



# ANNUAL REPORT 2023



# TABLE OF CONTENTS

- Leadership Letters ..... 2
- Results ..... 5
- **Strategy & Mission** ..... 8
- **Develop Better Technologies** ..... 10
- **Catalyze Farm Productivity** ..... 16
- **Strengthen Markets** ..... 22
- **Enable Impact** ..... 30
- Publications & Presentations ..... 36

To view previous IFDC Annual Reports, please visit <https://ifdc.org/annual-reports/>.

# 2023 BOARD OF DIRECTORS

- Dr. Rudy **Rabbinge**, Chair (until October 2023)*
- Thomas G. **Coon**, Co-Chair (as of October 2023)*
- Josephine **Okot**, Co-Chair (as of October 2023)*
- Sameer **Goel***
- Tom **Kehoe***
- Alzbeta **Klein***
- Dr. Rattan **Lal***
- Marcelo **Lessa***
- Esin **Mete***
- Peter **McPherson**, Chair Emeritus*
- William P. **O'Neill**, Jr.*
- Dr. R.S. **Paroda***
- Rejane **Souza***
- Mark **Schneiders***
- Dr. Paul **Vlek***
- Dr. Leigh Ann **Winowiecki***

## ON THE COVER

IFDC's Mission in Action represents how the organization views the holistic nature of its work.



## PUBLICATION CREDITS

### Contributors:

Veyrl Adell, Feyikemi Adurogbangba, Williams Atakora, Adam Crosswhite, Syam Dodla, Ekwe Dossa, Mariano Dossou-Kpanou, Anna Goodwin, Ruth Kamunya, Caroline Karuitha, Olga Kokode, Julie Kohler, Latha Nagarajan, Kiran Pavuluri, Yashpal Saharawat, Upendra Singh, Kasta Staggs, Glauco Teixeira

**Executive Editor:** James Thigpen  
**Editors:** Julie Kohler and Bethany Howard  
**Graphic Design & Layout:** Meg Ross  
**Production Assistant:** Madeline Smith

Copyright © 2024 by IFDC. All Rights Reserved.  
 All photographs, unless otherwise noted, are from the IFDC photo archives.

# STRENGTH IN UNITY: A LETTER FROM THE CHAIR OF THE BOARD



**Rudy Rabbinge**  
IFDC Board Chair

## THE BOARD

**A**s Chair of the Board of Directors, I am pleased to present the 2023 Annual Report. Through unwavering commitment, collaborative effort, and a shared belief in our mission, this year, we have made significant progress across all facets of our work.

### A STRONG FOUNDATION OF SUPPORT

Our financial foundation has never been stronger. Our donors remain deeply committed to the work we do, allowing us to expand and innovate in ways that are transformative. This trust is vital as we continue to advance sustainable agricultural practices worldwide.

### AN ENGAGED AND MOTIVATED TEAM

At the core of IFDC's success is our dedicated staff. Functioning at their optimal level, our team believes wholeheartedly in the mission, vision, and strategy that guide our efforts. This shared sense of purpose is evident not only in the results we achieve but also in the positive team spirit that permeates our organization. This collaborative culture enhances our ability to make a real impact in the regions we serve.

### DELIVERING MEANINGFUL RESULTS

Our programs continue to reach significant milestones, and the people we work with have expressed their appreciation for the impressive changes they are experiencing. Projects like 2SCALE have achieved great results, and we are seeing tangible improvements in the communities we support. The holistic "soil-to-shelf" approach we take ensures that every aspect of the agricultural chain benefits from our work.

### A REVITALIZED HEADQUARTERS

We have also invested in our own infrastructure. Our labs have been updated with new equipment. Our Training Center has been completely refurbished. One can feel the newness by simply walking through our headquarters' front doors. This renovation has not only modernized our facilities but has reinvigorated our staff, boosting morale and productivity. This physical revival mirrors the organizational energy propelling IFDC forward.

### LOOKING TO THE FUTURE

As we move ahead, I am confident that our strong funding, engaged staff, and impactful programs will continue to position IFDC as a leader in agricultural development. Together, we are building a future where sustainable farming practices improve both livelihoods and ecosystems, bringing lasting benefits to communities worldwide.

