

CASSAVA CASE STUDY:

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Rotten inedible tubers: the case of Cassava Brown Streak Disease

SUMMARY

This case study is based in Africa, where cassava is a key food security crop, and focuses on the gravity of the threat that cassava brown streak disease (CBSD) poses to resource poor cassava growers. The goal of the study is to illustrate how providing information on disease spread can help not only growers who plant infected material but also other growers in the region. _Planting infected cassava can negatively impact cassava production and intensify hunger in the region.

The case also highlights the role that non-governmental organizations (NGOs) and research organizations play in multiplication and dissemination of cassava cuttings and how this activity can be coupled with providing information on disease management. Both cassava mosaic disease (CMD) and CBSD can cause devastating losses depending on the susceptibility of the variety planted and the time of infection.

INTRODUCTION

Cassava is an important food security crop in many tropical areas of the world. An organization called New Partnership for Africa's Development has designated it as a crop of choice for poverty reduction in Africa. Cassava production in East African nations is under serious threat from two different diseases caused by viruses: cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). Accurate diagnosis is vital for effective management of these diseases. The case study is intended to serve as an undergraduate-level teaching resource that acquaints students with diagnosis of CBSD (currently the most damaging of the two diseases), presents facts on the disease, and discusses principles related to its management.

This case study is a decision-making scenario in which Neema, a mother of eight children, who is a hard-working small-scale farmer in Soroti, Eastern Uganda and the chairlady of a self-help group, faces a food security crisis. This crisis erupts after she shared the CMD-resistant cassava varieties she was given by Opio, an agricultural project coordinator with a local non-governmental organization (NGO) called UWEZO, with her neighbors; soon, the tubers develop disease symptoms and begin to rot.

What is the crisis?

The crisis is how to solve Neema's and her neighbors' problem and ensure they will have enough to eat. In addition, UWEZO hopes to be absolved from being blamed for distributing diseased cassava cuttings to growers. UWEZO obtained the cuttings from the cassava planting material multiplication center at the agricultural research center in Soroti.

Objectives:

Demonstrate to students the challenges that growers face when trying to manage cassava virus diseases on their farms. This case study will:

- Introduce key facts about CBSD and its importance
- Teach principles of CBSD pathology and management. (Students will realize that to develop an effective CBSD management strategy they need to understand how the disease develops and spreads from one farm to another).
- Explain how to diagnose CBSD in the field (challenges and constraints)
- Discuss the threat posed by CBSD to food security in the wider African Great Lakes region.

This case study will reinforce two fundamental plant pathology concepts:

- Planting genetically uniform crops is risky
- Plant pathogens are easily spread in vegetative propagation materials like cuttings.

BACKGROUND INFORMATION

Cast of players:

Neema: A hard-working mother of eight children from Soroti village in Eastern Uganda. She also is the current chairlady of her women's self-help group.

Opolot: An 85-year-old widower who is Neema's neighbor. He visited his married daughter who lives several villages away and brought back a gift of cassava cuttings. A few roots were rotten when he collected them from his daughter at harvest time, and since then most of his cassava has developed diseased roots.

UWEZO: (which means capacity in Swahili) is a local NGO that distributed cassava cuttings to the group in an effort to improve cassava production and food security in the area.

Mr. Opio: Agricultural project coordinator at, UWEZO

Dr. Anne Adungosi: Extension officer in charge of root and tuber crops with the National Agricultural Research Organization (NARO), Soroti, Eastern Uganda

Lance: A study abroad third year biology student, from a farm family in Midwestern USA. He is on attachment with Dr. Adungosi at NARO

Cassava: A woody shrub cultivated in the tropics for its starchy roots, and an important source of carbohydrates. Cassava plants are typically grown by planting cuttings (pieces of stem)

Key words/Acronyms: CMD, CBSD, NARO, NGO

THE CASE:

Mr. Opio is an agricultural coordinator at UWEZO, a local NGO, in Soroti, Eastern Uganda. UWEZO initially managed only human health promotion programs in the region; however they soon realized that most of the beneficiaries of the HIV and AIDS projects needed a secure food source all year. This was to ensure that medication was not being taken on an empty stomach. An agricultural project focusing on food security was born. Cassava was chosen because of its popularity in the region, as well as its ability to tolerate drought and be stored in the ground for long periods (*Figure 1*). Since then, the agriculture project has grown and currently provides cuttings for its beneficiaries, as well as linking them to other entrepreneurial groups that can help them add value to cassava such as producing high-quality cassava flour for baking, chips for animal feed, and production of cassava cuttings for sale as seed (*Figure 2.A and 2B*). UWEZO

has established seed multiplication blocks with an initial seed stock obtained from the local agricultural research center. This cassava cultivar was high yielding and resistant to cassava mosaic disease (CMD), an endemic viral disease in the region.

