or harsh sunlight) and more easily spread than witches' broom. Frosty pod's geographical range has increased significantly from its appearance in Ecuador in the 1920s to its more recent arrival in Belize and Southern Mexico. This pathogen, as indicated by the same genus name, *Moniliophthora*, is closely related to the one that causes witches' broom, but the two diseases are distinctly different.

To reduce the further spread of frosty pod, it is important for farmers to take swift action to remove infected pods before spores form. However, it can be difficult for farmers to notice the symptoms of frosty pod before it is too late to prevent its spread. The first sign of infection is small, bumpy swelling on the pods. In some cases the swelling is minor; in others it is more dramatic and noticeable. Then, small spots of yellow or brown discoloration begin to appear and grow. Within 12 days of the first signs of swelling, spores will appear forming a powdery, white discoloration on the pod giving it a "frosty" appearance. After rainfall, the spores are released into the air and infect other trees. A single infected pod has the capacity to produce 6 to 7 billion spores. The pod then dries up and becomes petrified.



Figure 6 Swelling is an early sign of frosty pod rot.



Figure 7 In the later stages of frosty pod, the pod turns white and has a "frosty" appearance; eventually the pod becomes petrified.

Learning about Diseases – Witches' Broom and Frosty Pod

In Ecuador and Colombia, farmers learn about witches' broom and frosty pod rot through farmer field schools. Working with a trained facilitator, the farmers learn to recognize the symptoms of disease, what causes them, and practical steps to prevent and control them. Farmers learn through interactive methods such as creating "disease zoos." A disease zoo is an educational display through which farmers learn about disease symptoms; for example, a zoo would include infected pods and vegetative brooms caused by witches' broom in various stages of growth. Concepts are reinforced through activities such as group quizzes and skits. Farmers learn both from each other and from the trained facilitator who is often an extension agent or successful farmer from their community.

Insect Pests

Cocoa Pod Borer (*Conopomorpha cramerella*)

In Southeast Asia, the greatest threat to cocoa production comes not from a fungal disease, but from a small insect called the cocoa pod borer. Total losses are approximately 40,000 MT annually. The cocoa pod borer insect is approximately 1 cm long and somewhat similar in appearance to a mosquito. The lifecycle of the insect is intrinsically linked to the cocoa pod.

The female lays eggs on the surface of developing cocoa pods. After a few days, the eggs hatch and larvae burrow into the pod. For two weeks, the larvae feed on the pulp and placenta that surround the developing beans inside the pod. The larvae then emerge leaving a long silk thread as they journey to the ground. The pod is susceptible to secondary infections and rot due to the holes left in the pod. Although the larvae do not eat the beans,

they do hinder the beans' development. The resulting beans are smaller, flatter and lower in fat than normal.



Figure 8 An adult cocoa pod borer (left) and larva inside a cocoa pod (right).



Figure 9 Damage caused by cocoa pod borer (left). The inside of a normal pod (right).

Controlling Cocoa Pod Borer

Like many farmers in the Philippines, Johnny Silva is familiar with cocoa pod borer and its potential to destroy his crop. After learning more about cocoa pod borer control through participation in a Farmer Field School, Johnny began using plastic pod sleeves to cover and protect the pods. When pods begin to form, Johnny places plastic sleeves over them. The pods are able to grow and develop normally, but the cocoa pod borer larvae are not able to bore through the plastic. Recently, Johnny began participating in a study to test the effectiveness of using “trichocards” to trap cocoa pod borer. This is a technique similar to one used in the US to address a common cotton pest known as cotton bollworm. The cards contain the eggs of the *Trichogramma* wasp that is a natural enemy of cocoa pod borer. When the eggs hatch, the wasps kill the cocoa pod borer larvae. He hopes that the results of this research will ultimately help other farmers to control this pest.

Cocoa Mirids/Capsids

“Mirid” and “capsid” are general terms used to refer to several species of insect pests found in cocoa growing regions. Different species are found in different regions, but the effects are similar. Globally, mirids/capsids account for 200,000 MT of losses.