On behalf of the Board of Directors, I express my deepest gratitude to our staff, donors, and partners. Your commitment drives our success; I look forward to continuing this journey together.

*With appreciation,*

**Dr. Rudy Rabbinge**

*Chair of the Board*

*International Fertilizer Development Center (IFDC)*

# IFDC'S 2023 ACHIEVEMENTS & FUTURE GOALS: ROOTED IN SOIL HEALTH



**Henk van Duijn**  
President and CEO



**A**s we reflect on the achievements and milestones of 2023, I am pleased to share with you in this Annual Report the progress and impact of IFDC's initiatives in promoting improved or restored soil health, sustainable agriculture, and enhanced food security across the globe.

In 2023, IFDC repositioned our organizational structure to match our 2020-2030 Strategy. This reorganization emphasizes the coherence of the pillars that support IFDC's operations and strengthens our impact in restoring soil health in a holistic ecosystem from the lab to the field to the market – all underpinned by an enabling environment. I am proud to present a new annual report structure that reflects this mission.

## DEVELOP BETTER TECHNOLOGIES

In 2023, we made significant advancements in innovations and product development. Several research projects sought to characterize and evaluate novel formulations of fertilizers, such as organo-mineral fertilizers, new potassium minerals, carbon capture technologies, and enhanced efficiency nitrogen fertilizers.

Other research programs evaluated applying nutrient management practices for wide row spacing of crops, utilizing green ammonia applications, expanding fertilizer deep placement technologies, and developing fertilizer recommendation practices for Ghana.

With funding from the U.S. Agency for International Development (USAID), through the Feed the Future Sustainable Opportunities for Improving Livelihoods with Soils (SOILS)-Space to Place (S2P) initiative (p. 10), we enhanced our analytical and formulation labs and greenhouses with advanced equipment that enable us to conduct innovative research and develop innovative solutions to improve fertilizer use efficiency and soil health. The initiative explored dissemination of existing or ready-to-go soil fertility technologies for short-term impact using the S2P approach and



developed and validated targeted, localized soil fertility recommendations and decision support systems for smallholder farmers.

## CATALYZE FARM PRODUCTIVITY

The launch of the Building Resilience and Inclusive Growth of Highland farming systems for rural Transformation (BRIGHT) project (p. 15) in Uganda represents a landmark initiative to transform the lives of over 100,000 farm households in highland regions. Funded by the Embassy of the Kingdom of the Netherlands, BRIGHT focuses on building resilience and fostering inclusive growth. Collaborating with the Integrated Seed Sector Development Uganda (ISSD Uganda) CommonGround program, the project is laying the foundation for resilient farming systems that can withstand the challenges of climate change and contribute to rural transformation.

Additionally, our Fertilizer Research and Responsible Implementation (FERARI) program (p. 12) in Ghana has made substantial progress in developing a systematic approach to support the widespread adoption of balanced fertilizers. This initiative has facilitated



practical policy recommendations, established the Fertilizer Platform Ghana, and engaged multiple universities and research institutes to adapt their research for practical applicability. FERARI has also provided research training to over 50 master's and bachelor's students, six doctoral students from Ghana, and 13 master's students from across Africa, thereby building a new generation of scientists in the fertilizer sector.

### STRENGTHEN MARKETS

In 2023, our 2SCALE program (p. 20) continued to apply its decade-long approach as an incubator and accelerator program, launching Inclusive Agribusiness Clubs (IACs) across nine African countries. These platforms foster inclusive agricultural practices by engaging relevant stakeholders in an inclusive agribusiness space to drive sustainable and equitable growth.

The interventions of our newest market systems-based program, HortiNigeria (p. 23), have led to sustainable results in crop production and productivity, increased income, value addition, and market access. The program is creatively engaging youth to demonstrate agriculture's economic potential. Dialogues with tech-savvy entrepreneurial young people are empowering and giving voice to the next generation of Nigerian farmers.

