ALLFED

Annual Report
2023

ALLIANCE TO FEED THE EARTH IN DISASTERS
allfed.info

ALLFED

Our Vision

Feeding everyone no matter what

Our Mission

To help build resilience to global catastrophic food shocks

ALLIANCE TO FEED THE EARTH IN DISASTERS

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ALLFED

Annual Report 2023

Cover

Jazaa, a seaweed farmer in Zanzibar, attaches seaweed seedlings to a rope

Photo: Natalija Gormalova/Climate Visuals Countdown

By early 2023, nearly a year after Russia's invasion of Ukraine, the prolonged conflict had significantly disrupted agricultural production and trade routes, impacting global food supplies. Consequently, several regions continued to face reduced imports and high food import bills, exacerbating food security challenges worldwide.

Ongoing geopolitical tensions and the war in Ukraine underscore the fragility of our interdependent trade systems. This crisis highlights the urgent need to transform scientific research into actionable policies to enhance global resilience and preparedness.

We are working on resilient food solutions that could save lives in the case of Global Catastrophic Food Failure (GCFF). Find out more in ALLFED's new Theory of Change on page 14.

Grains of wheat
Photo: Sharshonm/Shutterstock

Comment from the Co-founder

Dr. David Denkenberger

Dear friends, supporters, and collaborators,

As we reflect on 2023, it is with a sense of gratitude that I present the Alliance to Feed the Earth in Disasters (ALLFED) Annual Report. Your commitment to our mission has been instrumental in advancing our efforts to enhance global food security and resilience against catastrophic events.

This was ALLFED Institute's first full year as a 501(c)(3) registered organization, a "public charity" in the USA. It was also a year marked by significant global events. We witnessed India's population surpass China's. AI technology burst into the public consciousness with mass awareness of ChatGPT, reminding us of both the potential of technology and the inherent risks. The ongoing war in Ukraine and the explosion of conflict in Gaza at the end of the year underscored the persistent threat of conflict, while the looming dangers of nuclear and biological weapons added to the complex global security landscape. Furthermore, global temperatures shattered records, driving home the reality that climate change is no longer a future threat but a present one, with cascading, complex risks to food security that ALLFED continues to be concerned about.

Perhaps the greatest threat we face as a world isn't a single incident or event but rather a combination of threats and disasters that could negatively affect multiple aspects of our food systems. This is why, in addition to our 2023 research outputs on leaf protein concentrate, the utilization of agricultural residues in Africa, the intersection of nuclear winter with planetary boundaries, and the potential of seaweed in an Abrupt Sunlight Reduction Scenario (ASRS), we also explored infrastructure collapse scenarios, crop yield loss modeling, and supply chain interventions.

We were motivated this year to do more to transform scientific research into actionable policies to enhance global resilience and preparedness. Therefore, we introduced a new ALLFED Theory of Change, the framework for impact designed to guide our efforts in translating research into effective policies and planning, which you can read more about in this report. Additionally, we dedicated significant resources to policy engagement, resulting in the delivery of knowledge products and policy proposals to governments across multiple jurisdictions. Our approach is dynamic; we recognize the importance of countries influencing each other to adopt new resilience policies. Through fruitful collaborations in various regions, from Australia to the United States and Argentina, we aim to help governments translate our research into policies.

As we look ahead, our commitment to building resilience against global catastrophic food shocks remains steadfast. We are deeply grateful for your support and collaboration, which empowers us to make meaningful strides toward a safer, more secure future for all.

With heartfelt thanks,

David C. Denkenberger

Year in View: ALLFED in Numbers

6

We published 6 academic papers on topics ranging from research into seaweed as a resilient food to the fragile state of industrial agriculture. Read more on page 18

20

We presented our work at 20 events and conferences.

80k

80,000+ unique visits to our website.

36

ALLFED's work was strengthened thanks to 36 dedicated volunteers.

3

We led policy engagement initiatives with 3 governments.

1

Bicycle-powered wood chipper built for resilient biofuel production.

Read more on page 25

Year in View: ALLFED in Numbers

900 Applications received for our open positions in the Communications and Research Departments.

20 We experimented with, and enjoyed, 20 different resilient food dishes at our team retreat dinner.

29 Languages spoken by our multicultural team.

Team Members in Focus

I heard Dave on the 80,000 Hours podcast and was fascinated by the approach of applying engineering principles to large-scale, neglected problems. I love trying new foods and am always looking to learn and explore, in particular learning from Australian Indigenous traditional knowledge. I have eaten green ants and witchetty grubs in northern Australia, and too many bush foods to count when out on Alawa Country, in northern Australia.

—

Kevin Rassool
Research Associate & Research Project Coordinator

I first discovered ALLFED through the EA Forum and the 80,000 Hours job board. I have made over 20 varieties of leaf protein concentrate (LPC) and several types of pine needle tea. The LPC was generally quite nice, though it varied significantly between sources. I frequently eat sushi, ramen, and miso soup, which all have seaweed in them.

—

Ross Tieman
Research Associate and Data Coordinator

ALLFED Boards

2023 Board of Advisors

All ALLFED board directors served on a voluntary basis. We thank them for their time and contribution to our work.

