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Global plant pangenome network targets next breakthrough in crop genetics

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International collaboration brings researchers, industry and technology developers together to unlock genetic diversity for more resilient and productive crops

The global plant science community is taking a more coordinated approach to one of the biggest challenges in modern crop breeding: how to capture and use the full genetic diversity within a crop species. The James Hutton Institute has joined the newly launched International Plant Pangenome Network (IPPGN), a collaborative initiative bringing together scientists, researchers, industry partners and technology developers to advance plant pangenomics.

The field is moving beyond the traditional approach of studying a single reference genome. Instead, plant pangenomics seeks to map the broader genetic diversity within a species, including genes shared across plants as well as variations that may give individual varieties advantages in yield, resilience or adaptation. That shift could have significant implications for agriculture. As climate change alters growing conditions and pests and diseases continue to evolve, breeders need access to a wider pool of genetic traits to develop crops capable of performing under increasingly unpredictable conditions.

By making previously underused genetic variation easier to identify, compare and deploy, pangenomics could help accelerate the development of crop varieties that are more productive, resilient and suited to future environments.

Turning genetic diversity into breeding value

The opportunity is substantial, but the science remains technically demanding. Plant genomes can be considerably larger and more complex than those of many other organisms. High levels of repetitive DNA, heterozygosity and multiple sets of chromosomes make it difficult to assemble, analyse and compare genomes at scale. These challenges have slowed progress in plant pangenomics compared with similar work involving bacteria, humans and other animals.

Dr Miriam Schreiber, researcher at the James Hutton Institute, said the network is already helping researchers identify common technical challenges and create new opportunities for collaboration. “The network has already been extremely useful in highlighting the shared challenges that colleagues working in this area are facing,” Schreiber said. “It is a great place to connect with others and will no doubt lead to new collaborations and projects.”

The IPPGN is designed to address some of these barriers by creating a common platform for researchers to exchange expertise, data, analytical tools and best practices. For the agricultural sector, the value of such collaboration could ultimately be measured by how quickly genomic discoveries can move into practical breeding programmes.

Building the tools behind the science

One of the most immediate challenges is analytical capability. Many genomic tools were initially developed for organisms with less complex genomes and are not always suited to the scale and structure of plant genetic data. The network aims to create a closer feedback loop between researchers and technology developers, allowing scientists to share their experiences with existing tools and help shape solutions designed specifically for plant genomes.

Dr Rachel Rusholme Pilcher, Chair of the network and based at the Earlham Institute in Norwich, said the network’s strength lies in the willingness of members to share both successful approaches and failures. “We are fortunate to have a community that is incredibly generous with its expertise, experiences and ideas,” she said. Another priority is developing common standards for graphical pangenomes. Graph-based approaches are becoming increasingly important because they can represent genetic variation more comprehensively than a single linear reference genome. But without common standards for assessing the quality of pangenome graphs and ensuring that datasets can work across different platforms, the value of the underlying data could remain limited.

Establishing interoperable and reproducible approaches could therefore be just as important as generating more genomic data.

From genomic maps to climate-resilient crops

The larger opportunity for plant pangenomics is to turn genetic diversity into a practical resource for agriculture. A deeper understanding of variation within crops could give breeders more options as they seek traits linked to drought tolerance, disease resistance, yield stability and adaptation to changing environmental conditions. That could become increasingly important as agriculture faces the combined pressures of climate change, resource constraints and the need to increase food production without expanding its environmental footprint.

The IPPGN’s ambition is therefore not simply to advance genomic science. By creating a more connected global research ecosystem, the network aims to accelerate the discovery and deployment of genetic traits that can contribute to sustainable crop improvement and long-term food security.

The next challenge will be translating that scientific collaboration into usable breeding tools, consistent standards and commercially relevant crop traits. If the network can bridge those gaps, plant pangenomics could move from a specialist research field towards becoming a core technology underpinning the next generation of crop improvement.