### ENABLE IMPACT

IFDC's collaborative efforts in policy and market development have been essential to strengthening the agriculture sector. The High-Level Roundtable on Fertilizers in West Africa, held in Lomé, Togo, brought together over 300 regional fertilizer sector decision-makers to develop a roadmap for promoting fertilizer and soil health in West Africa and the Sahel. This roadmap aims to enhance local fertilizer production and distribution, as well as intraregional trade, thereby making fertilizer more accessible and affordable across the region and contributing to setting the stage for the 2024 Africa Fertilizer and Soil Health Summit.

### OUR HOLISTIC APPROACH

IFDC's four strategic areas are not separate operational functions – they work together to improve soil health. We work at key points across the entire spectrum of the food system as well as at various levels, from smallholder farmers to government bodies. Through it all, our work starts with the soil and ends with the soil – with a view to feeding 10 billion people by 2050.

As we look to the future, IFDC remains committed to revitalizing degraded soils and improving nutrient use efficiency, soil health, and microbiological dynamics. We are excited about the opportunities that lie ahead and the potential to expand our impact on a global scale. By prioritizing nutrient use efficiency and soil health as a cornerstone of our efforts, we aim to cultivate resilient farming systems that can thrive in the face of evolving challenges.

In closing, I want to express my gratitude to our dedicated staff, partners, and supporters who have contributed to IFDC's success. Your unwavering commitment and passion for sustainable agriculture inspire us to push boundaries and create positive change. Together, we will continue to make a meaningful difference in the lives of farming communities around the world.



# IFDC RESULTS

## MEASURING IMPACT 2019–2023

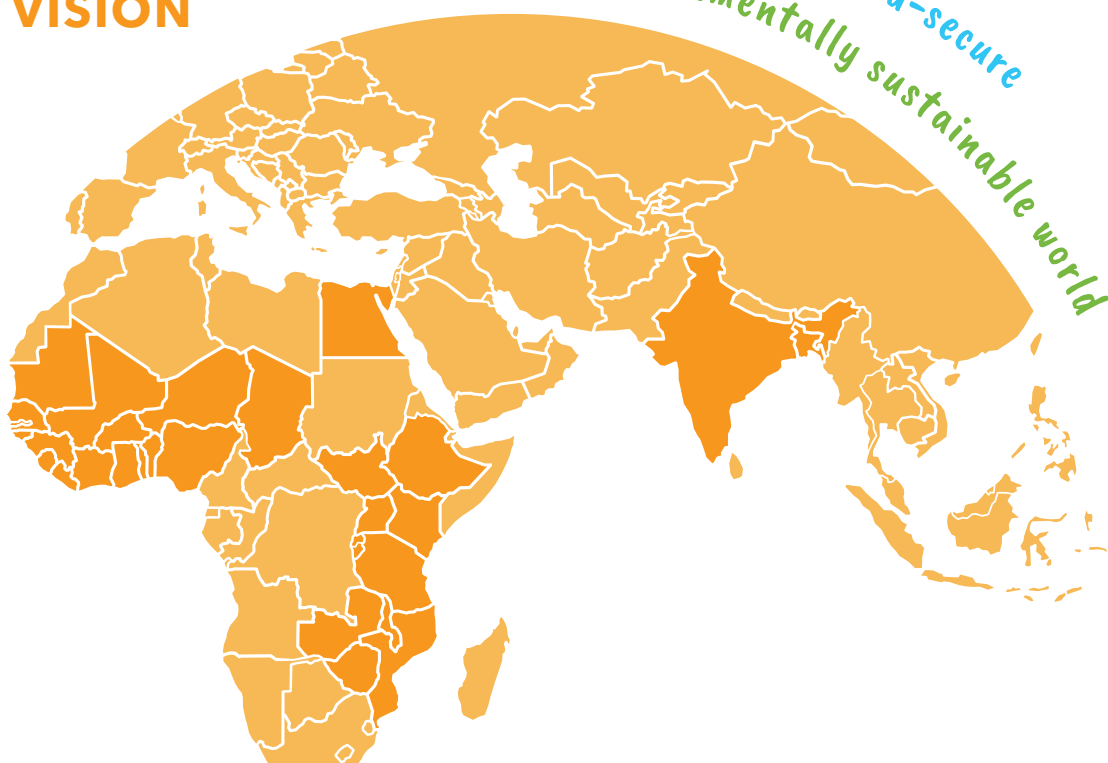
INDICATORS	2019		2020		2021		2022		2023	
	TOTAL	PROJECTS	TOTAL	PROJECTS	TOTAL	PROJECTS	TOTAL	PROJECTS	TOTAL	PROJECTS
Hectares under improved technologies	102,661	17	193,768	17	419,652	13	641,595	11	821,907	20
Farmer participants who applied technologies	213,654	17	416,522	18	527,003	11	945,930	11	650,917	20
Farmers trained (% women)	256,685 (31%)	20	267,023 (46%)	18	408,557 (53.4%)	14	258,566 (47%)	14 (13)	464,097 (38%)	22 (22)
Demonstration plots established	13,439	20	14,501	20	9,383	14	5,661	11	7,564	17
Public-private partnerships formed	523	21	838	24	245	14	331	12	424	21
Outreach activities	4,207	26	5,133	25	4,054	15	5,083	21	4,887	20
Climate-adaptive technologies & sustainable crop management technologies (hectares)*					302,482	3	428,122	8	549,407	13
Private sector firms (SMEs, MSMEs) that have benefited or improved as a result of interventions*					8,376	6	7,152	7	4,956	12
New jobs created as a result of agribusiness interventions*					14,242	3	22,316	2	7,141	1

