



Climate Vision 2050 BCG podcast

Episode 5: From Future to Fork

Act I: Introduction

[00:00:00] **Nick Howard:** What you are about to listen to is a work of imagination, but not fantasy, set in the year 2050.

[00:00:08] **Mutinta Banda:** Farmer Louissette Thibault [Lou-ease-ette Tea-Bow] steps onboard an elevator wearing a white lab coat. She pushes a button for the 30th layer. Blue and red lights illuminate her face as she ascends in Silo number 5, a grain elevator converted into a vertical farm in Montreal's Old Port, Canada.

(Sound of the robotics of the elevator moving upwards. The hum of LED lights.)

[00:00:26] **Louissette Thibault:** Layers 1-6 are for lettuce. 6-10 are for mangos and bananas. And I love to come to layer 15 to harvest strawberries, raspberries and blueberries...

(Sound of the elevator stopping.)

(Sound of her eating)

[00:00:37] **Louissette Thibault:** Oh, the new light recipe for these strawberries is the perfect blend of tart and sweet.

[00:00:43] **Mutinta Banda:** She continues upwards to the 25th layer where she's surrounded by rows of cherry tomatoes.

[00:00:49] **Louissette Thibault:** One of the LEDs on this layer is out. So I'm doing a replacement...

(Sound of reaching into her pack, pulling out the light, starting to screw it in...)

[00:00:55] **Louissette Thibault:** All set. Huh? Hmm. There are some unsightly splotches on these cherry tomatoes...

(Tastes one - spits it out)

[00:01:01] **Louissette Thibault:** [Spitting sound] Yuck. Totally bland... something is off with this...

[00:01:05] **Mutinta Banda:** In this episode, we'll explore how controlled environment agriculture, including greenhouses and vertical farms, have revolutionized how we grow fruits and vegetables indoors. We'll look at how climate change affects horticultural production today in 2050, and how growing indoors provides a way to efficiently use energy, water, soil, land and light.

[00:01:26] **Mutinta Banda:** I'm your host Mutinta Banda and you're listening to Climate Vision 2050.

[00:01:31] **News Clips:** The Southwestern United States saw its driest year on record in 2028.

[00:01:36] **News Clips:** As transportation costs increase, consumers look to more local options in 2034.

[00:01:41] **News Clips:** In 2043, experiments on Mars use horticultural techniques first developed here on earth.

Act II: How the World Works

(Sound of opening the laboratory door, cutting the tomato open as she does all of this.)

[00:01:46] **Mutinta Banda:** With a bag of the affected tomato plants in tow, Louissette makes her way to a small lab in the Silo number 5 complex.

[00:01:55] **Louissette Thibault:** This former grain silo had been abandoned since the mid-90s as port facilities and grain processing were moved away from the downtown core. Thirty years ago a plan was developed to turn this 20,000 square meter historic site into housing, shops, a rooftop restaurant and a vertical farm. It's heated by a tidal turbine in the river behind Habitat 67 [sixty-seven]. All throughout the downtown core today you see vertical farms integrated into the city fabric in high rises, etc. bringing food as close as possible to the population center.

[00:02:15] **Louissette Thibault:** I used to be a chef at a high-end restaurant, bistro Vrai ou Faux in the Mile End. But I wanted to be closer to the production of the food itself, so I came to work in urban farming. I've been on vacation to see my family in Rouyn-Noranda for the past two weeks. So I'm catching up on things since I've been gone...

[00:02:39] **Mutinta Banda:** Louissette puts on latex gloves and picks several leaves off of one of the tomato plants and puts them into a small bag.

[00:02:50] **Louissette Thibault:** Perhaps the LED being out affected the growth of this particular plant...

[00:02:56] **Mutinta Banda:** She grabs a small hammer, a vial of liquid and a rapid test.

(Sound of hammering the leaves)

[00:03:01] **Louissette Thibault:** I'll need to crush the leaves until they are mushy and then mix them with...

(Sound of faint dripping)

[00:03:06] **Louissette Thibault:** This test tube liquid. Now the eyedropper gets squirted onto this rapid test...