Peter Alexander
Senior Lecturer at the *University of Edinburgh's School of Geosciences* and the *Global Academy of Agriculture and Food Security*. He explores socio-economic and environmental interactions within the global food system using data and computational methods.

Talib E. Butt
Senior Lecturer in Engineering and Environment Management at *Northumbria University*. He predominantly focuses his career on risk assessment and addressing natural and anthropogenic hazards.

Greg Colburn
Founder of the *Centre for Enabling EA Learning & Research (CEEALAR)* and supporter of ALLFED since its early days, contributing to its funding and establishment in the UK. He also hosts researchers at CEEALAR.

Cameron Colby Thomson
CEO of *Good Ancestor Foundation*, on the Board of Directors of the *Human Rights Foundation*, and *Open Source Ecology*, an open-source AgTech foundation. He is an entrepreneur, investor, and philanthropist.

Scott David
Director of the *Information Risk & Synthetic Intelligence Research Initiative (IRSIRI)* at the *University of Washington*. Scott has been active in several programs, including the *World Economic Forum*, the *United Nations Sustainable Development Solutions Network*, and the *IEEE*.

Carina Fearnley
Associate Professor at *University College London* and Director of the *UCL Warning Research Centre*. She specializes in optimizing natural hazard warnings through interdisciplinary research, and the synergy of art and science for environmental hazard communication.

Katriel Friedman
International development practitioner, applying quantitative and methodical tools in development policy. He consults for the *World Bank*, where he helps design and oversees lending for health and nutrition across the Middle East and North Africa.

Prosenjit Ghosh
Professor at the *Indian Institute of Science*, where he researches and teaches about Earth systems and climate change. He made an important contribution to the development of CO2 standards and its acceptance in the global community.

Robin D. Hanson
Associate Professor of Economics at *George Mason University* and Research Associate at the *Future of Humanity Institute of Oxford University*. He has over 90 publications and 5200 citations, and he has pioneered the field of prediction markets since 1988.

Seán Ó hÉigeartaigh
Founding Executive Director of the *Centre for the Study of Existential Risk (CSER)* and Director of the *AI Futures and Responsibility Programme* at the *University of Cambridge*, central to research on artificial intelligence's long-term impacts and risks.

Martin E. Hellman
Professor Emeritus of Electrical Engineering at *Stanford University*, best known for his co-invention of public key cryptography. Martin is an *ACM A.M. Turing Award* laureate, often considered the "Nobel Prize of Computer Science."

Sella Nevo
Director of the *Meselson Center* at the *RAND Corporation*, dedicated to reducing risks from biological threats and emerging technologies. He led Karmel at *Google Research*, utilizing machine learning to tackle global humanitarian, development, and climate challenges.

Joshua Pearce
Co-author of *Feeding Everyone No Matter What* and co-originator of ALLFED. Professor at *University of Western Ontario* and the John M. Thompson Chair in Information Technology and Innovation at the *Thompson Centre for Engineering Leadership & Innovation*.

Curtis Rodgers
Lecturer at the *US Department of Energy's Project Leadership Institute* and partner at *Brick & Mortar Ventures*, supporting companies advancing the technological sophistication of the built world. He founded the *Society for Construction Solutions* and contributed to *NASA's 3D Printed Habitat Challenge*.

Jaan Tallinn
Founding engineer of *Skype* and *Kazaa*, co-founder of the *Cambridge Centre for the Study of Existential Risk* and the *Future of Life Institute*, and partner at *Ambient Sound Investments*. Jaan is an active angel investor and philanthropist.

ALLFED Institute Directors

All of our legal directors also served on ALLFED's Board of Advisors.

David Denkenberger
An accomplished mechanical engineer and Associate Professor at the *University of Canterbury*, Christchurch, He has authored or co-authored over 140 publications, including *Feeding Everyone No Matter What: Managing Food Security After Global Catastrophe*. He is a philanthropist, donating half his income to ALLFED.

Sonia Cassidy
ALLFED's Director of Operations and Communications, with international operational, business continuity, finance, HR, PR, crisis management, and communications experience. One of the *Future of Life Institute's* "Women for the Future", with ALLFED since 2017.

Anders Sandberg
Senior Research Fellow at the *Future of Humanity Institute*, specializing in low-probability, high-impact risks and future technologies. Anders is an interdisciplinarian also noted for his work in neuroethics, policy, and the pursuit of happiness.

ALLFED Team

Globally United

22
Countries

4
Continents

95
Team Members
including Board Members

The ALLFED Team outside CEELAR
Photo: ALLFED

17 team members from 9 countries came together in Blackpool, UK, in May 2023. We strengthened the focus of ALLFED's core work, enjoyed a three-course "resilient food dinner", and supported team members who embarked on the unconventional journey of a 24-hour seaweed-eating experiment.

We are grateful to the Centre for Enabling EA Learning and Research (CEEALAR) and Greg Colbourn for providing us with a home away from home and a perfect space in which to hold an intensive and productive deep dive into ALLFED's core work.