\* New indicators as of 2021

The number of projects represents how many projects contributed to each indicator.

### OUR VISION

Healthier soils and plants for a food-secure and environmentally sustainable world



### OUR MISSION

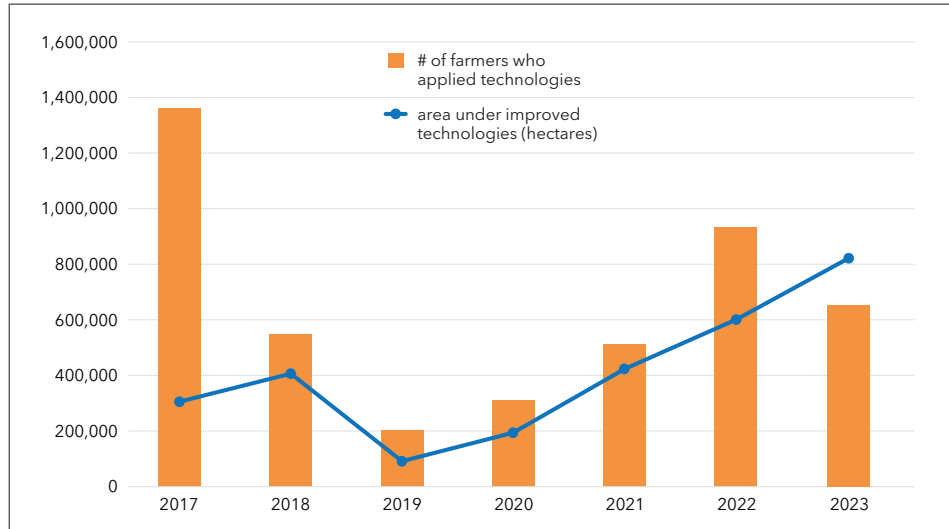
Bring together innovative research, market expertise, and strategic public and private sector partners to identify and scale sustainable solutions for soil and plant nutrition that benefit farmers, entrepreneurs, and the environment.

