Adaptation Atlas Data Storytelling Challenge (Track 2): Crop Pests and Diseases

In this notebook

Overview

With the climate continuing to warm, a silent but new threat is rising over Africa's farmlands: the proliferation of crop pests and diseases, wrought by altered temperature and rainfall patterns. It is these biological stresses that are increasingly undermining food security, yields are reduction, and test farmers' resilience across the continent.

This work explores how climate change influences the distribution, prevalence, and infestation levels of crop pests and diseases in Africa. Data-driven investigations find newly emerging areas at risk, susceptible crops and predict possible changes in pest behavior under future climates.

Objectives

This notebook aims at analyzing and visualizing patterns of pest and disease activity under different climate scenarios; the model projections combined with the scenario data will be used directly or in modified forms. This specific notebook covers:

- Classify crops most at risk from climate-driven pest and disease pressures in relevant regions of Africa.

- Determine how the changing climate pattern, like increasing temperature and rain, is affecting the prevalence and severity of pests and diseases.
- Identify emerging risk areas where the habitat for pests could be expanded and their breeding season lengthened under future conditions.
- Highlight areas that could especially require enhanced surveillance, systems for early warning, or new approaches to IPM in order to prevent any future eruptions.
- Analyze how pest and disease patterns have shifted in the last two decades and how they may continue to shift under different climate futures under SSP245 versus SSP585.

Data Sources

All analyses powered by datasets accessed through Observable's pest_db connector:

- Pest & Disease Crop Yield Impacts -> Projected change in yield loss (%) relative to today.
- Pest & Disease Performance -> Predicted % change in pest thermal performance curves, reflecting the goodness of conditions for pests to survive, reproduce, and disperse.

Jointly, these datasets put a full-frame lens on how climate change is reshaping agricultural pest pressures that inform adaptive strategies with the premise of safeguarding Africa's future food security.

Question 1

What crops are most vulnerable to climate-driven pest and disease pressures in different regions?

Across Africa, the quiet march of climate change is already being felt by farmers, often

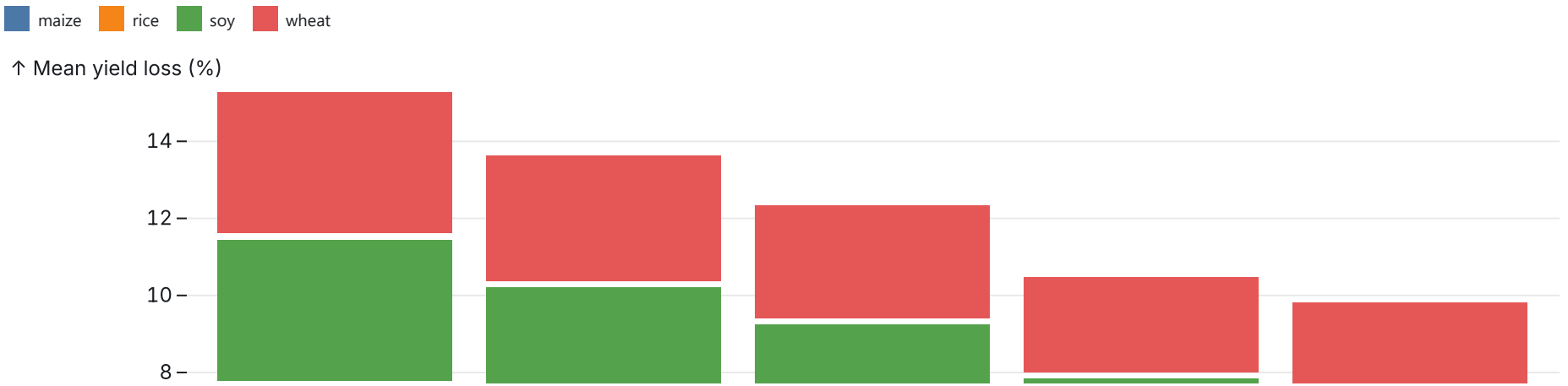
not through droughts or floods but through the increasing brazenness of pests and diseases in new regions. Temperature and seasonal changes are giving insects and other pathogens new opportunities to attack staple crops.

