

2023 ANNUAL REPORT

Our Mission:

To merge cutting-edge science discovery with practical implementation for safe, effective, & long-lasting solutions to crop losses caused by diseases, insects, and weeds.

Leadership Messages	... 2
2023 Highlights	... 4
Projects Overview	... 10
Financials	...14



MESSAGE FROM PRESIDENT & CO-FOUNDER, DIANA HORVATH



It is with great pleasure that I share with you our 2023 Annual Report. This has been a particularly momentous year, in which we delivered key outcomes for our partners, launched daring, new projects to deliver global impact, strengthened our team, and marked our 20th anniversary as an organization!

I co-founded 2Blades in 2004 to test a new model to achieve impact in agriculture. By shepherding discoveries at the lab bench into validation in the field and by fostering partnerships along the Innovation Chain, 2Blades helps to de-risk innovation for both commercial and small-holder implementation partners and create effective solutions for growers. Reflecting on the past 20 years, I could not have dreamed that 2Blades would become the organization it is today. Thanks to the tireless commitment and dedication of our team, supporters, and partners, we have produced crops that are more resilient to some of the most intractable diseases plaguing our global food supply. And we are just getting started.

20 years in, we remain committed to pushing boundaries, nurturing innovation, and delivering durable, environmentally-friendly solutions for more sustainable harvests for all.

Thank you for being part of our journey,



LETTER FROM ERIC WARD BOARD CHAIR

Over the past 17 years, I have had the distinct privilege of serving 2Blades in a variety of roles: President, Group Leader, and now as Board Chair. Since its founding, 2Blades has always played an important role in the agricultural innovation chain – linking upstream lab research with downstream impact in the field – but never has that

role been more important than today. From population growth to changing weather patterns, our global food system is facing threats in need of innovation solutions that have been part of 2Blades’ mission from the very beginning.

I am excited at the progress, detailed in this report, that 2Blades has made in addressing some of the most severe diseases threatening our crops. We’ve hit several major milestones in the past twelve months, including making important steps toward deploying Asian soybean rust resistance in Africa, launching our effort to combat mycotoxins in maize, and discovering hundreds of new disease resistance genes. We’re positioned to make an even greater impact in the coming years, particularly with the addition of key people to augment our outstanding team.

I extend my sincere gratitude to our staff, our partners, and our Board members for their unwavering support of our mission to deploy novel technologies that enhance sustainable agricultural production. Together, we are providing critical innovation that helps build a future where all people can enjoy food and prosperity.

Respectfully,

2023 VOLUNTEER LEADERSHIP

BOARD OF DIRECTORS

Eric Ward, Chair
Diana Horvath
Ken Moonie

Peter van Esse
Sylvia Wulf

BOARD OBSERVERS

Bernard Fung
Peter Hesketh

Nick Talbot

SUSTAINABILITY COUNCIL

Euler Bropleh
Christine Daugherty
Robert Easter
Alesha Miller

Frank O’Keefe
Katie Pratt
Tom Turpen
Maria Velissariou

SCIENTIFIC ADVISORY BOARD

Sir David Baulcombe
James Carrington
Jeff Dangl
Jeff Ellis
Jonathan Jones

Sophien Kamoun
Paul Shultze-Lefert
Brian Staskawicz
Cyril Zipfel

2023 HIGHLIGHTS





2Blades Launches Program to Tackle Asian Soybean Rust for African Growers

In May 2023, 2Blades initiated a focused effort to develop Asian Soybean Rust (ASR) resistance to protect soy crops in Africa. The new initiative implements resources and expertise developed for commercial soy production in North and South America and seeks to ensure that this progress benefits growers in Sub-Saharan Africa as well.

“Our new African ASR initiative exemplifies the principles of 2Blades’ mission. We advance innovations in plant science for both large- and small-scale agriculture, capturing value in commercial markets and using synergies to deliver benefits in developing markets,” stated Diana Horvath, Co-Founder and President of 2Blades.

Soybean is an important crop for Africa due to its high oil and protein content, ability to build soil nitrogen, and strong income potential. Globally, growth in demand for soy is highest in Africa, yet production there is only about 1% of total global soybean production. Demand is met by imports, contributing to a food import bill for Africa projected to reach \$90 billion by 2030.