### OUR REACH IN 2023

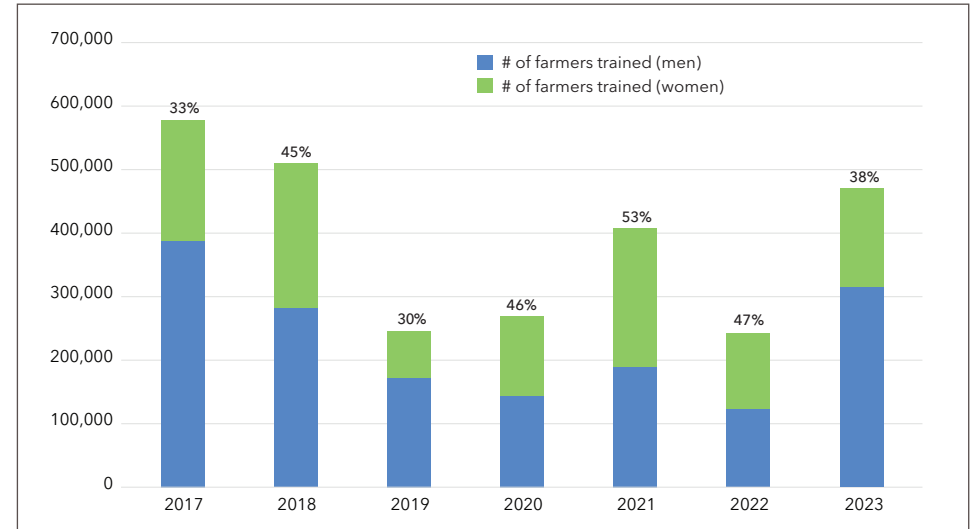
- 📍 BANGLADESH 📍 BENIN 📍 BURKINA FASO
- 📍 BURUNDI 📍 CABO VERDE 📍 CHAD 📍 CÔTE D'IVOIRE
- 📍 EGYPT 📍 ETHIOPIA 📍 GAMBIA 📍 GHANA 📍 GUINEA
- 📍 GUINEA-BISSAU 📍 INDIA 📍 KENYA 📍 LIBERIA
- 📍 MALAWI 📍 MALI 📍 MAURITANIA 📍 MOZAMBIQUE
- 📍 NIGER 📍 NIGERIA 📍 RWANDA 📍 SENEGAL
- 📍 SIERRA LEONE 📍 SOUTH SUDAN 📍 TANZANIA
- 📍 TOGO 📍 UGANDA 📍 ZAMBIA 📍 ZIMBABWE