One species of mirid is the brown cocoa mirid (*Sahlbergella singularis*) which is found in West Africa. Although black pod is the greatest threat in West Africa, brown cocoa mirids can also cause significant losses. When a farmer faces both black pod and mirids simultaneously, the result is often tree death. Mirids in both the nymph and adult phases feed on the pods, trunks and twigs. They leave behind lesions which can be infected by parasitic fungi that cause dieback of twigs and cankers on the trunk. The first year a farm is infested by mirids, the farmer may realize a 30% loss in production. In subsequent years, as the mirid population grows and damage to the trees increases, losses can rise to 75%.



Figure 10 Lesions on pods caused by mirids.

Introducing New Technologies

Joseph Chuks Anikwe is an entomologist at the Cocoa Research Institute of Nigeria where his research focuses on brown cocoa mirid. Having witnessed first hand the effects of mirids, Joseph is looking for better ways to control it. Pheromone (use of chemical attractants) traps have been used throughout the world to disrupt the mating cycle and assess the infestation levels of a wide variety of pests that target a wide variety of crops. To Joseph's knowledge, pheromone traps have not been used in Nigeria for any pests. He was interested in learning more about this technique and exploring its potential for use with brown cocoa mirids. Working with scientists at the US Department of Agriculture/Agricultural Research Service, Joseph developed the skills he needs to develop a pheromone trap for brown cocoa mirids.

Current Control Approaches

Although specific solutions vary from disease to disease and pest to pest, it is possible to speak in general terms about fungal diseases and pests as a group. Farmers need affordable, practical measures to limit the impact of diseases and pests on their farms. This is the role for integrated pest and disease management (IPM or IDM) which is an approach to pest and

disease control that utilizes information on pest and disease lifecycles and interactions with the environment to select methods of control that are effective, economically feasible and considerate of environmental effects; however, synthetic chemicals may be used as a last resort. The emphasis is on preventative and natural means of pest and disease control.

Fungal Diseases

Fungal diseases can be controlled with some success by use of copper-based fungicides. However, frequent application is required as the fungicide can be washed away by rain. Regular use of fungicide is too expensive for many smallholder farmers to afford. A more affordable and practical option is the adoption of cultural practices such as pruning and shade reduction that create an environment that is less favorable to fungal diseases. On older farms with very tall trees, effective pruning to this end may not be practical. A third option, currently in a field trial phase, is the use of species of *Trichoderma*, parasitic fungi, to control the fungal diseases. Different species of *Trichoderma* have parasitic relationships with black pod, witches' broom and frosty pod fungi and could be effective at limiting their spread. Cultural practices and "biocontrols" (such as *Trichoderma*), used together, are examples of integrated disease management.

Insect Pests

Integrated pest management encourages farmers to take preventative measures before pest problems appear. This preventative approach can include cultural practices such as pruning, frequent harvesting and pod sleeving. Farmers then monitor the pest population on their farm before determining the appropriate course of action. Pheromone trapping can be effective in gauging the infestation level or in disrupting the pest's mating cycle. Farmers can also utilize pests' natural enemies to control pest problems; for example, in Southeast Asia, field trials are studying use of wasps to control cocoa pod borer and use of black ants to control mirids.

Conclusion

The five pests and diseases described are estimated to cause almost one million metric tons of cocoa crop losses per year and there are several other pests and diseases which add to these losses. Given that the global production of healthy cocoa is approximately 3.6 million metric tons per year, the significance of these losses is obvious. In seeking long-term solutions to disease and pest issues, there are four factors to consider: affordability, practicality, environmental impact, and time horizon. For all of the diseases and pests discussed above, the long term solution is to develop disease- and pest-resistant varieties and ensure that farmers have access to quality, affordable planting material. Although much work has been done in this area, it will be years, if not decades, before this is a reality.

Disease/Pest	Location	Losses
Black Pod Rot	Global	450,000 MT
Witches' Broom	Latin America	250,000 MT
Frosty Pod Rot	Latin America	30,000 MT
Cocoa Pod Borer	Southeast Asia	40,000 MT
Mirids/Capsids	Global	200,000 MT

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