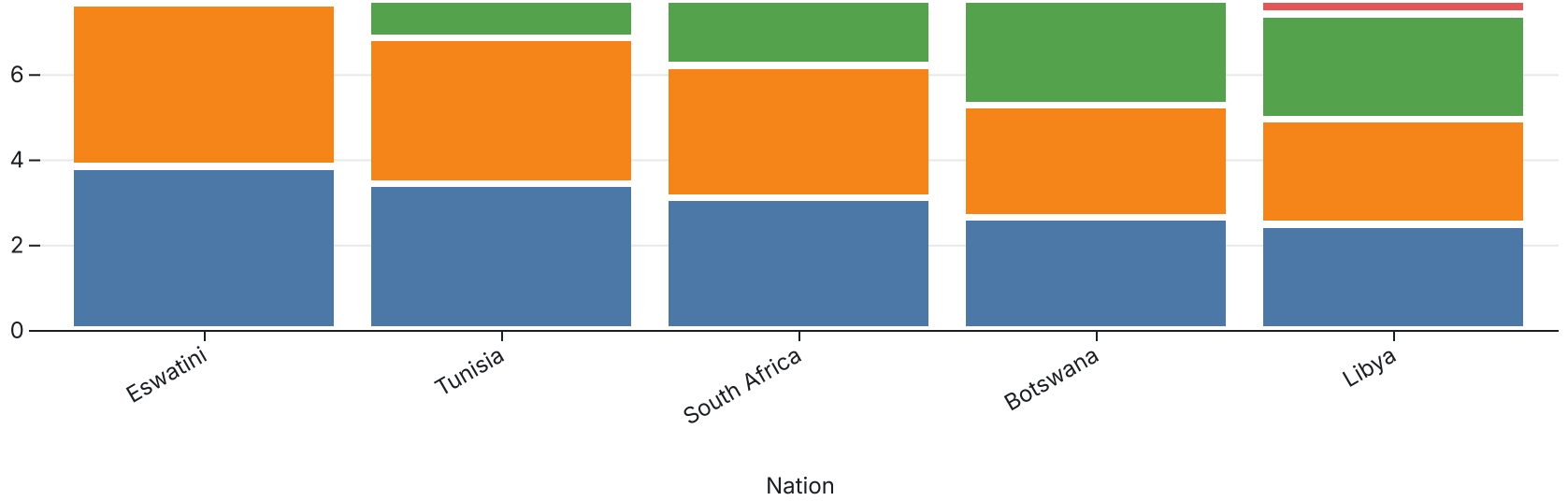
In this analysis, we explore which crops are most vulnerable to these emerging pest and disease pressures across the continent. Using data from the pest_yieldImpact table in the pest_db dataset below, we estimate the average change in yield loss (%) relative to today's levels.

Here's what the chart says:

- Positive values reflect greater yield loss-crops under increasing threat from pests and diseases in future climates.
- Negative values reflect losses decreased-rate of crops that can withstand changes in conditions.

By comparing the means of yield losses across nations and crop type, we start to see a story of vulnerability and resilience,a map of where climate change may hit hardest and where innovation and adaptation will matter most for Africa's food security.





What the Chart Reveals

As the climate shifts, so too does the invisible war between crops and the pests and diseases that threaten them. The visualization above reveals how this struggle unfolds across African nations, showing average yield losses (%) across four key crops that is: maize, rice, soy, and wheat.

Eswatini stands out as the most risky country, as for all four crops the yield losses are steadily high, which acts as an indication of high pest pressure and hence of rising environmental vulnerability. The close seconds in this esteem are Tunisia and South Africa, reflecting similar high risks but slightly lower average losses across the board. Interestingly, the loss patterns across crops remain remarkably consistent, indicating that climate factors may be amplifying pest and disease prevalence across the board, rather than targeting specific crops.

While at the other end of the scale, Botswana and Libya incur relatively more modest losses, even there, no crop is completely spared. In a nutshell, that will underscore another cardinal point-the fact that climate-driven impacts of pests and diseases are continental, not isolated.

Together, these are the patterns that tell a story of shared vulnerability and urgent opportunity. For building resilience, Eswatini's adaptation strategies should give priority to integrated management of pests, especially for maize and wheat, while North and Southern Africa need to strengthen regional monitoring systems that can detect an outbreak of pests before spreading.

In short, this chart is more than data ,it’s a snapshot of Africa’s evolving food landscape, where every degree of warming reshapes the balance between crops, pests, and survival.