As Kenya and many other African countries seek to bolster domestic soy production and reduce dependence on imports, a daunting threat has emerged: Asian Soybean Rust. Asian soybean rust is a fast-moving, highly-destructive disease caused by the airborne fungus *Phakopsora pachyrhizi*. ASR is the most significant disease across the large soy production areas of Brazil, where it causes rapid outbreaks and yield losses of up to 80% within just 3 weeks of initial infection. Brazilian growers rely on fungicides to combat ASR but the cost of this control measure is too expensive for many growers in Africa, who are mostly small-holder farmers. Moreover, *P. pachyrhizi* is rapidly adapting and building tolerance to existing fungicides, and the available genetic resistance in soy is being overcome by the pathogen. ASR is present in most African soybean-growing regions today, putting the economic potential of soy production in Africa at risk.

Over the last sixteen years, 2Blades has gained a deep understanding of *P. pachyrhizi* and found many new sources of disease resistance in soy relatives. The new initiative will make use of these significant resources and expertise to advance effective, durable ASR resistance for African growers in high-performing regional varieties.

“This initiative complements and builds on the work of several organizations contributing to African soybean production and regional food and feed production, including the Syngenta Foundation for Sustainable Agriculture, International Institute of Tropical Agriculture, Kenyan Agriculture and Livestock Research Organization, International Livestock Research Institute, Soybean Innovation Lab, and Seed Co, with whom we have developed relationships over the years,” said Horvath. “We look forward to building effective partnerships to help achieve a resilient soy industry across Sub-Saharan Africa.”



2Blades Welcomes New Leadership Team Members, Sets Sights on New Crop Disease Projects

In 2022 and 2023, 2Blades bolstered its leadership team and Board of Directors to accelerate its mission of providing long-lasting solutions to crop disease and global food security. The new hires came as 2Blades expanded its work on economically important crops like soybeans and corn. “This past year has shown us how vulnerable our food systems are to environmental, social, economic, and political factors,” said 2Blades President and co-founder, Dr. Diana Horvath. “Meeting this challenge requires new and bold ideas to produce more resilient crops, and I am thrilled by the talent and diversity that we have brought on board to advance our efforts.”

New hires to 2Blades’ leadership team include (L to R):

Kamil Witek, Group Leader. Dr. Witek has been a member of the 2Blades Group at The Sainsbury Laboratory in Norwich, UK since 2019 and was promoted to Group Leader in March, 2023. Before joining the 2Blades group, he spent nine years as a post-doctoral researcher at The Sainsbury Laboratory where he created germplasm collections and developed novel techniques to clone a variety of functional plant immune receptors. Dr. Witek was awarded his Ph.D. by the Institute of Biochemistry and Biophysics PAS in Poland, where he studied interactions between potato and major viral pathogens.

Dr. Josiah Musembi Mutuku, Group Leader. Prior to his role as 2Blades Group Leader in St. Paul, MN, Dr. Mutuku served as Director of Research at the Central and West African Virus Epidemiology (WAVE) Institute based in Abidjan, Cote d’Ivoire. At WAVE, he helped to implement science strategy across 10 Central and West African countries. Previously, Dr. Mutuku was awarded the Japan Society for the Promotion of Science (JSPS) fellowship while at the Riken, Yokohama Institute, Japan. He obtained his Ph.D. from Kagoshima University.

Karen Century, Director of Operations. Dr. Century brings over 20 years of experience in the ag-biotech industry, including research and business roles at BASF. Her career has focused on developing disease and pest control biotech traits and bringing these technologies to market. She earned her Ph.D. in Plant Pathology from the University of California, Berkeley, as a National Science Foundation graduate fellow.

Apolonio Huerta, Business Development Manager. Dr. Huerta previously worked as a Venture Capital Fellow at Redalpine Venture Partners in Zurich, Switzerland where he helped source Life Science and Digital Health start-ups with innovate technologies and transformative business models. He completed his Ph.D. from the Swiss Institute of Technology (ETH).

Wilson Paine, Director of External Affairs. Mr. Paine arrives at 2Blades following substantial development and public affairs experience, including most recently as Vice President of Institutional Advancement & External Relations at Ferrum College. Paine began his career as a Presidential Management Fellow at FEMA and the U.S. Department of State. He is a graduate of Ferrum College and holds a masters in theological studies from Harvard University.



2Blades and Supporters of Agricultural Research (SoAR) Foundation Host Discussion at 2023 World Food Prize

During the 2023 World Food Prize, 2Blades and the Supporters of Agricultural Research (SoAR) Foundation hosted a Norman E. Borlaug Dialogue Series event titled, “Progress and Impact in Delivering Agricultural Innovation.” The event was moderated by Rob Bertram, Chief Scientist for USAID and included panelists from across the agriculture innovation chain:

During the discussion, the panelists recounted examples of crop research and development that have delivered impact in the field by increasing the supply of safe, healthy food or increasing crop resilience to improve the livelihoods of farmers around the globe.