# OVERVIEW OF **PROGRESS**: RESULTS INDICATORS FOR 2023

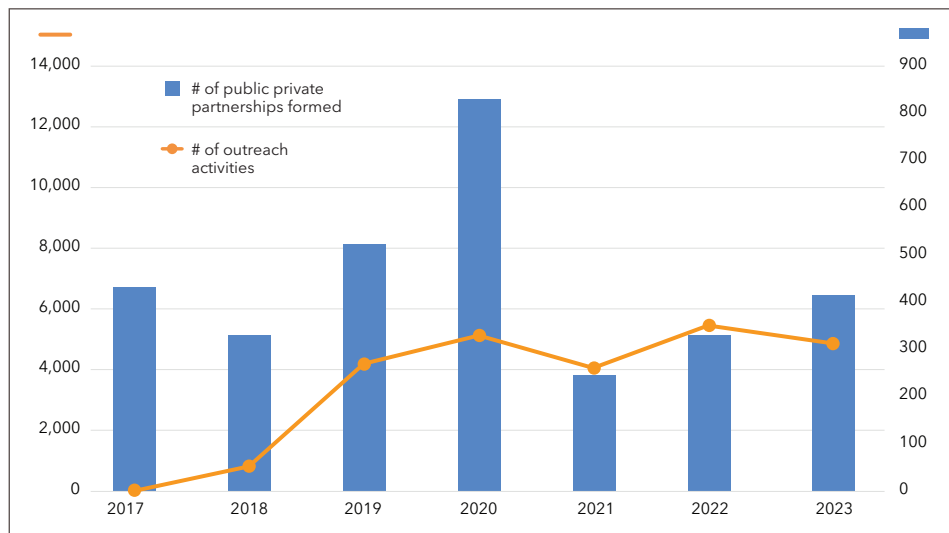
## USE OF TECHNOLOGIES



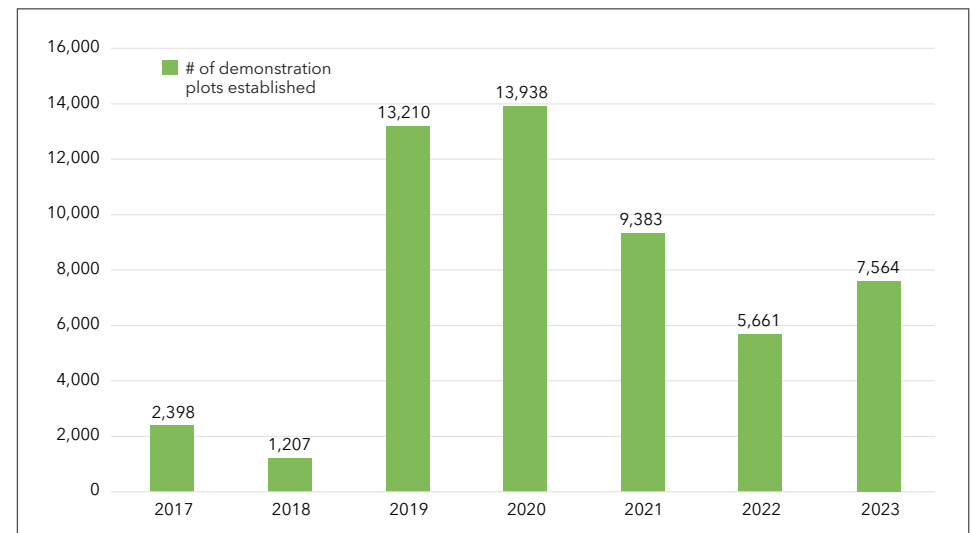
## FARMERS TRAINED



## PARTNERSHIPS & ACTIVITIES



## DEMONSTRATION PLOTS



# COMPARING PERFORMANCE BETWEEN 2022 AND 2023



258,566 ▲ 455,406

**FARMERS TRAINED (38% WOMEN)**

Direct farmer participants in short-term capacity building on management practices and/or technologies



5,661 ▲ 7,564

**DEMONSTRATION PLOTS ESTABLISHED**

Management practices and/or technologies tested in farmer fields for knowledge dissemination



5,083 ▼ 4,742

**OUTREACH ACTIVITIES**

Dissemination activities: workshops, forums, stakeholder consultations, publications, and print, radio, and television media



641,595 ▲ 821,907

**HECTARES UNDER GOOD AGRICULTURAL PRACTICES**

Improved management practices and/or technologies (managed or cultivated by farmer partners)



428,122 ▲ 549,407

**HECTARES UNDER CLIMATE-ADAPTIVE TECHNOLOGIES**

Improved technologies that promote improved climate risk reduction (mitigation/adaptation) and/or natural resource management (NRM) practices



945,930 ▼ 650,917

**FARMERS APPLYING GOOD AGRICULTURAL PRACTICES**

Improved farm management practices and/or technologies



22,316 ▼ 7,141

**NEW JOBS CREATED**

Jobs created resulting from agribusiness interventions



331 ▲ 424

**PUBLIC-PRIVATE PARTNERSHIPS**

Agreements between public and private firms/actors and research, academic, civil society, and stakeholder associations



7,152 ▼ 4,956

**PRIVATE AGRI-ENTERPRISES**

Number of private sector firms (SMEs, MSMEs) that have benefited and improved as a result of interventions

# IFDC'S WORKING ECOSYSTEM FOR IMPROVING

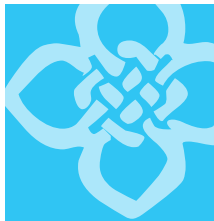
## GLOBAL SOIL HEALTH



IFDC is dedicated to addressing the critical challenge of sustainably feeding a global population that will reach 10 billion by 2050. As the world struggles to produce a larger quantity of nutritious food in the face of accelerating climate change, improving soil health must be every nation's top priority.



Farmers' soils increasingly bear the burdens of climate change, population growth, and widespread food insecurity, while struggling to sustain the critical role of agriculture in economic development. With healthy soil as the foundation of a productive agricultural system, sustainable soil management practices and innovations foster resilience, improve food security, and drive economic growth.