[00:03:11] **Mutinta Banda:** Clearly defined lines appear on both the C and T lines of the test.

[00:03:17] **Louissette Thibault:** [Sighs]. Maudit. Positive for tomato spotted wilt virus. [Ugh!!] Excusez-moi.

[00:03:21] **Louissette Thibault:** This virus is caused by a small insect called thrips that has infiltrated the farm somehow. Now all of these tomatoes, what could have been bruschetta on crusty bread, a warm winter chili, or a fresh Caprese salad will need to be thrown out.

[00:03:40] **Louissette Thibault:** I'll have to control the contamination before it spreads through all of the tomatoes...

(Door slams, soundscape fades out...)

[00:03:45] **Mutinta Banda:** Today in 2050, the global population has reached approximately 10 billion people. Feeding everyone while using resources efficiently has been a massive challenge.

[00:03:54] **Mutinta Banda:** Matt Westerlund [Matt Westerlund] is a BCG managing director and partner and expert in controlled environment agriculture.

[00:04:00] **Matt Westerlund:** Here in 2050, we're in a different world when it comes to the care for our climate and the world around us and the way that we feed ourselves. I have chosen to dedicate my entire life's work, basically to our ability to grow food as sustainably as possible so that we can live sustainably with the world around us.

[00:04:24] **Mutinta Banda:** Decades ago the industrial agricultural system was damaging the environment.

[00:04:28] **Matt Westerlund:** We were over-spraying chemicals. We were over-tilling fields and destroying biological life in the soil. The 2020s were a decade where the world really started to reckon with the long-term cost of agricultural production and look, we need to eat, so we're not gonna stop producing food. The question was going to be, well, how are we going to do this in a completely different way?

[00:04:54] **Mutinta Banda:** When we talk about controlled environment agriculture, we're referring to the ways we use technology, infrastructure and basic mechanical engineering to replace or enhance the natural ways that plants have grown outdoors, in an indoor environment. Today we see this applied to fruit and vegetable production, but the lion's share of our human calories still come from outdoor row crop agriculture such as wheat, maize, rice and soy and other varieties grown over hundreds of millions of acres.

[00:05:08] **Mutinta Banda:** Today these greenhouses and vertical farms exist all over the world, and have even extended beyond our planet. The Base Town Mars colony, a pilot mission by NASA, is an extreme example of controlled environment agriculture. It provides solutions to the same agricultural challenges we see today on earth in 2050 in both the wealthiest and poorest nations. We recorded an interview with one of the colonists during a recent holiday back on earth.

[00:05:29] **Evan Fraser:** So my name is Evan Fraser and I'm the head of recycling and composting on humanity's first community on the Red Planet on Mars. Which is a position of great authority and responsibility because on Mars there are no surplus organic materials. Every scrap of organic material has to be created, has to be grown out of the harsh Martian environment and so in Base Town, we've developed extremely sophisticated ways of producing organic material, then once we've produced it, we recycle everything, we compost everything, and we turn it back into food in a true example of a circular food economy.

[00:06:07] **Mutinta Banda:** Greenhouses and vertical farms don't solve every problem that our global food system is faced with today. It's hard to compete with sunshine, temperature and rain from the sky. Equitable access to food, high-volume grain production and protein shortages are a few examples of pressing problems that require broader and different solutions.

[00:06:22] **Mutinta Banda:** However, the Mars farm provides a window into how controlled environment agriculture can operate in the harshest environmental conditions and resource-scarce environments.

[00:06:30] **Evan Fraser:** The early to mid-2020s was really a fulcrum point or an inflection point in human history where, to put it colloquially, mother nature started playing for keeps. People had to find alternative ways of producing food without very much land, with extremely efficient use of natural resources and very close to the consumer. And those technologies that we developed in response to the climate change perturbations of the 2020s were exactly the same set of technologies that we needed in order to feed this human community that I now called home, this Base Town up here on Mars.