“Delivering advances in plant science faces significant technical, regulatory, political, and even adoption challenges. Yet despite these obstacles, important innovations are making progress – from demonstrating efficacy in the field to reaching markets and providing benefits,” stated Diana Horvath, Co-Founder and President of 2Blades. “This event was an opportunity for us to reshape the narrative around agricultural innovation by highlighting examples and trends where demonstrable progress and impact in the field have been achieved.”

The event was held during the 2023 World Food Prize in Des Moines, Iowa. Heralded as the Nobel Prize for food and agriculture, the World Food Prize brings together researchers, scientists, policymakers, business leaders, and farmers to recognize and honor achievements that advance human development with a demonstrable increase in the quantity, quality, availability of, or access to food through creative interventions at any point within the full scope of the food system. The 2Blades-SoAR discussion featured experts throughout the agriculture innovation chain, each of whom shared examples of programs with demonstrated benefits in the field. Examples featured were (i) the orange-fleshed sweet potato – a vitamin A-enhanced variety which now makes up 40% of the market in Mozambique, (ii) short-stature corn – a climate-smart variety that withstands heavy winds and drought, (iii) a strong soy value chain in Africa focusing on profitability for smallholder farmers, and (iv) soy varieties that withstand the leading soy disease in field trials in Brazil. Further examples of new tools and innovations in the pipeline were also discussed.

Panelists emphasized that there is good progress in delivering innovation; discovery platforms are getting better and faster and are being applied to more crops – even underutilized and traditional crops, regulatory systems are improving, with new approvals coming along for transgenic and edited crops, and African countries like Kenya are making significant strides to support innovation. One area that has lagged in the global South is technical capacity. Despite gains in training of scientists, more training and especially more jobs are critical for strengthening regional capacity and adopting new technologies. Effective partnerships are essential.

2023 HIGHLIGHTS

High-quality Soy Rust Genome Published in *Nature Communications*

2Blades and a group of international collaborators published research on *Phakopsora pachyrhizi*, the causal agent of Asian soybean rust and one of the most damaging plant pathogens of the past century, in the April 2023 issue of *Nature Communications*.

2Blades' Work Featured in *SeedWorld* Publication

In "Fighting Back Against Asian Soybean Rust," the article describes 2Blades' efforts and partnerships to develop new soybean varieties with strong ASR resistance: "With new Asian Soybean Rust resistant soybean varieties on the way, there's hope for South American farmers."

2Blades and Computomics Launch Pilot Project Using AI Tools

The collaboration will explore the implementation of Computomics' machine learning technology, xSeedScore®, with datasets from 2Blades' gene discovery platform, NLRseek™, to enhance the discovery and use of resistance genes across crops and pathogens.



2Blades announced the completion of a non-exclusive license agreement with NAPIGEN for access to 2Blades' TALEN technology for applications in organellar genome editing. The editing of plant mitochondrial and chloroplast genomes opens new opportunities for altering traits in crop plants that have not yet been easily targeted by other editing methods (e.g., CRISPR/cas9), and which have significant implications for improved crop nutrition, growth, and yield.

How are TALENs used to improve our crops?

TALENs are another tool to extend the diversity of traits and allows breeders to selectively change the qualities they want, such as:

improved yields 

better taste 

resistance to disease and pests 

resilience to climate change, drought, or salinity 

improved quality of products derived from crops 

Examples of TALENs used to improve our crops:

Soybeans that produce premium quality oil 

Rice which is more aromatic and resistant to bacterial blight 

Potatoes with better taste, less browning, and lower levels of potentially carcinogenic acrylamides 

Wheat with complete resistance to powdery mildew 

◆ ASR resistance for Africa

Soybean is a crop of increasing importance for Africa due to its high nutritional content for food and feed, industrial uses, and ability to improve soil health. Massive demand for the crop is driving increases in cultivation, which is met by costly imports. *Africa has fantastic potential for growing soy, with some areas yielding higher than the U.S., however production is critically limited by one "explosive" disease - Asian Soybean Rust (ASR).*

◆ Eliminating fungal toxins in maize

Corn is the world's most-produced grain and the top food crop in sub-Saharan Africa (SSA). The demand for corn in SSA is expected to triple by 2050 due to rapid population growth, even as climate change, plant disease, and pests threaten harvests. *Corn is increasingly threatened by fungal pathogens and the poisonous mycotoxins they produce that contribute to many human health disorders and livestock disease, and deaths, via contaminated corn-based food and feeds.*