Neema, has been a client at UWEZO for several years. She has personally seen the benefits of cassava for food security, especially a few years ago when there was drought. Following that, she convinced other members of her group to plant this improved variety from UWEZO because it was higher yielding and resistant to cassava mosaic disease (CMD). They could also harvest extra tubers to improve and sell. CMD was a problem previously, but yields have stabilized since growers began planting CMD-resistant varieties.

One afternoon, Neema sends her 15-year-old son Lucas to the farm to harvest a few roots of cassava to boil for their lunch (*Figure 3*). Lucas takes an unusually long time and then returns to report that he had tried about ten plants and most of them seem to have rotten and inedible roots. Neema grabs the hoe and runs to the farm to confirm her son's claims. Sure enough, after digging up several plants she observes the same situation. Suddenly, the CMD-resistant varieties that she has been planting are now getting diseased and producing rotten tubers. This means that she will not produce enough food for her children, let alone be able to keep any surplus for adding value or selling. The problem is even bigger; several other members of the self-help group are finding rotten cassava roots on their farms.

Soon after this, Neema talks to her neighbor, Opolot, who is growing another cassava variety from cuttings he brought from his daughter's farm. Opolot remembers noticing a few roots producing similar symptoms to those Neema describes at harvest, but his plants have less severe

symptoms than those from Neema's farm. Since the problem seems widespread in the village, Neema promises to contact Mr. Opio at UWEZO and report back to Opolot.

In distress, Neema takes a few roots and stems to Mr. Opio's office at UWEZO. She is understandably upset at the situation after having waited a year to begin harvesting this cassava crop. She explains how she planted cassava in batches every 3 months to ensure a steady supply, and now it seems that she could lose most of it. She threatens to report the NGO to the local administrative officer (the area chief). She also wants to mobilize her self-help group and others in the village to boycott the NGO's programs.

Neema shows the roots to Mr. Opio. Most of them have a dark brown hard rot inside (*Figure 4A and B*). She further explains that she had observed that some roots had constrictions (poor quality tuberous roots that have narrower sections). Mr. Opio looks at the stems and notices that the tissue between the nodes seem to be purplish in color, drying up and dying (*Figure 5*). Neema had not observed the typical CMD symptoms of leaf chlorosis (yellowing) and distorted leaf blades (*Figure 6*) on any plants during the past year. In contrast, her leaves had mild chlorosis and no distortion (*Figure 7A and B*) and were different from leaf symptoms caused by cassava green mite (CGM) feeding (*Figure 8*) or nutrient deficiency (*Figure 9*). Mr. Opio calms Neema and promises her that he will consult Dr. Adungosi at the agricultural research center in Soroti. They would then visit Neema's farm and interview her as well as several of her neighbors and group members and see how best to resolve the crisis.

Mr. Opio is also unsure what the problem is and is very sad because of the devastation the disease is causing. He is worried because of the extent to which farmers in this location have adopted and planted this particular CMD-resistant variety in the years that followed the peak of

the CMD epidemic. He feels worse because he is well aware of several cassava cutting distribution campaigns by UWEZO to promote CMD-resistant varieties. He understands how much effort leaders of self-help groups like Neema have devoted to ensuring the success of these campaigns. Above all, he is afraid that UWEZO could be blamed for promoting and distributing diseased cassava cuttings.

When Dr. Adungosi examines the rotten root samples from Neema's farm, she quickly diagnoses it as cassava brown streak disease (CBSD), a disease that was last reported from the area decades ago. Clearly, there is a re-emergence of the deadly disease in the area. It turns out that the CMD-resistant variety that Neema and her neighbors have been growing is highly susceptible to CBSD. CBSD is spread either by a whitefly vector (a vector is a living organism that spreads disease) or by planting infected cuttings. She visits several farms including Neema's and Opolot's and interviews the farmers to learn their sources of planting material. She is accompanied by Lance, an American student who is on internship at NARO to survey the extent of the problem. Dr. Adungosi is disturbed by the potentially large impact of the problem they must confront. She requests the local chief to help convene a farmer awareness meeting where she explains to the farmers what the problem is, and how to recognize and manage it. In this meeting, she intends to absolve UWEZO from possible blame.