[00:07:03] **Mutinta Banda:** Evan's farm is in a series of caves dug into the cliff face near Base Town. If you were to enter, you would see among the red rock and soil, stacked layers of plants, lit with LEDs of blue and red light. The way it operates is similar in many ways to the vertical farms we see across the world today.

[00:07:27] **Evan Fraser:** So on Mars, when we produce fruits and vegetables, we have to start with some basic organic material.

[00:07:32] **Mutinta Banda:** The martian colonists were able to harvest the sandy soil or martian regolith [REG-O-LITH] of the planet and transform it using cyanobacteria [SIGH-AN-O-BACTERIA] into this basic organic material. There was also the need for water...

Evan Fraser: And, luckily there's a couple of frozen craters, towards the North Pole on Mars that have a fair bit of frozen water that we've been harvesting and melting.

[00:07:53] **Evan Fraser:** And then we're very careful about recycling all of that organic matter and all of that water.

[00:07:58] **Mutinta Banda:** We're able to use less than 10% of the water that was used in an old-style field setting. We can give each plant exactly the amount of water it needs and anything that is left over can be immediately captured and recycled.

Evan Fraser: And in these caves, we've got LED lights, which are powered on nuclear electricity.

[00:08:21] **Mutinta Banda:** The energy to power all of the LED lights and HVAC systems comes from renewable resources. This was a key challenge to overcome to make vertical farms sustainable.

[00:08:31] **Mutinta Banda:** One crucial difference between the Base Town farm and many of the vertical farms we see on earth is that the Martian colonists impose far stricter rules around human presence...

[00:08:43] **Evan Fraser:** We wanna minimize people coming in and out of the caves. In that, that creates a biosecurity risk that people may inadvertently—say on their shoes or whatnot—bringing pathogens or viruses in that might affect the plants.

[00:08:55] **Mutinta Banda:** Eradication of pests in vertical farms and greenhouses is often easier to manage than in outdoor field settings because the area is so well controlled. But once a contamination has occurred it can be extremely difficult to remedy.

Mutinta Banda: Back on earth, outside the silo number 5 vertical farm, Louissette drives a truck through 2ft of snow towards a disposal area. She enters through an automated fence and steps out wearing her parka, boots, hat, gloves and scarf.

(Sound of an electric truck going through the snow opens the car door, starts trudging through the dry snow, and some wind sounds in the background too.)

[00:09:13] **Louissette Thibault:** Below 30 celsius for two days now. That's cold enough that your eyelashes and nose hairs start to freeze.

[00:09:21] **Mutinta Banda:** Louissette places the bags of tomatoes into a large blue tube structure about her height and extending 20 feet into the distance.

(Sound of putting the plants into an industrial composter.)

[00:09:24] **Louissette Thibault:** In this industrial composter, the plants will die and the disease along with it. Once the virus has infected the crops there is no way to recover them, but the thrips will not infect next year's crops from this soil.

(Sound of putting the tomatoes into the composter.)

Louissette Thibault: Along with disposal, part of the eradication process will also be to wage biological war against any thrips still in the facility. I'll deploy a predatory insect - minute pirate bugs - to move in and destroy them.

(Evil laugh.)

[00:09:53] **Louissette Thibault:** They won't see it coming. First though, I'll need to visit a greenhouse I also farm in Ville de Sainte-Eustache. Outskirts of Montreal.

(Starts walking away)

[00:10:00] **Louissette Thibault:** Some of these tomato plants were initially transferred here from there.

(Sound of the electric truck starting)

(Soundscape fades out)

[00:10:11] **News Clips:** Governments worldwide invest in vertical farms around urban centers in 2029.

[00:10:15] **News Clips:** A new study looks at how the higher nutritional content of fruits and vegetables indoors affected prenatal health in 2038.

[00:10:23] **News Clips:** Geneticists have been working on developing new types of “fruit fashions” in 2042 as consumers look to foods like spicy strawberries and sweet garlic...

[00:10:33] **Mutinta Banda:** There are two main forms of controlled environment agriculture that we see today in 2050; vertical farms and greenhouses.