Our core team members can be found all over the world:

Argentina, Australia, Canada, Colombia, Czech Republic, Egypt, Estonia, France, Germany, India, Mexico, Netherlands, New Zealand, Nigeria, Oman, the Philippines, Poland,South Africa, Spain, Sweden, United Kingdom and the United States of America.

ALLFED Team

Great Work Deserves Great Appreciation

Morgan Rivers and Juan Garcia Martinez receiving their Medals of Honor in Blackpool, UK
Photo: ALLFED

Team Member in Focus

Improving civilizational resilience has been a personal goal of mine, and producing related scientific papers has remained a part of my career endeavors – I have found the latter more satisfying at ALLFED than anywhere else I've worked so far. Each and every team member seemed to be focused on the stated mission while providing support to their colleagues. Such conditions were great for refreshing and expanding my skill set.

—

Rachel Palm
ALLFED Research Associate

Medals of Honor

Juan Garcia Martinez and Morgan Rivers

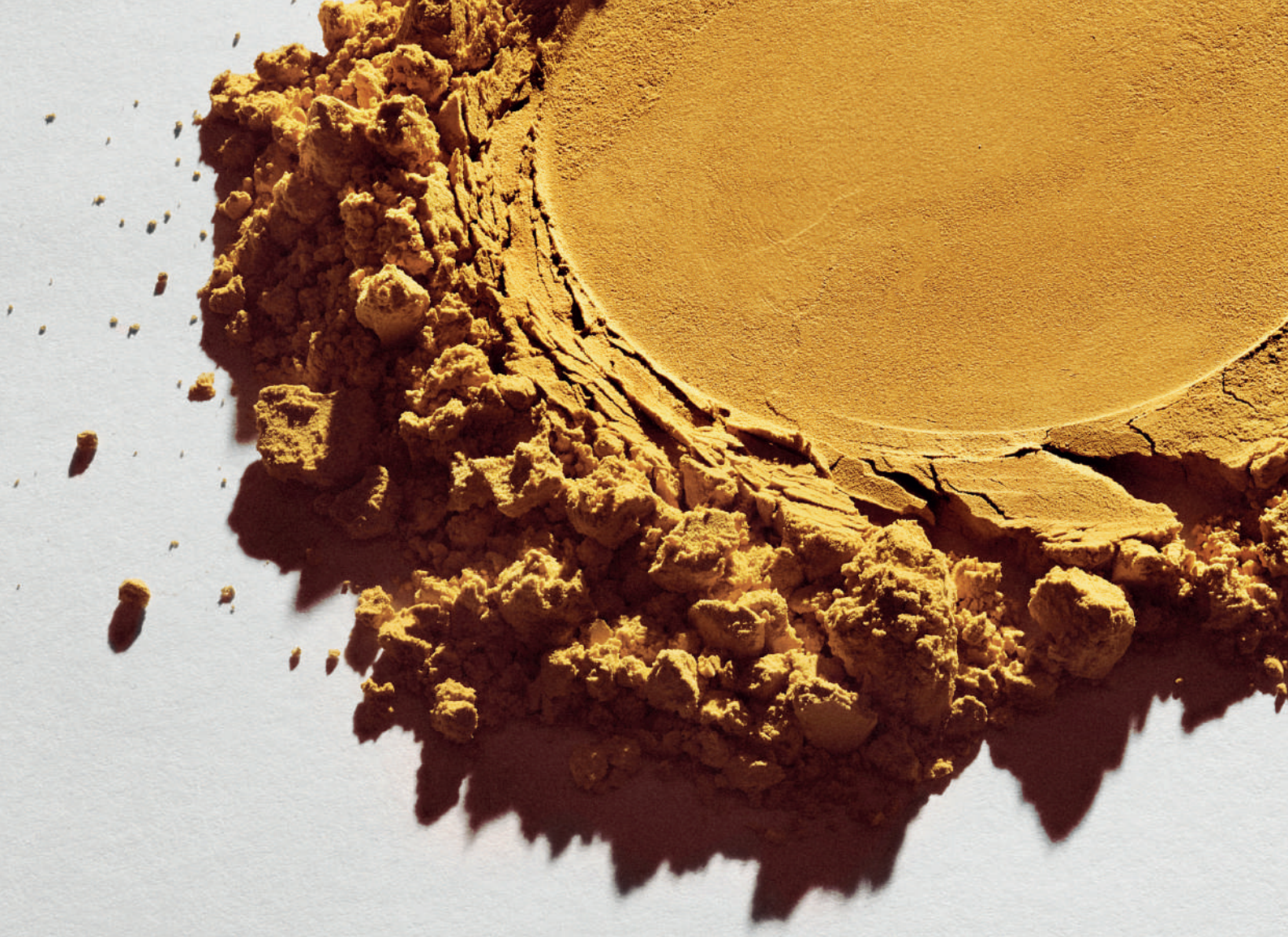
Medals of Honor are awarded each year to ALLFED **team members who go above and beyond** our expectations and beyond their normal roles and responsibilities. In 2023, we awarded two Medals of Honor to Morgan Rivers, Research Associate, and Juan Garcia Martinez, Research Manager. Morgan's outstanding contributions to ALLFED's integrated model and Juan's research performance exceeded our expectations. Moreover, both brought additional funding to the organization, supporting our mission and vision.

