Using diversity to fight and manage crop pests and diseases

The challenge

Rising temperatures, unpredictable rainfall patterns and increasing pests and diseases are just ways in which climate change is threatening future crop productivity. Pests and diseases are a natural part of any ecosystem – what farmers fear, are outbreaks or epidemics that can cause high yield losses. Worldwide, farmers lose an average of 10-16% of their annual harvest to pests and diseases, but cases vary widely by crop, region and threat – farmers can lose as much 100% of their crops in one season to a single pest or disease. Losses take a heavy toll on local and regional food supplies – wilt diseases in bananas, bean fly and rust in beans, leaf blight in maize and blast in rice are among the culprits.

In a world of increasing unpredictability and where there is no 'one size fits all', the only way forward is to address multiple challenges using holistic approaches that consider systems, landscapes and genetic diversity together as a central solution.

Bioversity International research approach

Our research shows that using agricultural biodiversity and a series of low-tech management practices are effective, cost-efficient and environmentally-friendly ways to manage pest and diseases for increased productivity and reduced agricultural loss. We conduct research at different scales, from variety within a crop to the species and landscape level. For example, we have found that planting varieties of the same crop in mixtures, can be highly effective at reducing pests and diseases in farmers' fields. Diversity is particularly valuable as a complementary tool to other practices such as seed cleaning, growing crops further away from each other and selective breeding.

Agricultural biodiversity is an economically viable and accessible option for smallholder farmers who may not be able to afford chemical inputs.

Using diversity for pest and disease management also encourages farmers to maintain local diversity on their farms, an important source of genetic material that could be used for breeding resistant varieties in the future.

Bioversity International works through local and international partnerships with communities, researchers, government actors and development agencies to develop solutions that can then be taken to scale.

Building on successful research undertaken over the past 40 years, new demands, including those brought on by changing climatic conditions, are calling for ongoing research that includes:

- Complementary research in new locations and with new crops
- Refined scaling tools for training and learning among national agricultural research systems and farmer organizations
- Cost-benefit analyses to document the economic impact of our pest and disease management approaches in comparison with other treatment options.

Using intraspecific crop diversity in farmers' fields

In Uganda, planting susceptible varieties of common bean with at least 50% of a resistant variety in the same plot, significantly decreased bean fly damage - in this case, we used a local resistant variety called Kasirira.

Our expertise in using intraspecific diversity to manage pests and diseases is a hallmark of our research portfolio. Since 2006, Bioversity International and partners have been working with farmers and national researchers in China, Ecuador, Morocco and Uganda, to see how diversity within a crop can add value to pest and disease management. We focus on traditional and modern varieties of

Photo: Red-winged Grasshopper (*Arphia pseudonietana*), a minor pest that mainly feeds on grass. Credit: Bioversity International/C.Zanzanaini

six crops: banana, barley, common bean, faba bean, maize and rice. Field trials across all four countries have consistently shown that using more varieties of a crop increases resilience to pests and diseases, reducing the likelihood of severe outbreaks and damage. Results from trials in China showed that growing crops in varietal mixtures was much more efficient for pest and disease management when three or more varieties were planted in the same plot, compared to when only one of two varieties were used.

In Ecuador, our banana trials confirmed that planting resistant and susceptible varieties together can reduce the Sigatoka infection affecting bananas by 40%. The Sigatoka infection of Gros Michel, the most susceptible variety, was reduced by 50%.

In Morocco, the more varieties planted together in a field the better. To give a comparison, fields with only one variety had an average yield of 350 kg per hectare, whereas the blend of five varieties had an average yield of 1,374 kg per hectare, higher than all other mixtures.

Managing outbreak and reducing spread in Uganda

With the help of out-scaling activities, 50,000 farmers were trained in the management of banana Xanthomonas wilt (BXW), resulting in an increase in productivity by at least 5-10% in Kenya and Uganda sites.

Banana Xanthomonas wilt (BXW) attacks all banana cultivars causing up to 100% yield loss. Left uncontrolled, it is estimated that Uganda could lose an estimated US$ 295 million worth of banana output (valued at farm gate prices), which translates to a loss of US$ 200 per year of food and income per household. Only 10-20% of planting material needs to be infected to quickly pass the disease on to healthy plants, reducing both the size of banana bunches and the number of harvests.

Getting enough clean planting material is a big challenge for smallholder farmers, but techniques as simple as sterilizing knives used to manage plants can greatly reduce the spread of BXW.

Introducing disease-resistant banana varieties in the Philippines

A new banana variety developed in collaboration with partners has now been successfully exported to Japan, offering more income opportunities for the Filipino farmers.

Improvements to harvesting time, ripening protocol, packaging and branding, have helped GCTCV-219 (a Philippine selection of a Giant Cavendish tissue-culture variant from the Taiwan Banana Research Institute) gain entry into the Japanese market. GCTCV-219 is a banana variety resistant to the deadly banana disease Fusarium wilt – including its latest strain Tropical Race 4 currently threatening production in Asia, Oceania and Africa.

Landscape diversity approaches to pest control

Having forest patches near coffee farms in Costa Rica has shown to increase pest control by birds and limit the mobility of coffee borer beetles.

In Costa Rica, a major coffee producing area, we are studying how birds can act as natural predators to the coffee borer beetle (CBB), an insect that causes more than US$ 500 million in losses for coffee growers globally. We have found that both local and migratory birds are natural predators of this pest, and coffee plants that were covered in nets to prevent access to birds showed much higher infestation rates of CBB compared to exposed shrubs. Fellow scientists estimate that CBB-preying birds can save a medium-sized coffee farm up to $9,400 over a year's harvest.

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Photo: Banana plant affected by Xanthomonas wilt, Uganda. Credit: Bioversity International/N.Capozio