◆ Accelerating the discovery and use of resistance genes

Today there are a limited number of plant pathogen resistance genes validated for use in agriculture and finding and implementing functional ones remains difficult. Our two proprietary technologies (PRRseek™ and NLRseek™) enable the rapid identification of functional resistance genes from diverse sources, including wild relatives of our most important food crops. *These technologies allow us to extend the gene pool and identify novel sources of resistance that can be quickly introduced into crops.*



◆ Combating an explosive threat to soybean production to improve livelihoods of Sub-Saharan farmers

We are:

- Implementing our expertise and resources developed across **10 years & \$25M in funding** at our Norwich lab, hosted at The Sainsbury Laboratory, to focus on delivery for Africa,
- Employing proprietary platforms & **150+** soybean rust strains,
- Mobilizing to deploy a set of **NLR, PRR and novel** resistance genes with multiple modes of action,
- Assembling a library of resistance genes from both **existing and new genes** with different modes of action,
- Creating a soy **Innovation Chain** of current & new partners to **scale** our program and ensure **translation & deployment** of technologies to **small-holders**.

◆ Mycotoxin Mitigation Initiative

We are:

- Working from a **newly created center** for the genetic control of mycotoxins in the US & Africa hosted at the University of Minnesota
- Testing receptors that stimulate immune responses to *Aspergillus* and *Fusarium*
- Mining proprietary gene discovery platforms
- Rapid-testing receptors and pathogen elicitors in a corn **protoplast assay system** to identify pairs that trigger immune responses.
- Creating a maize **Innovation Chain** of current & new partners to **scale** our program and ensure **translation & deployment** of technologies to **small-holders**



Scaling a Digital Resource of Resistance Genes for Accelerated Deployment

Conventional methods

5-10 years, Lots of Resources, Few Genes



NLRseek™ and PRRseek™

2-4 years, Few Resources, Many Genes

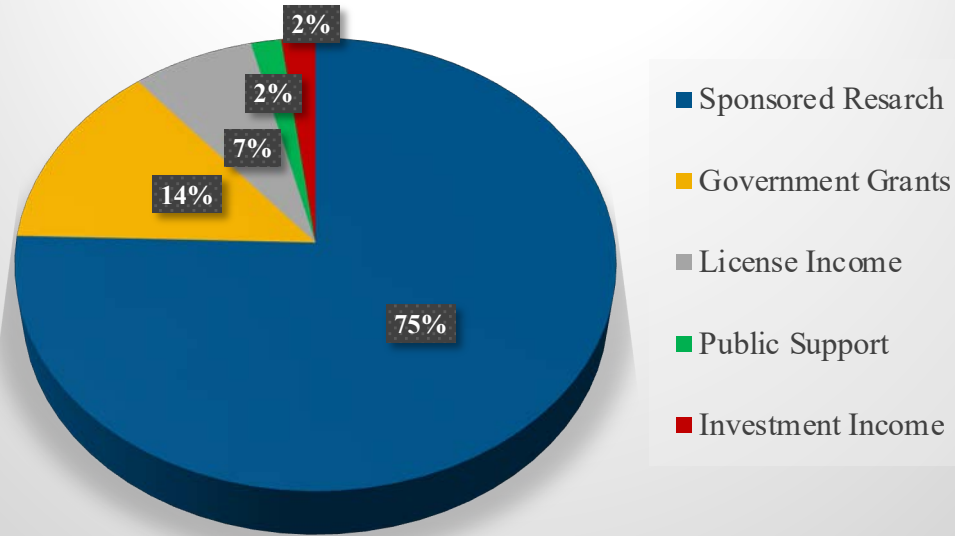


We are:

- Screening and scaling our proprietary **PRRseek™** and **NLRseek™** platforms, using the existing cereals library further and creating new libraries for legumes and other crop families.
- Accessing sources of **plant diversity** through a broad range of plant species and across individuals within a species, by exploring partnerships with diversity and seed-bank resources
- Identifying functional immune receptors and **building knowledge to protect against future threats**
- Exploring **partnerships to scale** data storage; build and refine software and hardware tools; implement machine learning algorithms
- Building the largest gene platform and **gene library for all plant species, including those without a reference genome.**
- Greatly **accelerating the speed and efficiency** of gene isolation
- Creating integrated resources for greatest reach and impact