ALLFED Volunteer of the Year 2023

Zainab Asal

Zainab was selected as ALLFED Volunteer of the Year for 2023 for her **outstanding commitment**, contributing over 400 hours. Her consistent efforts, ability to adapt to changing priorities, and valuable contributions to volunteer management and onboarding of new team members into research projects were key in her selection for this recognition.

Congratulations and thank you for your hard work, Zainab!



I enjoyed and learned a lot from your paper on single cell proteins in global food shocks. What a monumental and timely accomplishment.

I am reading more of your ALLFED papers and find them very educational and forward-looking in an inspirational way.

—

Ron Milo
Full Professor in the Department of Plant and Environmental Sciences, Weizmann Institute of Science

Single-Cell Protein Powder
Photo: **Solein**

Building Long Term Resilience to Global Catastrophic Food Failure (GCFF)

Humanity is currently underprepared for a Global Catastrophic Food Failure (GCFF)

Serious disruptions to food supplies could occur in several different ways:


An Abrupt Sunlight Reduction Scenario (ASRS)


Cyber Attack


A Superpandemic


Extreme Weather on Multiple Continents


Solar Storm


High-Altitude ElectroMagnetic Pulse (HEMP)

All are risks that could disrupt the production and flow of resources and commodities essential for the survival of humanity.

ALLFED believes that **making our food systems more resilient to potential crises** is incredibly important. However, achieving this resilience is a huge challenge, and the work is just beginning.

To effectively respond in catastrophes, we need to conduct research, test technologies, and plan interventions. These steps are essential for producing enough nutritious food under challenging conditions and **ensuring its fair distribution and access**.