Questions and problems for the students to reflect on:

1. What are the major symptoms of CBSD?
2. How is CBSD spread?
3. How can it be managed?
4. Is Neema responsible for the disease? What explanation could she offer her self-help group members?

5. Why do you think the symptoms on Opolot's cassava are less severe than those of Neema and her neighbors?
6. What should Dr. Adungosi advise Mr. Opio, Neema and her neighbors to do?
7. Dr. Adungosi asks Lance to prepare a report about the situation for a journalist for a local newspaper and for his university newspaper. What should the reports include?

Activities for the case study

There could be two parts to the activity as time, location and interest allow.

Part one: This is a classroom activity in which students will be divided into groups and assigned a perspective to support. The students will be given the case study and other CBSD reading materials beforehand. During the in-class activity, groups will review the case study and identify key information about CBSD (for example, how is the disease disseminated across regions and among farms? What symptoms are likely to be observed on infected tubers?). The students will then discuss each player in the case and their contribution to the problem, and then present this information to the rest of the class. Role playing is recommended as a presentation format.

Part two (optional): Students visit fields with CBSD-infected cassava plants at a local agricultural research station. Students gain first-hand experience on how to diagnose CBSD and discuss management options with the station staff.

Resources to prepare for class

Students should be presented with the introduction, cast of characters and a fact sheet on CBSD that provides background on the

disease: <http://www.asareca.org/sites/default/files/ASARCBSDFactSheet.pdf>.

Read a brochure detailing CBSD symptom expression:

<http://www.crsprogramquality.org/storage/pubs/agenv/cbsd-brochure-english.pdf>

Watch two 5–minute-long YouTube video recordings on cassava production, the CBSD problem and differentiation of CBSD symptoms from those of CMD:

- i. “Cassava Farming” <https://www.youtube.com/watch?v=Ey2-h7841U0>
- ii. “Scientists declare war on cassava brown streak”
<https://www.youtube.com/watch?v=y2cIS3hr5XE;>

Figure captions

1. Young cassava plants growing in the field
2. Cassava utilization A: Cassava chips B: Cassava flour
3. Harvesting healthy cassava roots
4. A and B: Symptoms of CBSD on cassava roots
5. Symptoms of CBSD on cassava stems
6. Leaf symptoms of cassava mosaic disease (CMD)
7. A and B: Symptoms of CBSD in cassava leaves
8. Symptoms of cassava green mite (CGM) feeding damage on cassava leaves
9. Leaf showing yellowing caused by cassava nutrient deficiency

Photo Credits. Figures 1-4: Virus Resistant Cassava for Africa – Plus, VIRCA-PLUS,

Donald Danforth Plant Science Center, St. Louis, MO, USA, VIRCA-PLUS, DDPSC

Figures 5-9: J. Legg, International Institute for Tropical Agriculture, IITA

Classroom Management

Case Summary

The case takes a real world approach to highlight issues that arise when the impacts of plant disease threaten to become a natural disaster. The risk of using one variety (genetic uniformity), the dependence of growers on one crop (cassava), and the distribution of varieties from other places are familiar from many agricultural disasters to which parallels can be drawn (e.g., the Irish potato famine in the 1840s). In addition, problems beyond food security are intertwined with disease management, including poverty reduction, economic productivity and human health implications; these should be considered.

This case study is recommended for students of field crop production, root and tuber crop production, IPM, plant health management, plant pathology, horticulture, or sustainable agriculture, where students can apply previously learned information. It is useful but not critical that students have a background and working understanding of plant disease cycles and IPM options available for disease management.

Suggestions on How to Use This Case

The case study is designed for presentation in one 50- to 60-minute-long class session, using a small group or whole-class review and discussion style. The instructor serves as a moderator to maintain order and connect student ideas.

Background: We recommend that students prepare for the class by reading a few items (requires about 10 minutes): the cast of characters and a fact sheet on CBSD that provides background information on the disease <http://www.asareca.org/sites/default/files/ASARCBSDFactSheet.pdf>.

