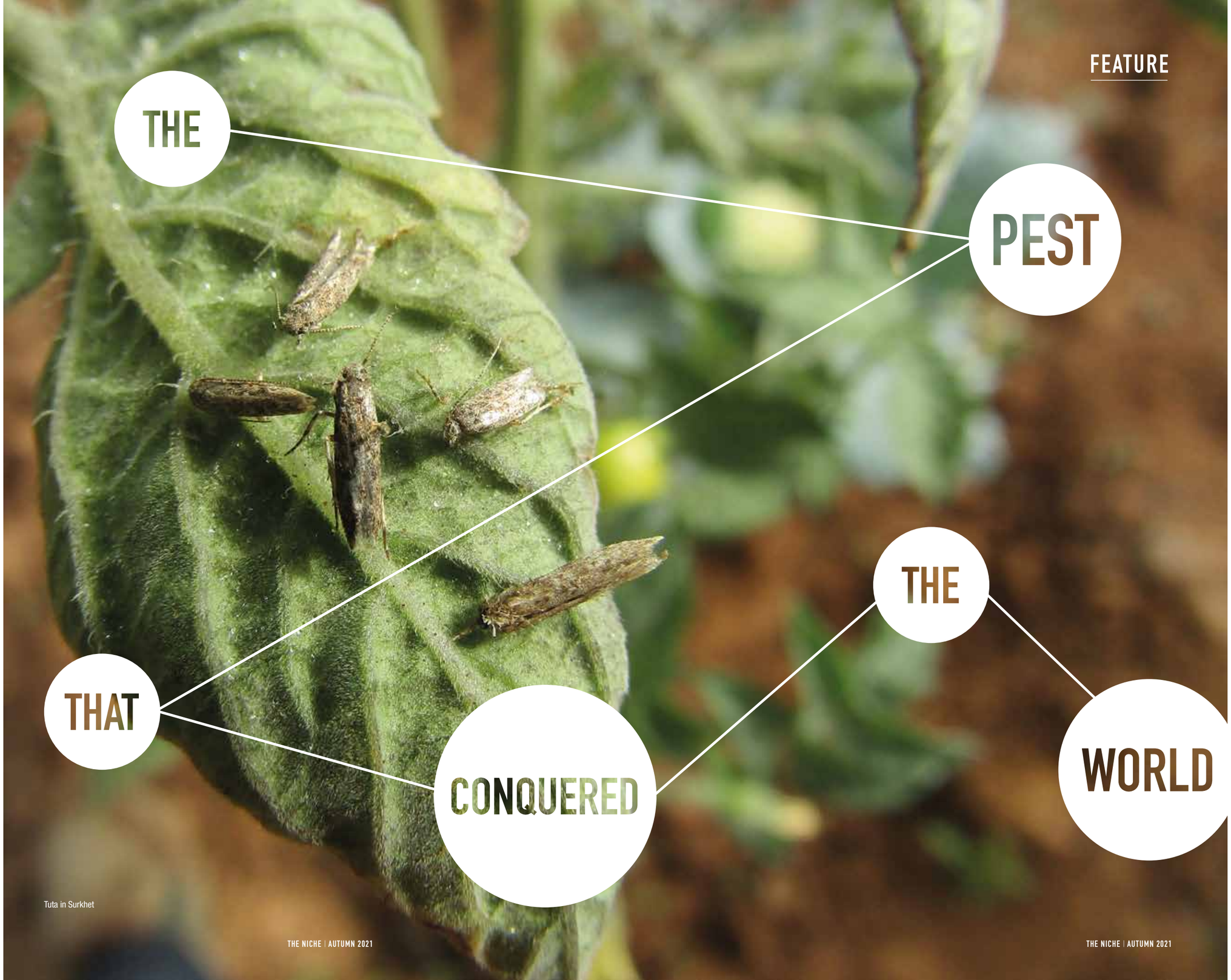

Tuta in Surkhet

MONITORING AND MANAGING THE TOMATO LEAFMINER

It's summertime and your tomatoes are perfectly ripe. You pick one to add to your family meal or the crate of produce you plan to sell at the market, but there's a problem – the fruit is covered in tiny pinholes.

The invasive tomato leafminer *Tuta absoluta* could be the culprit of those pinholes. Despite the charming rhyme in its name, *Tuta absoluta* is a serious pest. Native to South America, the pest now plagues Europe, Africa, the Middle East, and Central and South Asia. While it prefers tomato, *Tuta absoluta* also attacks aubergine, potato, and pepper, among other crops, and has the potential to cause 100 percent crop loss. In its wake, the pest leaves behind holes in the fruit or "mines" on leaves, which dries the leaves and gives an entire field a scorched appearance after an attack. Farmers in 12 countries in sub-Saharan Africa reported losses of over 1 million tonnes, an estimated loss of nearly USD $800 million annually.

With the increase of globalization and extreme weather events due to climate change, the spread of invasive species has become more rampant. Heavily relying on natural resources, developing countries are often most at risk or have the most to lose from invasive species spread. Traditionally, in developing countries, crops such as tomato are seasonal, but over the past decade, the rising demand and opportunity to export has caused year-round production through protected cultivation methods and resilient varieties. An increase in urban population, short shelf life of vegetables, and short marketing chains have encouraged urban agriculture in developing countries. Such urban agriculture is particularly vulnerable to invasive species attacks.