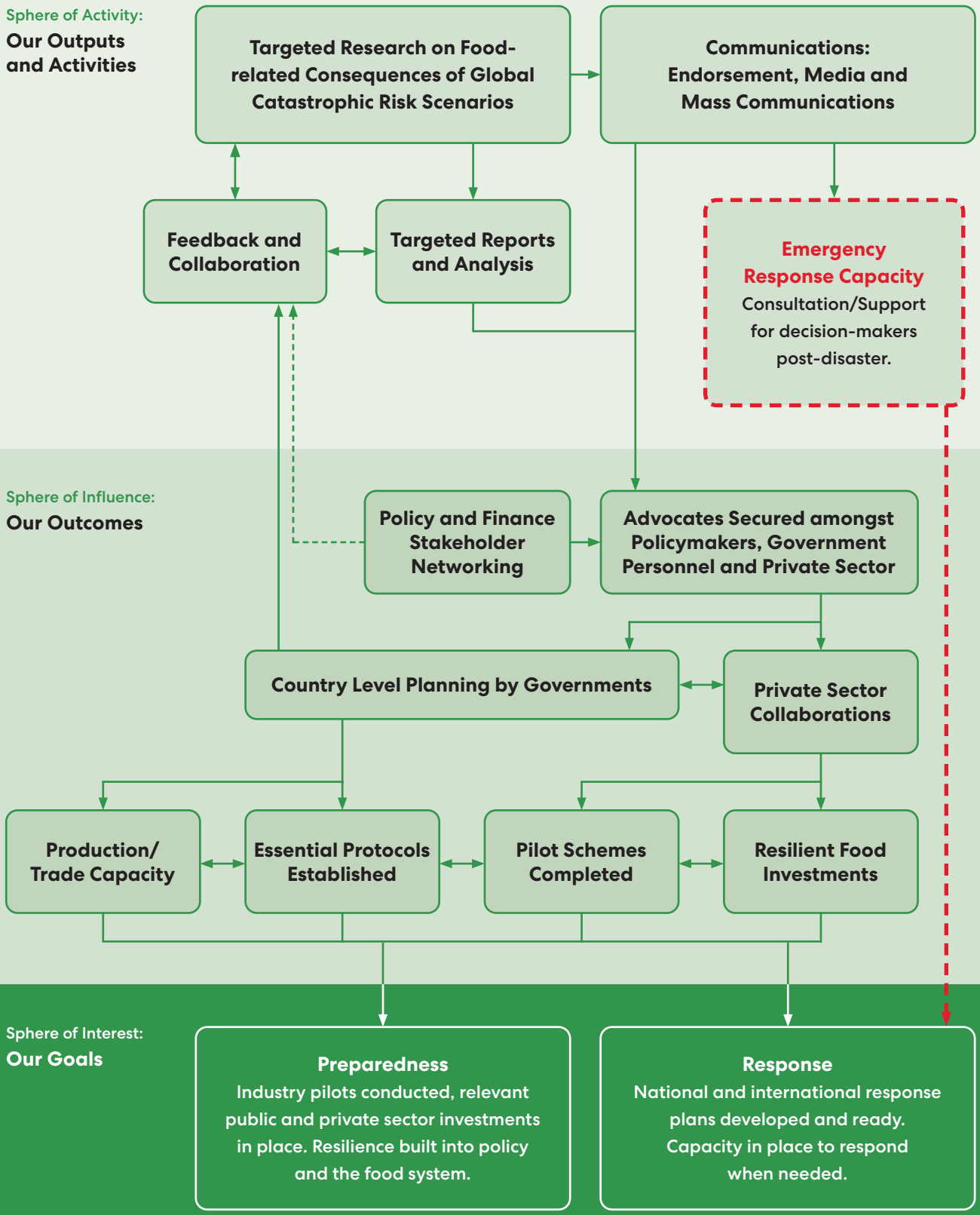
Our new Theory of Change

The challenge is enormous—as a result, there are a number of steps that need to be taken before the world can have confidence that it is prepared for a GCFF. However, **the good news is that many of the necessary actions have already been identified and started**, and not all of them are costly. Furthermore, every country can do things to make itself and others better prepared for future major food crises. This offers **a unique opportunity to make a difference**, something that might not seem obvious at first when considering such large-scale disasters.

This year, we spent time developing a Theory of Change to bring another layer of rigor to our strategic approach. The Theory of Change provides a foundational structure for transforming research findings into effective action.

ALLFED

Theory of Change for the threat of Global Catastrophic Food Failure (GCFF)



Harvest After the Blackout

Finding Strategies for Survival After a Global Catastrophic Infrastructure Loss

Jessica Moersdorf
ALLFED Volunteer Researcher

In recent years, we have witnessed how fragile and dependent the global agricultural system is. It relies heavily on machinery, fertilizers, and pesticides, becoming vulnerable to disruptions in international trade and electrical grids. Solar storms, nuclear detonations, cyberattacks, or pandemics could disable power-dependent infrastructure, severely affecting the food supply chain.

Motivated by this challenge, we set out to develop methods for forecasting changes in crop yields in the event of a disaster.

We focused on four crops: wheat, corn, rice, and soybean. Our team built a model that considers various factors affecting crop yields, including climate conditions (temperature, moisture, soil) and agricultural practices (fertilizer, irrigation, pesticides, technology) under two scenarios: one with existing stocks (Phase 1) and a second with depleted stocks (Phase 2).

We found that crop yields could decrease by 15% to 48%, depending on the crop, scenario, and region. The most severe yield reductions would be expected in highly industrialized agricultural regions, such as Europe, North and South America, and large parts of Asia.

With stocks of fertilizers, pesticides, and fuel still available (Phase 1), we would have to take essential steps to **adapt to new conditions** and prepare for a potentially resource-depleted world, as we see in Phase 2 of our study. To lower dependency on the grid and create a more secure food system, we would have to cooperate and develop non-electrical logistic infrastructure, establish a communication system, and overall **adjust as a society**.

We need further research to improve the model's accuracy, analyze a wider range of data and crops, and conduct region-specific studies, particularly in identified hotspots and Africa. Regardless, we strongly emphasize the need to **prepare and adopt a resilient food system** that is sustainable and can withstand the consequences of a catastrophic power outage on our food chain.

Learn more

Photo: **Foto Murthy/Unsplash**

FOOD FACT

Wheat is a major dietary staple for over a third of the world's population; it is secondary in its consumption only to rice, which more than half the world relies on.

Harvesting Hope

Seaweed's Role in Sunlight-Scarce Futures

Florian Ulrich Jehn
ALLFED Data Science Lead

In an Abrupt Sunlight Reduction Scenario (ASRS), such as a nuclear winter, asteroid impact, or large volcanic eruption, particles would be injected into the atmosphere, limiting sunlight. This threat could devastate current agricultural practices, leaving millions, even billions, facing the threat of starvation. In our quest to address the **critical need for resilient food sources** under such conditions, we focused on seaweed. We chose seaweed because it can grow quickly in a variety of environments.

To explore the feasibility of seaweed as a source of nutrition after a nuclear war, we used an empirical model based on *Gracilaria tikvahiae*, a common red algae. We assessed how quickly global seaweed production could be scaled to provide a significant fraction of global food demand. Our findings were promising: **seaweed cultivation** in tropical oceans could scale up to meet about 45% of equivalent human food requirements, including 15% of direct human nutrition, 10% of animal feed, and 50% of biofuels. All of this could be done using **low-tech solutions** and within 9 to 14 months.

Interestingly, the results also show that the growth of seaweed increases with the severity of the nuclear war, as more nutrients become available due to increased vertical mixing. This means that the humble seaweed has the potential to be a **lifeline** after a global catastrophe.

Read more

FOOD FACT

Seaweed could be grown in tropical oceans, even after a near-worst-case nuclear winter.

Farmer harvesting seaweed
Photo: EoNaYa

ALLFED

Growing Seaweed to Feed the World During Disasters

Disaster events can emit large amounts of particles into the atmosphere, affecting the climate for decades by limiting sunlight and creating global cooling.

As a result, agriculture could be decimated.