Question 2

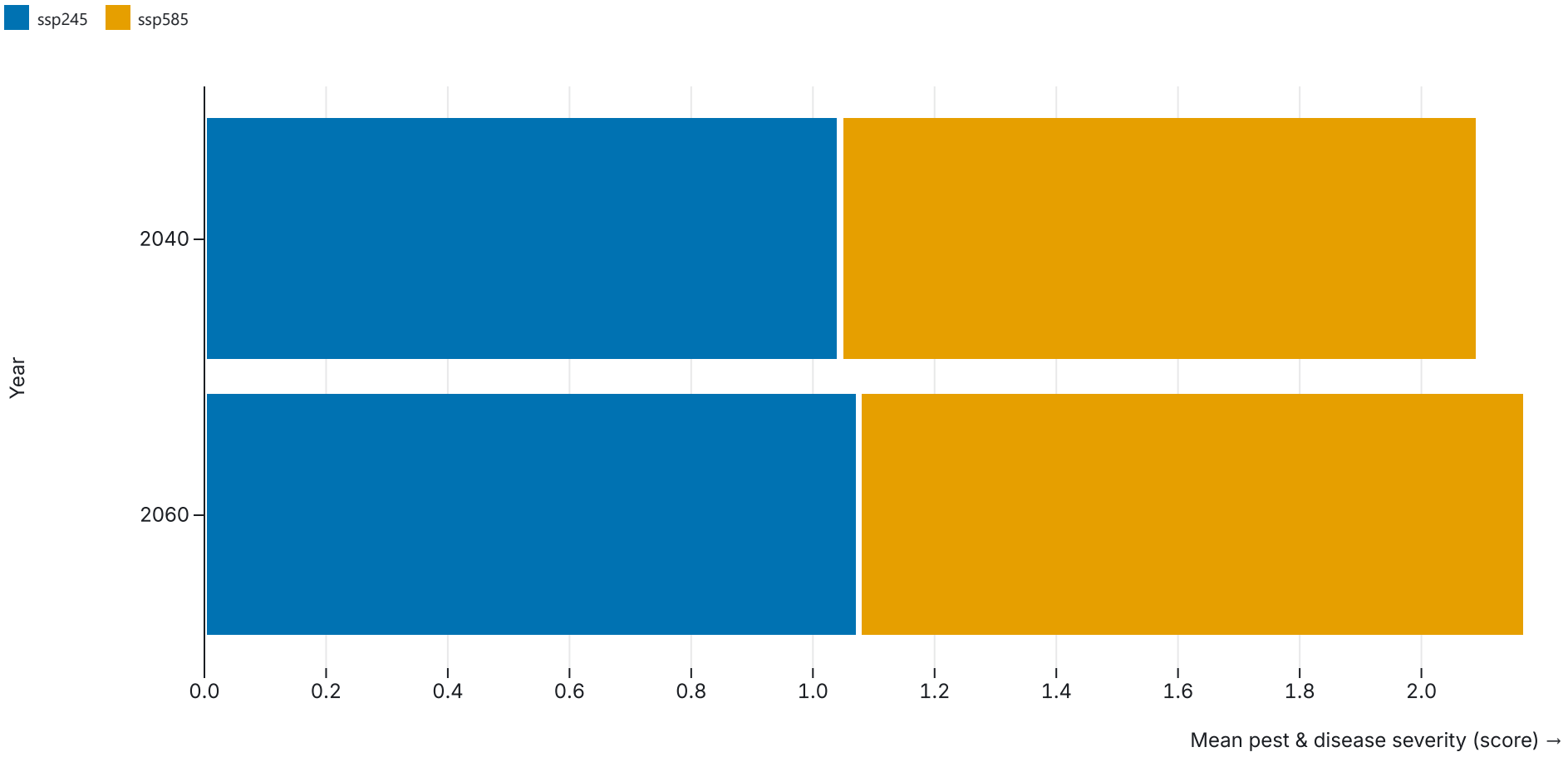
How are changing climate patterns affecting the spread and severity of pests and diseases?

Across Africa, the changing rhythm of the climate is quietly shifting the balance between crops and the pests and diseases that attack them. Rising temperatures and increasingly unpredictable rainfall patterns are steadily yet rapidly creating conditions that favor the survival, reproduction and spread of crop-destroying pests that threaten the harvests on which millions depend.

This analysis examines how changing climates are likely to impact the severity of pest and disease outbreaks over the coming decades. Using data from the *pest_performance* table in the *pest_db* database, we assess how the intensity of pests and pathogens shifts under two future climates: SSP245 (moderate emissions) and SSP585 (high emissions), as averaged across the 2040s and 2060s.

To interpret the chart easily:

- Higher performance values (> 1) ->pests become more active, adaptable, and widespread under warmer, wetter, or more variable conditions.
- Lower values (< 1) -> indicate reduced pest activity and limited spread potential, where environmental conditions become less favorable.



What the Chart Reveals

The above graph has a sobering message: how a warming world is rewriting the behavior of pests and diseases. In both the climate scenarios-SSP 245 (moderate emissions) and SSP585 (high emissions), the severity of the pest and diseases goes up with time, while the magnitude of change is strikingly different.

By the 2040s, already pests are becoming more active, and average scores of severity were climbing above today's baseline. However, under SSP585-the high-emission pathway-pressures from the 2060s onward become very much more extreme, suggesting that in general, pests will flourish in the hotter and more variable climates of

the future. The two scenarios are diverging, indicating that each degree of additional warming means higher survival of pests, faster reproduction, and wider spread.

Ultimately, this is not about insects and pathogens but what they mean for Africa's farms and food systems. Crops that could once be grown safely within stable climatic zones will face compound stresses-increasingly from drought, heat, and pest outbreaks.