[00:10:40] **Mutinta Banda:** Greenhouses today employ lots of new high-tech gadgetry but the basic concept is nothing new. In fact, it was basic greenhouse technology that allowed Louis XV to grow pineapples at the palace of Versailles in the 1700s.

Matt Westerlund: We use a simple, clear structure to allow moisture to build up artificially within the structure. And we allow light from the sun to still penetrate. But you have almost entirely robotic greenhouses today, which are, yes, of course, located on a field outdoors where they can still benefit from the free energy the sun provides.

[00:11:16] **Mutinta Banda:** Unlike vertical farms, greenhouses are built out horizontally rather than up vertically. They are modular structures and the technology they employ is accessible to everyone.

[00:11:26] **Matt Westerlund:** We see many greenhouses, really all around the world, in places where some of our most at-risk, farmers who really beared the brunt of the environmental change over the past few decades have been able to use this technology and continue to grow successfully to feed their families, their villages and their communities.

[00:11:49] **Mutinta Banda:** Climate challenges in recent decades such as pollution, drought, floods, soil degradation and heat waves have increased the need to have more control over agricultural production. Historically, many countries used to import the majority of fresh fruits and vegetables during the winter seasons from places with warmer climates.

[00:12:08] **Evan Fraser:** So we had these weird situations where people would buy little packages of strawberries and blueberries in their grocery stores that had been produced, say, on the other side of the planet, and shipped using airplanes tremendously, water, energy and input-intensive system that required food to travel thousands of miles.

[00:12:28] **Mutinta Banda:** Folks in California for example would pick strawberries or tomatoes and apply gas to ripen them while in transport up North to Canada. This resulted in cardboardy, tasteless, flavorless fruits and vegetables year round.

[00:12:46] **Evan Fraser:** But of course now here in the 2050s and especially up here on Mars, everything we eat is local. Everything we produce is consumed within a small number of miles from these locations. And this has actually really improved the taste and the nutrition of the food that we eat and the fruits and vegetables that we eat.

[00:13:03] **Mutinta Banda:** In the outskirts of Montreal in Ville de Saint Eustache, [Ville de Saint Ew-Stache] Louise arrives at a vast network of greenhouse facilities. They cover hundreds of acres - huge domed structures surrounded by a white snowy landscape. Red and blue lights radiate faintly from the domes as the sun shines down upon them. She enters one of the greenhouses.

(Opening the door, the sound of stomping the snow off of his boots.)

[00:13:25] **Louissette Thibault:** We’ve got a strict series of protocols to enter and exit... to ensure there is no cross contamination...

(Sounds of Louissette undressing.)

[00:13:32] **Mutinta Banda:** She walks into a tunnel through a plastic-bubbled doorway and begins removing her parka, boots, snow pants, hat, gloves and scarf. She puts on a white lab coat and walks through a series of decontamination partitions...

[00:13:47] **Louissette Thibault:** We call this one the Hoover...

[00:13:49] **Mutinta Banda:** Air blasts Louissette from all sides in the wind tunnel.

(Sound of air blasting from all sides. Louissette is yelling now.)

[00:13:53] **Louissette Thibault:** It’s basically like standing inside a vacuum!

(Sounds stop)

[00:13:56] **Mutinta Banda:** She enters the greenhouse and walks down the aisles of fruits and vegetables...

[00:14:01] **Louissette Thibault:** Here in the greenhouse we have enoki mushrooms, potatoes, bananas, bok choy, kale, collard greens... I don’t see signs of the thrips on these... [Gasps]

[00:14:09] **Mutinta Banda:** At the tomato section, she finds wilting rotten tomato plants.

[00:14:18] **Louissette Thibault:** Seeds dripping off the vines... yellow, blackened and scarred tomatoes!!! [Ugh-hh]. How could this have happened?

(Sound of running back towards the entrance)

[00:14:21] **Louissette Thibault:** I'll need to check all of the records for who has been in and out of the greenhouse since I've been gone, dispose of all of the tomatoes and put dividers up between these and the other plants.

(Sound of grabbing the sheets, and tapping into the computer.)