Reviewing a brochure detailing CBSD symptom expression in different plant parts is also

recommended. Watching two or three, 5-minute-long YouTube videos on cassava production, the CBSD problem, and differentiation of CBSD symptoms from those of CMD will give students a useful background on the problem detailed in the case study. These videos are: “Cassava Farming” <https://www.youtube.com/watch?v=Ey2-h7841U0>; “Scientists declare war on cassava brown streak” <https://www.youtube.com/watch?v=y2cIS3hr5XE>; and “Cassava brown streak disease” <https://www.youtube.com/watch?v=y2cIS3hr5XE>. It is recommended that these materials be distributed a lesson or two prior to the class and an electronic reminder to complete the pre-class work be sent shortly before the class. This ensures that students have adequate time to review the information and gain an understanding of CBSD transmission, symptoms, possible impact of the disease and available management options. For students with no background in plant pathology, and/or cassava production, and/or farming systems in Africa, reading the entire 14-page background information on CBSD is recommended: http://teca.fao.org/sites/default/files/technology_files/Cassava%20Brown%20Streak%20Disease%20%28Uganda%29.pdf. The recording on cassava potential (cassava farming) would also assist such students to gain perspective and further appreciate the importance of CBSD in cassava production in the context of the case study.

Information Review and Case Introduction: Students should be prepared to provide answers to three to five open-ended review questions in 2 to 5 minutes at the beginning of class to demonstrate their understanding of the issues and key terms/concepts for this case (e.g., “tolerant varieties” and selection of planting material). A quick response system like clickers, index cards or a show of hands can be used to get this feedback. This information allows the instructor to assess the students’ comprehension of the background information and decide how much material to present during the introduction and review.

The instructor can begin by briefly (3 to 5 minutes) introducing the learning objectives and clearly explaining what will take place during the exercise. A brief overview of the keywords and the cast of characters is recommended (the level of detail is adjustable depending on how well prepared students are for the activity).

Activity: After this introduction, students are divided into groups of 4 to 6. The groups are assigned to one of two possible teams. One team will focus on the perspective of Dr. Adungosi, who must develop talking points to explain the possible causes of the disease, why the situation has escalated and what farmers can do to mitigate the problem. The other teams focus on the perspective of Lance, the undergraduate American student on internship, and prepare possible talking points for an interview with journalists on the situation and how it has been handled (solved). Depending on the size of the class, multiple groups of students can be assigned to each of these teams. To start, students are allowed approximately 5 to 7 minutes for individual reading of the case. Then the teams of students spend 12 to 15 minutes discussing among themselves the problem facing Neema, Opolot and the members of the self-help group. They should think of possible questions that can be asked or observations that could be made to narrow down possible causes and management of the problem as well as to determine the potential impact of the problem on the characters. Groups should focus on preparing talking points depending on the perspective of the team to which they have been assigned. Students may search for additional information in the background document if they wish to. In our experience, some students enjoyed role-playing their assigned character; this helped to stress the critical nature of the CBSD problem.

Recommendations: During small group discussions students will be expected to write out on an electronic discussion board or actual chalk board/white board a minimum of three, 140-letter

maximum “text/ tweet like” statement, comments or questions they would give or have for Neema, Opolot, Mr. Opio or Dr. Adungosi on the issues. This activity facilitates discussion by requiring concise clear “tweets”; instructors should encourage students to distill and articulate their ideas and understanding. It is also an opportunity to provide additional information and highlight important issues and relevant points with the entire class.

After the small group discussions, a group representative will give a brief presentation on their discussion and the talking points that arose. Thereafter, students are encouraged to give their personal opinions on possible causes of disease spread, impacts of NGO crop production projects in communities and effective disease management to avoid food security threats (5 to 7 minutes). At the end of class the instructor gives a concise wrap-up (5 to 7 minutes) of the main points. A handout is distributed regarding how Neema’s CBSD “education” could empower her to handle CBSD diagnosis in future: <http://www.crsprogramquality.org/storage/pubs/agenv/cbsd-handout-english.pdf>

The case was tested in four universities in Eastern Africa: Makerere University in Uganda; University of Nairobi, Kenyatta University and Chuka University in Kenya. Questionnaires and a show of hands were used for both pre and post-case to get feedback on time management, knowledge of content, and value of the case study approach to present the information. The introduction to the case at one of the institutions was time consuming because it was a large class and the students had not gone over the material in advance. Students provided with the material beforehand had more meaningful discussions. The case made an impact even with students who were not familiar with the crop and disease after a solid introduction and watching the videos. The lecturer’s role was to moderate the discussion. With the bigger classes it was valuable to have a team of teaching assistants and lecturers to help connect student ideas. More than 70% of

the students appreciated the interactive nature of the teaching approach. Students in three out of four schools spontaneously role-played the characters in the case during the class presentations. Role playing was therefore incorporated as a suggestion for the group discussion section. Students reported that the case study approach enhanced their understanding of the CBSD problem better than with a traditional teaching approach and said they would like to see more case studies in their classrooms.