This is what the data tells us: if emissions continue, Africa's fields could keep on becoming increasingly hostile environments for crops but havens for pests. It is a wake-up call for urgent adaptation-smarter surveillance of the Cropping fields, climate-resilient crops, and policies that protect farmers before the next wave of pest pressures reaches them.

Question 3

Where are emerging risks appearing due to shifting pest habitats or expanded breeding seasons?

According to NASA, as Africa warms, the invisible boundaries that once contained crop pests and diseases are starting to blur. A warming climate is shifting where and when pests can survive, breed and attack crops-alteration in potential hotspots of vulnerability.

This map shows how emerging pest risks are diffusing over Africa owing to range shifts and extended breeding seasons under future climate scenarios. For any pair of projected yield losses from pests in the 2040s and 2060s, the visualization here will show those areas that are likely to have increasing pest pressures under a warmer and more variable climate.

The aim is to know the risk zones that will be developing later in order to facilitate early warning systems, adaptive management of pests, and regional coordination to safeguard harvests and food security over the coming decades.

🎨 Color Guide — Emerging Pest Risk (Δ Mean Yield Loss %, 2060 → 2040)

- ☐ **Dark Red `#b2182b` — Rising pest risk**
  Regions projected to experience **higher yield losses** and **intensifying pest pressure**, indicating expanding pest habitats or longer breeding seasons.
- ☐ **Muted Grey `#d9d9d9` — Stable or minimal change**
  Areas showing **little to no change** in pest risk; environmental factors may offset pest activity or maintain current patterns.
- ☐ **Deep Blue `#08519c` — Decreasing pest risk**
  Regions where **pest pressure is projected to ease**, possibly due to climatic conditions becoming less favorable for pest survival and reproduction.

Note:
Color scaling is **fixed across both SSP245 and SSP585**, ensuring consistent interpretation between climate scenarios.
Δ values represent **changes in mean yield loss (%)** from **2040 → 2060** based on modeled pest projections.

CLIMATE PATHWAY

SSP245 (Moderate Emissions)