### HOLISTIC APPROACH

IFDC's holistic approach combines science-based innovations, market systems development, an enabling policy environment, and strategic partnerships to assist farmers and countries to identify and scale sustainable agricultural solutions, including improved nutrient use efficiency. These approaches boost soil health and crop productivity. With our partners, we seek to close the yield gap, eradicate global hunger, safeguard the soils on which our lives depend, and generate economic resilience for farming households and the countries in which they live.

With this focus, IFDC is driving the global effort to ensure that the world can feed itself sustainably, now and in the future.

### FOUR PILLARS TO PROSPERITY

Demonstrated in our Mission in Action (see graphic on the right), our four strategic priority areas, or pillars, function as an ecosystem for improving and sustaining soil health.

By collaborating with regional, national, and international partners, IFDC tests and adapts promising technologies that improve soil health and plant nutrition based on data and soil analysis to fit the needs of smallholder farmers in different regions. This approach allows farmers to make evidence-

based decisions regarding soil management practices – such as organic or mineral fertilizer application and incorporation of locally available organic resources and other soil amendments – tailored to the specific needs of their land to ensure optimal nutrient use efficiency and minimal environmental impact.

As a result, farmers increase farm productivity, profitability, and sustainability – growing a higher quantity of higher quality, nutritious food, using fewer external resources. As earning capacity grows, farmers are more willing to invest in new technologies and innovations to improve their soils and increase future incomes.

### GETTING THE HARVEST TO MARKET

An abundant harvest requires access to markets. IFDC works to strengthen market systems so that farmers can reliably access new technologies and knowledge to improve livelihoods, reduce environmental impact, and boost climate resilience. Robust market systems drive new technologies and innovations that support the continual improvement of soil health that farmers have worked to achieve.



A successful market system requires a supportive enabling environment to thrive. IFDC enables impact by improving policies, strengthening capacity, and sharing knowledge. We provide technical support and training to help countries improve their investments in soil fertility and plant health. IFDC advocates for improved soil health by supporting regional and national dialogues, strengthening capacity to develop and implement

policy regulations, improving public and private sector partners' technical capacity, and sharing new knowledge and data related to soil health and plant nutrition.

### **BIG DATA FOR SMALL FARMERS**

Integrating data-driven soil management, cost-effective innovations, better farming practices, market linkages, and effective policy advocacy, IFDC creates a positive cycle of sustainable soil health improvement. We ensure that these improvements are sustainable, scalable, and beneficial for smallholder farmers, their communities, and the Earth.