[00:14:36] **Mutinta Banda:** She returns to the entrance-way where a barrel of dividers is located. She taps the greenhouse's main computer...

[00:14:45] **Louissette Thibault:** Show me a list of anyone who has entered in the past two weeks.

[00:14:51] **Louissette Thibault:** What the? No way. Ugggh-hhh! It looks like they allowed a group of third graders to come in as part of an eco-educational program. I told them I was against it, so they did it while I was on vacation.

[00:15:07] **Louissette Thibault:** Well now, that will be the end of those nasty kids in here.

(Soundscape fades out.)

[00:15:11] **Mutinta Banda:** The controlled environment agricultural revolution has allowed us to produce any crop, anywhere, anytime, regardless of the outside environment. Of course, there have been many bumps along the road.

[00:15:24] **Mutinta Banda:** The earliest experiments were on crops like leafy greens and microgreens. But there were many tricky crops that we had difficulty optimizing for vertical farms, for example, spinach...

Evan Fraser: When you grow spinach in a field, the leaves are very flat and consumers in the 2020s like their flat-leafed spinach. When you grow it in a vertical farm, the leaf for some reason that we've never fully understood tends to curl a little bit. It doesn't change the taste of the nutritional qualities, but it is a slightly different shape.

[00:15:52] **Mutinta Banda:** Head lettuce was another one that didn't seem to come out exactly as people expected; it was ropery and stringy. Blueberries and strawberries were difficult too, there seemed to be a relationship between the plant and the soil that resulted in a flavor that was less desirable to consumers when grown indoors.

[00:16:12] **Evan Fraser:** Once we started exploring the microbiome of the soil using genetic approaches, we were able to better understand all of the different pathways whereby the soil microorganism on earth creates flavor and nutrition and whatnot in plants. And that gave us a whole new set of tools in the 2030s that allowed us to really expand the number of crops that you could grow under a vertical farming or controlled environment setting, as well as boost the flavor and nutritional profile.

[00:16:40] **Mutinta Banda:** This helped us to create different types of what we call "light recipes" to grow fruits and vegetables with specific health, flavour and nutritional profiles in mind.

Evan Fraser: This is one of the nice things about using LED lights as opposed to natural sunlight, is that you can tune the wavelengths. And so for example lettuce. Say lettuce takes about 20 days to grow, if you start the growing season with a blue light, you end up with a slightly bigger plant. And then in the last few days, you increase the red lights, you end up with cancer-fighting antioxidants that sort of purple the leaves. What we've learned up on Mars is that you can really fine-tune the food you eat by creating a light recipe for each and every individual plant.

Mutinta Banda: The level of control that this affords us has allowed us to not only fine-tune individual plants, but we've managed to save entire species of beloved fruits and vegetables from extinction due to climate change, pests and fungus.

Matt Westerlund: I think the best example is probably our beloved banana, which has been for many, many decades and generations, probably one of the world's favorite fruits. And one that, you know, as many would remember, we almost lost in the 2020s, to disease. Because it was such a genetically specific organism once it fell prey to disease and mold we truly almost lost it. So it's really been a miracle, a particularly tasty miracle that I think kids around the world are excited we were able to pull off. Controlled environment agriculture allowed us to build a bubble, literally a bubble around the bananas to save them from extinction and disease.

[00:18:24] **News Clips:** More renewable energy is needed to power urban farms in 2028.

[00:18:29] **News Clips:** In 2032, engineers have developed more powerful wind tunnels to help control pest infestations in indoor facilities, while not relying on pesticides.

[00:18:38] **News Clips:** Arctic regions around the globe can now enjoy lemons grown indoors all year round in 2045.

[00:18:43] **Mutinta Banda:** It's afternoon and Louissette is in the kitchen at her home. She pulls out the bag of strawberries and blueberries she collected from silo number 5 earlier and begins preparing one of her favourite recipes on the stove.

(Eggs cracking, flour going into a bowl, whisking... turning on a stove.)

[00:18:58] **Louissette Thibault:** Crepes surees - sweet crepes in English. It is basically a thin pancake with fruit on top, but no one makes them as well as I do. And of course...