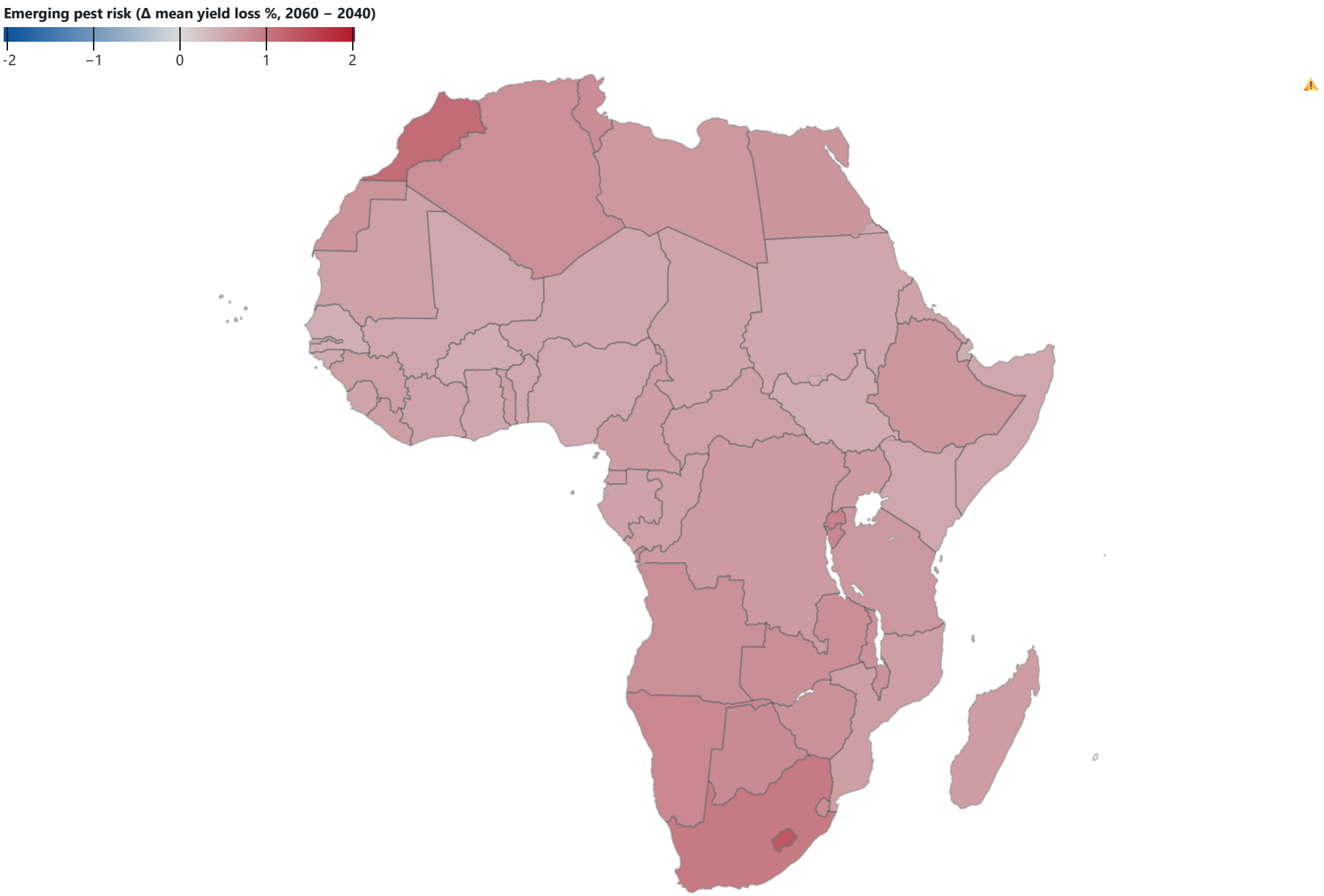
PROJECTION YEAR

2040

BOUNDARY TYPE

◉ Country ○ Admin 1 ○ Admin 2 ○ Watershed

Country Admin 1 Admin 2 Watershed



What the Chart Reveals

Across Africa, the quiet rhythm of farming is changing. As temperatures rise and rainfall

becomes unpredictable, the balance between crops and the pests that attack them is breaking. What used to be predictable growing seasons are now marked by new waves of insects and diseases thriving in the warmth.

In the Moderate Future (SSP245)

In this future, the change comes gradually but steadily. The map glows with warm red shades, showing how pest pressures are expected to rise across most of the continent between 2040 and 2060. Regions in Southern, Northern, and Eastern Africa will see the strongest increases as longer warm periods allow pests to breed more frequently and survive longer. Even lighter areas, where increases are smaller are still face growing risks. This is a future where adaptation is still possible. With early warning systems, improved pest management, and cooperation among neighboring countries, Africa's farmers could still stay ahead of the problem.

In the High-Emission Future (SSP585)

This scenario tells the same story but with urgency and intensity. The continent is covered in deeper red tones, showing that pest risks spread faster and more severely. Warmer conditions allow insects to move into areas that were once too cool or dry for them to survive. Northern, Eastern, and Southern Africa face the heaviest strain, as faster pest reproduction and longer breeding seasons drive up yield losses. Here, there is little sign of stability. The changes are rapid and widespread leaving farmers struggling to respond.

A Choice Between Two Futures

Both maps point in the same direction: pest risks are increasing across Africa. But the speed and severity depend on which path humanity takes. Under the moderate-emission pathway, countries still have time to adapt. Under the high-emission pathway, the risks grow too quickly, outpacing farmers' ability to cope.

Africa now stands at a crossroads. The choices made today that is stronger climate action, smarter pest management and better regional coordination will determine whether future harvests thrive or vanish under the weight of a warming world.