In the case of *Tuta absoluta*, the pest's resiliency is what makes it so difficult to manage. The *Tuta absoluta* moth has high mobility capabilities and both the moth and larvae can survive harsh climates as well as live among a number of alternative host plants. *Tuta absoluta* has also developed significant resistance to many synthetic chemical pesticides, which can have undesirable effects on key beneficial insects.

Virginia Tech's Feed the Future Innovation Lab for Integrated Pest Management (IPM Innovation Lab) – a programme funded by the U.S. Agency for International Development — monitors and manages a number of global invasive species, *Tuta absoluta* included. Given the pest's resiliency, the programme developed a novel modelling system to track *Tuta absoluta* as it moves throughout Nepal, where tomato is a major cash crop and vital to small-scale farmer livelihoods.

Typically, trade networks present data that aids in building the accuracy of modelling systems, but tracking these flows within developing countries can be a major challenge. The intricate web of supply chain dynamics makes it difficult to document transactions, and even in economically developed countries, obtaining commodity-specific flow data is constrained.

"It was clear to us from the beginning of this project that we needed a new way both to understand and track crop threats," said Abhijin Adiga, research assistant professor at the University of Virginia's Biocomplexity Institute, which is the implementing partner of the project. "Our focus countries in Africa and South and Southeast Asia lack the data that we typically rely on to map pests or disease. Thus, we developed a simulation system based on network science and statistical analysis to incorporate openly available data and mechanisms of spread based on expert knowledge to establish the correlation between spread of the pest and commodity flow patterns."

The data includes climate information, biology, host crop production, human population, gross domestic product, and other factors. This system is intentionally made to be generic so that in the future, many countries should be able to use this framework for a range of needs, including tracking invasive species, natural or human-initiated disasters, climate change, and food flows.

The programme's novel pest modelling system found that if left unmitigated, *Tuta absoluta's* spread could be devastating to crop production, livelihoods, and biodiversity in Nepal, with a potential economic impact of $25 million. The programme also found that over a five-year period, *Tuta absoluta* will most likely spread to all vegetable-growing areas of mainland Southeast Asia and that its primary mode of spread is through human mediation.

As tomato shipments move from region to region, and market to market, so does *Tuta absoluta* in both tomato fruits and seedlings. With this knowledge, it's easier to identify possible management solutions for curbing the pest's spread, including improved quarantine measures between regions that trade with one another.

"Discovering that this pest's mode of spread is through human action reiterates to us the value of global collaboration," said Muni Muniappan, director of the IPM Innovation Lab. "The sooner we can alert countries at risk of invasion, the faster they can begin to prepare to manage it or deflect its entry. It also shows us that this spread could be preventable."

Southeast Asia isn't the only region at risk of *Tuta absoluta's* reign. Thus far, the IPM Innovation Lab has tracked the pest from South America to Costa Rica in Central America and Haiti in the Caribbean. If left unmitigated, the pest will likely enter the U.S., one of the world's biggest producers of tomatoes and an industry worth billions annually.

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"With the knowledge that the pest is on its way to the U.S.," Muniappan says, "we can put into place monitoring mechanisms that will help farmers not only know if the pest is in their field, but if the invasion is major or minor, which is necessary when planning how to resolve the problem."

To monitor pest spread, the IPM Innovation Lab introduces into farmers' fields simple, sustainable technologies such as pheromone traps, which are traps that use pheromones to lure insects. The programme also recommends the application of neem oil, a natural insecticide that keeps pests from laying eggs on a plant.

Pramod Jha, professor emeritus at Tribhuvan University in Nepal and a project collaborator, said that understanding the dynamics of invasive species spread is imperative to achieving zero hunger, no poverty, and good health and well being, which are among the sustainable development goals of the United Nations.

"Invasive species like *Tuta absoluta* present a major threat to biodiversity, especially in a country like Nepal, which hosts valuable and unique biodiversity hotspots," he said. "It's important to remember that biodiversity serves both people and the surrounding ecosystems. In Nepal, for example, some animal species are now threatened because their food sources are declining from invasive species spread. Everything is connected – if we protect our environment, we protect ourselves."

Jha collaborates with Adiga on another IPM Innovation Lab project that tracks the spread of invasive weeds over time in Nepal, focusing especially on the impact of elevation and climate change on spread. The programme has found that as extreme climatic events persist, invasive weeds are climbing faster and higher than ever before, pushing out native species critical to the lifeblood of the country.

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As *Tuta absoluta* continues to make its way around the world, no country is exempt from its entry, which is why projecting where it's headed and how fast — and recognizing the potential disproportionate impact on developing countries — is so crucial. Without novel techniques like pest modelling systems that account for a range of complex scenarios, communities are left underprepared.

"Worldwide, invasive species cost trillions of dollars a year," said Muniappan. "There must be a concerted effort into curbing their further spread since it is not an isolated problem. We can make greater headway if we communicate about the knowledge we gain through emerging techniques and share our best practices." ✺

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