Nuclear War

Large Volcanic Eruption

Asteroid Impact

Seaweed can be a resilient alternative food, growing fast in a wide range of environmental conditions

Seaweed farms can be built using low tech tools such as ropes, buoys and anchors

After a disaster, seaweed can still grow up to

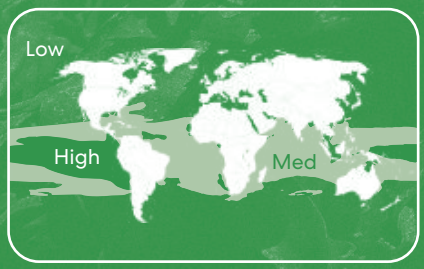
15%

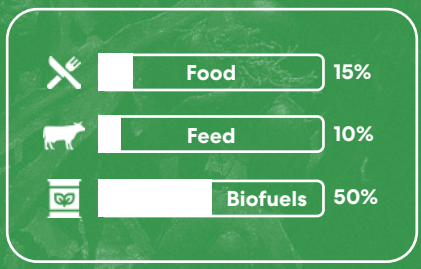
per day in high growth zones

Seaweed production could be scaled up in 9 months to up to

45%

of equivalent human food requirements





Challenges

- Consumption limits in humans and animals
- Scaling infrastructure and processing

Full research paper and sources: zenodo.org/records/7615254

ALLIANCE TO FEED THE EARTH IN DISASTERS

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Papers, Publications, and Science Communication

ALLFED's latest peer-reviewed publications on resilient food solutions

Earth's Future

Status: published

Jehn F.U, Dingal F.J, Mill A, Harrison C, Ilin E, Roleda M.Y, James S.C, Denkenberger D

Seaweed as a Resilient Food Solution After a Nuclear War

Read more about this paper and our recommendations on page 16 of this report.

Global Challenges

Status: published

Moersdorf J, Rivers M, Denkenberger D, Lutz B, Jehn F.U

The Fragile State of Industrial Agriculture: Estimating Crop Yield Reductions in a Global Catastrophic Infrastructure Loss Scenario

Read more about this paper and our recommendations on page 15 of this report.

Revista de Estudios Latinoamericanos sobre Reducción del Riesgo de Desastres (REDER)

Status: published

Ulloa Ruiz M.A, Torres Celis J.A, Rivers M, Denkenberger D, García Martínez J.B

Soluciones Alimentarias Resilientes Para Evitar La Hambruna Masiva Durante un Invierno Nuclear en Argentina / Resilient Food Solutions to Prevent Mass Famine During a Nuclear Winter in Argentina

Factors such as location, agricultural production capacity, and supply chain resilience augment Argentina's capacity to respond to an Abrupt Sunlight Reduction Scenario (ASRS) and to play a crucial role in the distribution and exportation of food in a catastrophe. Preparation and response could mean the difference between starvation and production of sufficient, varied, and nutritious food with a surplus to export.

Biomass

Status: published

Ugwoke B, Tieman R, Mill A, Denkenberger D, Pearce J.M

Quantifying Alternative Food Potential of Agricultural Residue in Rural Communities of Sub-Saharan Africa

Read more about this paper and our recommendations on page 24 of this report.

Biomass

Status: published

Mottaghi M, Meyer T.K, Tieman R.J, Denkenberger D, Pearce J.M

Yield and Toxin Analysis of Leaf Protein Concentrate from Common North American Coniferous Trees

This study on thirteen Nigerian communities found that utilizing agricultural residue as resilient food could provide enough calories to feed between 3.9 and 18.1 million people annually, potentially covering 10 to 48% of Nigeria's food deficit.

Papers, Publications, and Science Communication

Stanford Digital Repository

Status: published

Jehn F.U

Anthropocene Under Dark Skies: The Compounding Effects of Nuclear Winter and Overstepped Planetary Boundaries

Global catastrophic events are often studied in isolation, but their risks are interconnected. This investigation examines the interplay between nuclear winter and planetary boundaries.

Policy and Preparedness

Observatorio de Riesgos Catastróficos Globales (ORCG)

Status: published

Torres J, Ulloa M, Tiznado D, Tinoco R, Bas G.B, Sevilla J, Garcia J, Morgan R, Denkenberger D

Food Security in Argentina in the event of an Abrupt Sunlight Reduction Scenario (ASRS) Report / Seguridad alimentaria en Argentina en caso de un Escenario de Reducción Abrupta de la Luz Solar (ERALS): Propuesta Estratégica

ALLFED collaborated with Observatorio de Riesgos Catastróficos Globales (ORCG) to produce a report on protecting Argentina from severe global food crises, specifically those caused by abrupt reductions in sunlight, based on similar work done by ALLFED for the U.S. and Australia. Read more about our work with the Argentine government on page 21.

Bridging Worlds: The Importance of Science Communication

***Science communication is key** to disseminating our research. In 2023, some of our fantastic volunteers and I crafted easy-to-understand summaries, making our research findings more accessible.*

We also pushed forward with our CRASSH (Catastrophic Risk and Social Science and Humanities) Working Group, diving into how global food crises intersect with societal and economic issues.

—

Farrah Jasmine Dingal
ALLFED Research Associate

As someone whose youngest memories include standing in line for food due to severe shortages, ALLFED's mission strikes me as important and neglected on a global scale.