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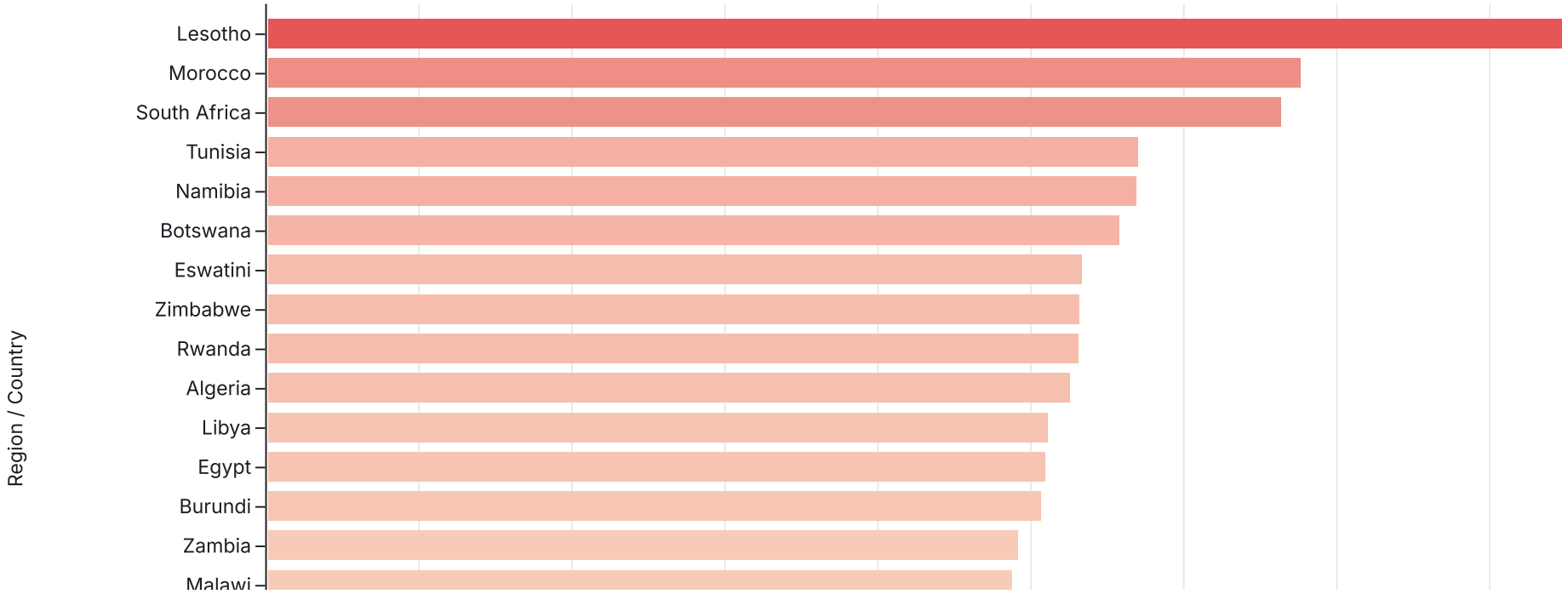
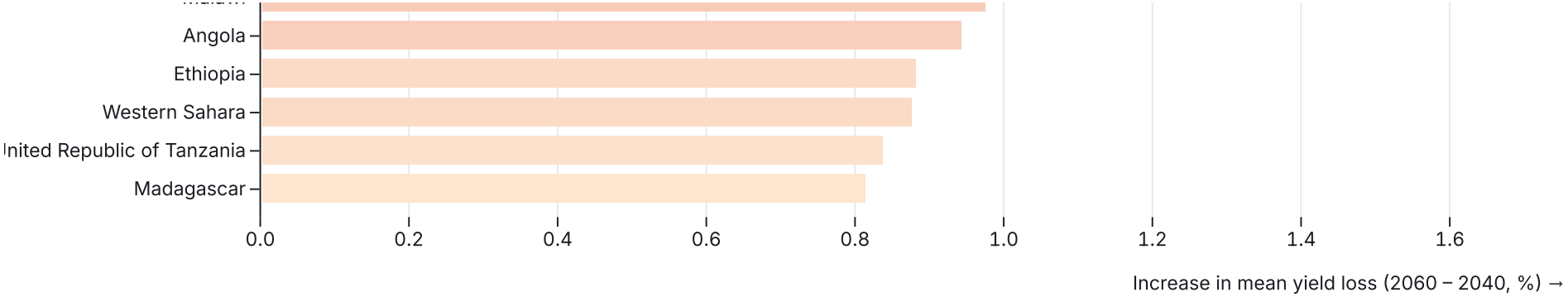
Question 4

Which regions are likely to require increased surveillance, early warning systems, or changes in integrated pest management (IPM) strategies?

In the next couple of decades, the encroaching web of pests and diseases will give a test for Africa's protection of its crops. As the climate heats up, slight changes in temperature and rainfall are disrupting life cycles of crop-damaging species, allowing them to move into new regions, increase faster, and live longer.

This analysis examines which countries in Africa are likely to face the largest increases in yield losses due to pests between the 2040s and 2060s. By using the *pest_yieldImpact* table from the pest_db dataset, we take a look at changes in mean yield loss (%) to point out emerging hotspots of pest occurrence that may soon necessitate increased vigilance in terms of monitoring and early warnings, with full support of IPM strategies.





What the Chart Reveals

The chart shows a surprising pattern: Lesotho, Morocco, and South Africa will see the largest increases in pest-related yield losses between the 2060s and 2040s. These steep increases point to shifts in climate conditions that make the regions-warming winters, increased length of the growing season, and changing rainfall cadence-ideal for pest survival and reproduction.

Lower down the list are Tunisia, Namibia, Botswana, and Eswatini, with fair to moderate increases, thus indicating expanding pest ranges that might shortly pose a threat to a variety of crops. Even those with smaller projected changes, such as Tanzania, Madagascar, and Ethiopia, are not out of the woods, as the pests will migrate toward cooler, higher-altitude zones that once served as natural barriers.

These put together point toward a continental shift in the hotspots of pests-from traditionally warm regions toward new frontiers introduced by rising temperatures. The increasing divergence between countries underlines how climate change is re-drawing Africa's agricultural risk map, where both southern and northern zones face increased biological pressure.