(Fridge opening.)

[00:19:06] **Louissette Thibault:** Maple syrup. [Chef kissy noise] There is a maple tree in my backyard that I tap every year...

[00:19:12] **Louissette Thibault:** Food tastes best when it has traveled as little as possible. I even have my indoor garden on the windowsill with some fresh herbs, basil and oregano and a few cherry tomato plants. This aquaponic system waters them...

(Sound of turning on the aquaponic system.)

(Soundscape of cooking during the line below.)

[00:19:33] **Louissette Thibault:** Now a flip of the crepes, a few berries on top, syrup... and voila!

(Fork and knife, eating.)

[00:19:33] **Louissette Thibault:** [Takes a bite, eating sounds.] Mmmmm. Parfait!

(Soundscape fades out.)

Act III - Looking Forward and Looking Back

[00:19:46] **Mutinta Banda:** Looking back on the history of the controlled environment agricultural revolution, we can see some key inflection points along the way.

[00:19:54] **Evan Fraser:** Well, one of the things that happened between 2025 and 2040, was a massive industrial investment in infrastructure. The infrastructure of what we now call the new green economy. And, it was a redeployment of tens of thousands of workers, over a very, very short period of time. And that was only possible through massive government funding allowances that created sort of almost a war footing like approach to deal with the effects of climate change. And climate change became so bad in the late 2020s that society as a whole realized that it needed to make this sort of almost war footing like investment to prepare society and avert a massive human catastrophe.

Mutinta Banda: Back in the 2020s, approximately one in three people worked in agriculture. For the last 20,000 or so years farming has been the main occupation for humanity. Today, we're still seeing shifts in terms of the agricultural workforce as the industry continues to change and adapt.

Mutinta Banda: The Netherlands created a basis for controlled environment agriculture through their flower and tulip production. Some other early key players around the globe helped to demonstrate the viability of this approach and spark people's imaginations in terms of what could be possible.

Matt Westerlund: It was a few Canadian players that due to their climate and their northern geographic position really kind of needed to pioneer the technology and grow it. They're the ones that really first brought at scale regional greenhouse production to the broader North American continent. Another example is there was some really early and exciting investment by some of the larger government investment funds in the Middle East into vertical farming. It's obviously a very different situation in the Middle East where it was much more about an existential threat to food security. Growing in the desert is simply not possible. And I think that some of the innovations that they unlocked really proved that indoor agriculture did not need to be just a niche thing for wealthy cities. It could be proven out in many different environments, even in the harshest environment, in the middle of the desert.

Mutinta Banda: We can be grateful for the ways controlled environment agriculture has made fruit and vegetable production more sustainable, but also take a sober look at the issues it has not solved and what still needs to be done.

[00:22:20] **Mutinta Banda:** In future episodes of Climate Vision 2050, we'll be exploring other solutions to our global agricultural challenges including ensuring equity and access to food, providing solutions to protein shortages and how to improve crop yields and efficiency through techniques such as regenerative farming. So as always, stay tuned for future episodes.

[00:22:41] **Nick Howard:** You've been listening to Climate Vision 2050, a podcast from BCG that explores how the world radically reduced carbon emissions and saved itself from climate catastrophe. Our narrator, Mutinta Banda [Moo-tin-tah Bahn-dah] is played by Atibo Onen [Ah-tee-bow Oh-nen]. Farmer Louissette Thibault [Lou-ease-et Tea-Bow] is played by Sarah Hurley. You heard from Matt Westerlund BCG managing director and partner and controlled environment agriculture expert as well as Evan Fraser, Director of the Arrell Food Institute at the University of Guelph, and author of "Dinner on Mars" imagining himself as the head of composting and recycling at a farm near Base Town on Mars.

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BCG is a global consulting firm committed to climate and sustainability action. We understand there are many possible futures, and we hope you enjoy our journey through some of them in this series. Learn more about our work on climate and sustainability at [BCG dot com slash climate](https://www.bcg.com/climate).