—

Dušan D. Nešić
Co-Founder of EA Serbia, Operations Director at Principles of Intelligent Behavior in Biological and Social Systems (PIBBSS)

Carrot harvest in Cameroon, Africa
Photo: Laura Cook

Argentina Policy Engagement

RCG

In 2023, through research, modeling, and interviews in **collaboration** with the Observatorio de Riesgos Catastróficos Globales (ORCG) team, we produced a report titled "Seguridad alimentaria en Argentina en caso de un Escenario de Reducción Abrupta de la Luz Solar (ERALS)" / "Food Security in Argentina in the event of an Abrupt Sunlight Reduction Scenario (ASRS)".

Sulfate and soot particles released into the atmosphere as a result of a nuclear war, a volcanic eruption, or the impact of an asteroid or comet, could reduce the amount of sunlight reaching the Earth's surface, on which the global food system depends. Agricultural yields would then plummet.

Some regions of the world appear to have better conditions for surviving and managing an ASRS. These include the island nations of New Zealand and Australia (Boyd & Wilson, 2022) and continental countries such as Argentina, Uruguay, and Paraguay (Xia et al., 2022).

We evaluated different countries in Latin America, and Argentina is one of the world's leading producers and exporters of food, especially grains and oilseeds. Therefore, in the event of an ASRS, Argentina would play a **crucial role in food distribution and exportation**, even with its production decreased. Adapting the country's food systems quickly and effectively would make the difference between a national famine and producing sufficient, varied, and nutritious food with a surplus to export.

Considering the importance of Argentina's geographical location, it is **critical for the government to actively participate in the development of contingency plans** aimed at addressing possible threats in the region.

We had eight key recommendations for the Argentinian government, which were communicated through the report.

Photo: **Samuel Silitonga, Pexels**

Argentina
Policy Engagement

We congratulate the different actors who have been involved in the effort of the strategic proposal for 'Food Security in Argentina in the event of an Abrupt Sunlight Reduction Scenario (ASRS)', thank them for their fruitful work, and hope that the recommendations resulting from this guide can serve as input for the new national plan 2024-2030.

—

Silvia La Ruffa

Secretary of Federal Articulation of Security

Executive Secretary of Sistema Nacional para la Gestión Integral del Riesgo (SINAGIR)

June 2023

Communication and Supply

Development of response plans to ensure food and water supply to the population in the face of this risk.

Formulate strategies and legal frameworks for internal food rationing and waste reduction.

Maintain open trade policies to enhance food production and facilitate access to critical inputs and materials.

Clear and centralized communication strategy through the dissemination of the emergency management plan.

Food Production

Redirection of animal feed and biofuel production resources toward human food consumption.

Adaptation of agricultural systems to increase food production, including the deployment of solutions such as relocation of crops tolerant to low temperature and precipitation conditions, rapid construction of greenhouses taking into account the Argentine bioclimatic regions, and the expansion of cultivation areas through the adaptation of arable land currently not used for food production.

Adaptations of aquaculture to increase food production, including national seaweed industry reactivation and strengthening of the fishing sector.

High-tech adaptations to increase food production include industrial food technologies such as the conversion of paper and biofuel industries for lignocellulosic sugar* production and the production of single-cell protein from methane.

*Lignocellulosic sugar refers to the sugars derived from lignocellulosic biomass, which is a type of plant biomass. Lignocellulosic biomass can come from various sources, including agricultural residues (like straw and corn stover), forest residues, and energy crops (such as miscanthus and switchgrass).

Leaf Protein Concentrate

Leaf protein concentrate (LPC) is a protein-rich substance extracted from green leaves. This process involves juicing the leaves and then separating out the proteins from the juice.

The resulting concentrate is high in essential nutrients. LPC is considered a resilient food because it can be derived from agricultural residues or tree leaves killed by a catastrophe, making it an innovative solution to food security issues. LPC is one of the resilient food solutions ALLFED researchers learned more about in 2023.

Leaf Protein Concentrate (LPC) from Alfalfa

Photo: Eric Toensmeier/Flickr

Fields of Opportunity

Reducing Global Hunger with Agricultural Residue as a Food Source

Ross Tieman
ALLFED Research Associate
& Data Coordinator

Around the world, nations are already grappling with the growing challenge of food insecurity. There is a growing risk of global hunger due to civil conflicts, extreme weather, crop pests, and economic shocks. Additionally, Global Catastrophic Risks (GCRs) could trigger a 5%+ reduction in global food supplies, significantly exacerbating global hunger.

African countries are particularly affected, with the current strategies for providing food security not sufficient with current food production practices. We wanted to look at two different potential food solutions. First, to look at the potential of adopting **agricultural residue as a resilient food** by extracting nutritional value from Leaf Protein Concentrate (LPC). Second, to provide a new methodology to quantify residue calories as a resilient food to **reduce hunger now**.

We focused on crop residues grown in thirteen communities in Nigeria. We considered factors such as the type of crop residue, its suitability for direct consumption by animals, and its conversion to human edible LPC.

Given the available data on residue, results showed Nigeria could potentially harvest an additional 3 to 13.8 trillion calories of food annually from agricultural residue. These calories could **feed between 3.9 million and 18.1 million** additional people each year. If implemented now, this would meet between 10% and 48% of Nigeria's current total food deficit.