The real story that this chart tells-in much more concrete terms-is a call to urgency and opportunity. Scaling up integrated pest management, investing in early-warning systems, strengthening cross-border monitoring networks will be required in countries like Lesotho and Morocco. Lacking proactive adaptation, it could be that pests might emerge

as the silent driver of food insecurity-undermining decades of progress made toward agricultural resilience.

Question 5

How have pest and disease patterns changed over the past two decades, and how might they evolve under different climate scenarios (e.g., SSP245, SSP585)?

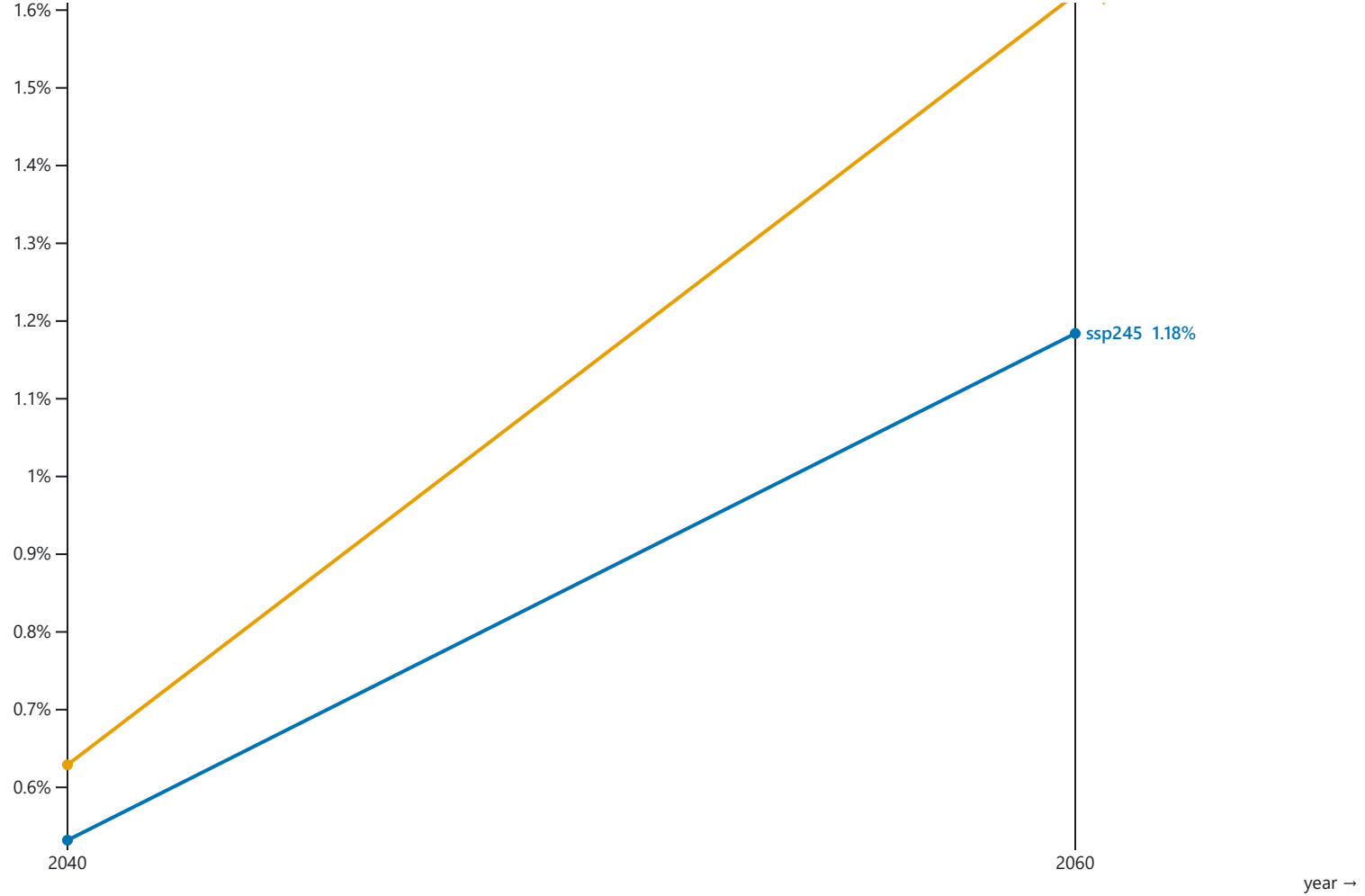
During the last couple of decades, the farmlands of Africa started to develop the slow but sure fingerprints of climate change: warmer temperatures, shifted rainfall and longer growing seasons. The result has subtly reshaped how pests and diseases behave-changing not just where they appear but how aggressively they spread and attack crops.

This analysis examines how yield losses due to pests and diseases are changing across time and how these might play out under different climate futures. Using the *pest_yieldImpact* table from the pest_db dataset, we are comparing projected mean yield losses (%) between the 2040s and 2060s to give an indication of how more biological pressure might be put as the planet warms.