2022 FINANCIALS

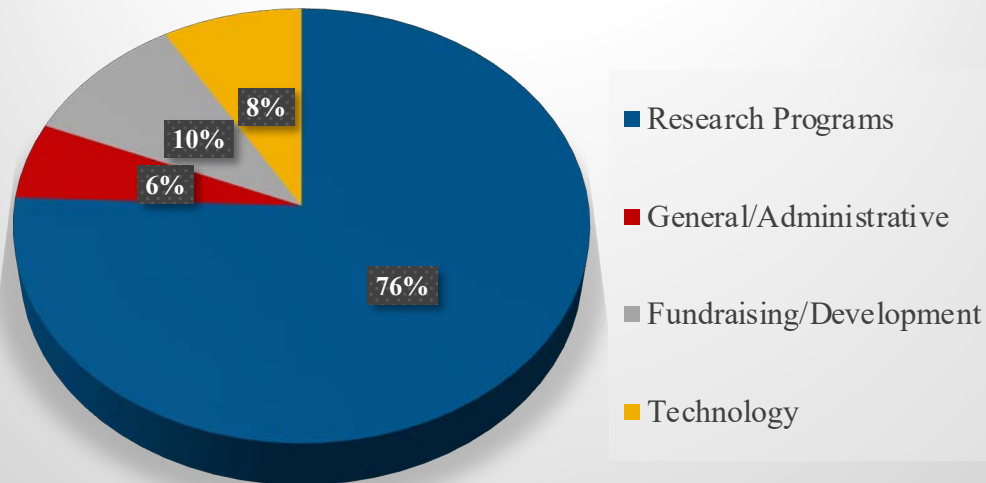
Revenue



OPERATING REVENUES

	REVENUE (\$)	% OF REVENUE
Sponsored Research	4,884,500	75.48%
Government Grants	876,638	13.5%
License Income	464,825	7.2%
Investment Income	129,413	2.0%
Public Support	115,605	1.8%
Total	6,470,981	

Expenses



OPERATING EXPENSES:

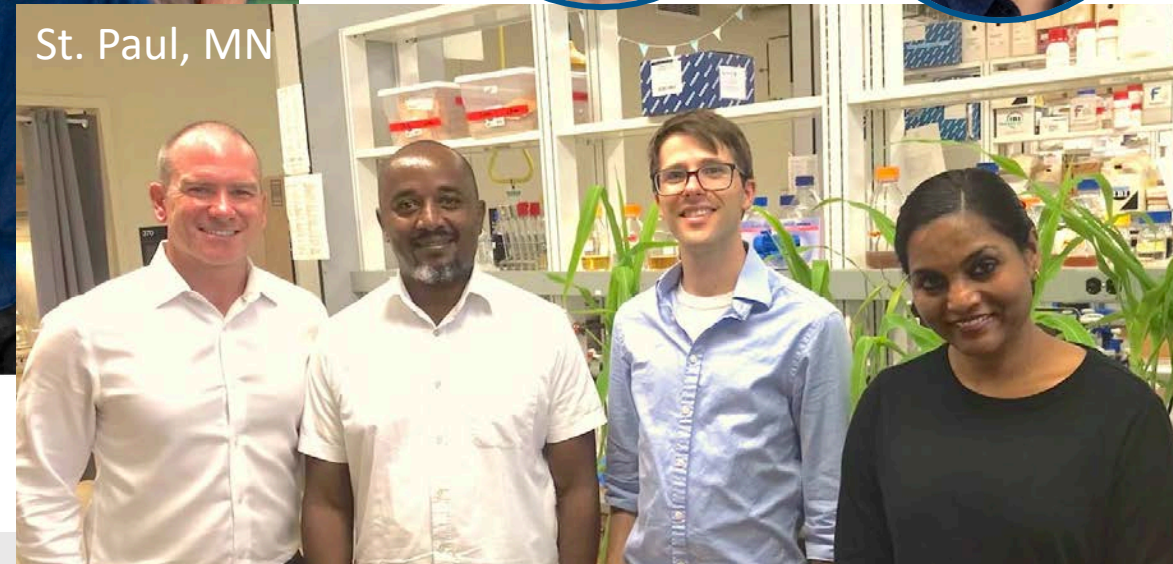
	EXPENSES (\$)	% OF EXPENSES
Research Programs	4,436,342	75.6%
Fundraising/Development	595,962	10.2%
Technology Intellectual Property	501,837	8.6%
General/Administrative	333,631	5.7%
Total	5,867,772	

OUR TEAM

Norwich, UK



St. Paul, MN



A world-leading, mission-driven science translation team



Whoever could make two ears of corn, or **two blades** of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together.”
– Jonathan Swift, *Gulliver’s Travels*



2BLADES
20 YEARS OF CROP INNOVATION