Further research is needed on LPC's toxicity levels and safety for human consumption before widespread adoption, and there is a need to develop low-tech community production methods. Yet, the **potential of agricultural residue as a food source is undeniable** and could tip the scales in favor of "feeding everyone, no matter what."

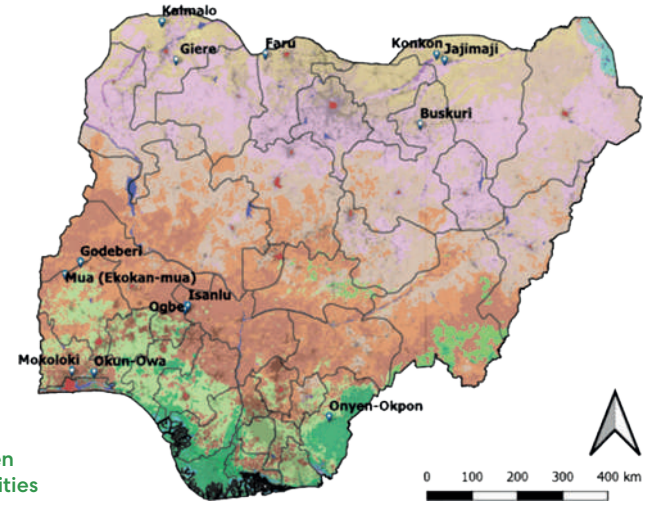
Read more

FOOD FACT

Harvested agricultural residue can be either

1. processed into Leaf Protein Concentrate (LPC), with the remainder of the concentrate's fiber mass consumed by animals and then returned to fields as manure, or

2. eaten by animals.



Map of the Thirteen Nigerian Communities
Image: Blessing Onyeche

Pedal to the Metal:
Bike-Powered Wood Chipper

Henry Vennard
ALLFED Intern

Bike-Powered Wood Chipper Prototype
Photo: ALLFED

I designed this bike-powered wood chipper prototype to **enable biofuel production in a catastrophic scenario** that could cause electricity loss. I was excited and motivated to find a solution to a niche but important problem and have the opportunity to do so with a creative team of people who made the project a joy to work on.

My favorite part of the project was tinkering with the bicycle (amazing machines!) and how quickly we moved from an idea to a functional prototype. The project did not come without challenges, but we tried many things and ended up with a result that exceeded our expectations and enabled us to scale up wood chipping for gasification production. The purpose is for **gasification to replace diesel and gasoline (petrol)** in scenarios with extreme loss of electricity or loss of industry.

Dry and Mighty:
Advancing Seaweed Drying Technologies

Simon Charman
Mechanical Engineering Student at University of Canterbury

I worked with David Denkenberger on the wood-fired seaweed dryer prototype, a project that perfectly combined my passion for practical design and build projects and **my desire to make a positive impact** through engineering.

It's exciting to think that, if successful, my work could directly contribute to producing 45% of human food requirements in a catastrophe.

The most challenging part was the initial research and decision-making. Drying seaweed with wood was a novel idea, so I relied on quick general research and made judgments from my engineering knowledge. I ended up with a **simplified yet effective design** for the wood-fired seaweed dryer, using the most minimal materials I could to simulate a catastrophic disaster scenario.

I tested the prototype using the seaweed species *Gracilaria chilensis*, ultimately proving the functionality of the dryer.

Seaweed Dryer Prototype
Photo: ALLFED

ALLFED has been doing important work and pioneered a field. Food security, in nuclear winter, or more broadly in the context of massive supply chain disruption or disruption of societal stability, is an important and increasingly needed endeavor.

—

Feedback from one of the 'recommenders' in the grant process for the Survival and Flourishing Fund.

ALLFED was grateful to receive a substantial grant toward our work in 2023.

Seaweed farmers planting young seedlings in the Solomon
Photo: Adam Sébire/Climate Visuals

Appreciations and Acknowledgements

The support of our donors, volunteers, and partners enables ALLFED to make significant breakthroughs in researching resilient food solutions

The generosity of our community, combined with our commitment to using resources wisely, ensures that every contribution, whether of time or money, is not only deeply appreciated but truly makes a difference.

We extend our heartfelt gratitude to our Co-founder, David Denkenberger, and his wife, Jill Stone, whose generosity in devoting half of his annual income has fueled ALLFED's efforts since its inception in 2015.

We would also like to extend our thanks to Greg Colbourn and the Centre for Enabling EA Learning & Research (CEEALAR) for their generous support of ALLFED's 2023 team retreat. Their contribution provided the crucial physical space for our fully remote team to come together in person, allowing us to engage in deep reflection and thoroughly review ALLFED's Theory of Change.

Additionally, we wish to express our gratitude to the Survival and Flourishing Fund for their significant support through the grants allocated to us in 2023, which enabled us to undertake substantial and impactful work.

Lastly, a sincere thank you to each and every one of our individual donors. Your generosity allows us to continue this crucial work, and every donation truly makes a difference. We deeply appreciate your support.

Thank you for your unwavering support, collaboration, and belief in our vision to ensure we can feed everyone, no matter what.

If you would like to get involved in supporting ALLFED with your time, through a donation, or as a collaborating partner, then please contact us at **allfed.info/contact**

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