The study assumes two different climate pathways:

- SSP245: In this medium-emissions scenario, adaptation and mitigation continue steadily to partially restrain global warming.
- SSP585: A high-emission, fossil-fuel-driven pathway of development under a stronger warming and variably extreme climate with limited mitigation.

Together, these scenarios help illustrate how the severity of pest and disease impacts could diverge sharply depending on the world's choices around emission, with higher-emission futures amplifying better pest survival, reproduction, and spread across Africa's key food systems.



What the Chart Reveals

The chart paints a clear and unsettling picture of how pest and disease impacts are projected to intensify under a warming climate.From 2040 to 2060, the mean yield loss resulting due to pests and diseases increases under both climate pathways but the rate of change tells two very different stories.

Under SSP245, the moderate-emissions pathway rises gradually from about 0.6% to 1.18%, reflecting a world that is warming but makes steady progress in both adaptation and emissions control. In this scenario, farmers are strained by increasing challenges, but the rate of change remains within reach for improved monitoring, pest management

but the rate of change remains within reach for improved monitoring, pest management, and resilient crop practices.

In sharp contrast, the SSP585 trajectory, which represents a high-emission, fossil fuel-based development future, demonstrates an increase that is far steeper-from around 0.65% to 1.62%. Here, stronger warming accelerates pest lifecycles, extends their range, and improves chances of survival in formerly unsuitable areas. In such a world, pests and diseases become year-round threats instead of seasonal nuisance.

Together, the two lines show a rare defining truth: every fraction of a degree of warming carries real biological consequences. The gap between these two scenarios is a reminder that the choices made today, in emissions, adaptation, and land management will determine whether Africa's future farms can outpace the rise of pests or be overwhelmed by them.

🌾 Conclusion: Climate Change and the Increasingly Frightening Crop Pests in Africa

Climate change is rewriting the rulebook on farming across Africa's farmlands. The data gives a story that is both scientific and human of crops under siege, shifting ecosystems and farmers at the modern frontline of some quiet biological transformation.

From the maize in Eswatini to the rice in Tunisia and wheat in South Africa, the rising temperatures and unpredictable rainfall are allowing new ground by pests and diseases. The maps and charts expose a continent where the compass of risk is spreading northward, southward, and upward to once-safe highlands as temperatures rise and rainfall becomes unpredictable. The once-stable boundaries of pest habitats are blurring, giving way to longer breeding seasons and wider infestations.

Under the SSP245 medium-emission scenario, the situation looks bleak but contains paths that are manageable. Pressures from pests rise steadily, requiring continued vigilance, adaptation and regional cooperation. But under the high-emission scenario of SSP585, the outlook is grave: hotter conditions and erratic rainfall amplify pest survival toward driving root area widespread yield losses that overwhelm farmers' coping capacity.

The message from the data is crystal clear: the resilience of Africa's agriculture will depend on no single factor but also notably on innovations in pest management and warning systems. It will require enhanced surveillance, climate-smart crop development, and equipping farmers with localized forecasting tools to safeguard the future of food in the continent.

Africa is standing at a crossroads. Today's decisions on emissions, adaptation, and cooperation will determine whether tomorrow's farms stay productive and resilient or fall before the unyielding onslaught of a heating climate and its pest allies. The window for prevention is still open, but the shrinking with every passing season.

Appendix

This section is all the underlying code and variables to power the notebook

```
nbTitle = "Adaptation Atlas Data Storytelling Challenge (Track 2): Crop Pests and Diseases"
```

Question 1 Query

```
cropLossSummary = ▸ Array(20) [Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Row, Ro
```

Question 2 Query

```
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Question 3 Query

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Question 5 Query

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Question 4 Query

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```

Imports

```
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```

```
lipsum = ƒ()
```

```
import {pest_db} from "b2a8f20822affaca"
```

Default Adaptation Atlas Styling

This can be found here to be modified and adjusted

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import {atlas_stylesheet} from "8a953dc1cde63a86"
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Adaptation Atlas Boundaries

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admin_boundaries = ▸ Object {adm0: Object, adm1: Object, adm2: Object}
```

```
watershed_boundaries = ▸ Object {watershed: Object}
```

Additional Resources

- **Notebook Style and Developer Guide**
- **Existing Adaptation Atlas Notebooks**
- **Example:** Use Python and Google Earth Engine to process soil data
- Adaptation Atlas Data Guide

- Adaptation Atlas Data Guide
- Atlas Data FAQ
- Observable JS Documentation
- Observable JS vs vanilla Javascript
- Data wrangling in JS vs R, Python, and SQL
- Adaptation Atlas ObservableHQ
- Zindi Challenge Link