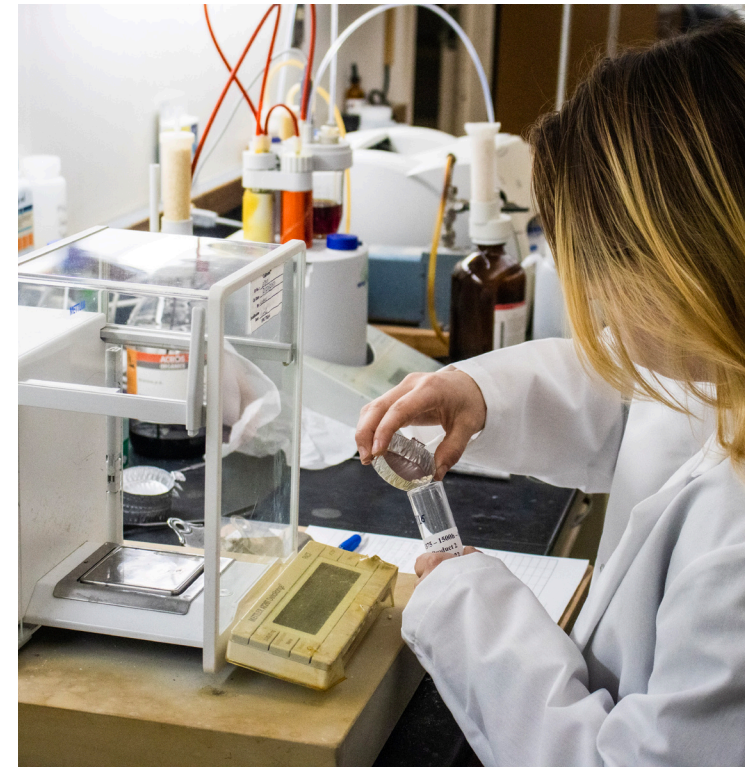


# INNOVATIONS & PRODUCT DEVELOPMENT



In 2023, 16 projects were conducted, and 14 new projects were secured with 19 different donors. The projects included characterizing and evaluating various novel formulations of fertilizers such as organo-mineral fertilizers, new potassium minerals, carbon capture technologies, and enhanced efficiency nitrogen fertilizers. Projects also included evaluating nutrient management practices for crops with wide row spacing, expanding fertilizer deep placement technologies, and developing fertilizer recommendation practices for Ghana.

With the help of funding from USAID and the SOILS-S2P initiative, our analytical and formulation labs and greenhouses gained new capabilities. For example, microwave digestion units, autodiluters, perchloric acid fume hoods, soil and plant sample grinders, pelletizers, simultaneous thermal analysis (STA) machines, Eirich modular mixing tool kits, LI-COR portable photosynthesis measurement systems, texture analysis machines, and Skalar instruments were added to our lab. Greenhouse gas-measuring LI-COR equipment valued at \$0.5 million was installed with the help of funding from an industry partner.





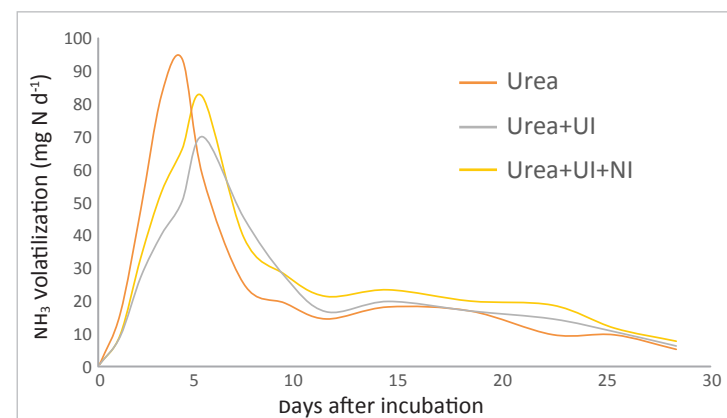
## STUDY: INTERACTIVE EFFECTS OF UREASE AND NITRIFICATION INHIBITORS AND MICRONIZED SULFUR ON NITROGEN USE EFFICIENCY OF UREA

While fertilizers are vital for food production, their environmental and health impacts necessitate a redesign. This study explored new micronized sulfur-containing nitrogen (MSN) fertilizers that offer potential benefits compared to traditional options. The objective is to understand the transformation and loss pathways of MSN fertilizers such as 40-0-0-13 (MSN40) and 11-0-0-75 (MSN11) in different soil types. This study evaluated the transformation and loss pathways of N from the above fertilizers with and without urease inhibitor (UI) and nitrification inhibitor (NI) in comparison to urea.

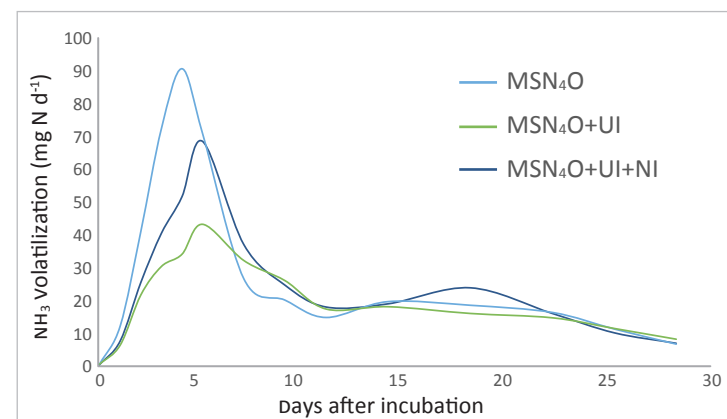
The study showed that the MSN fertilizers had slightly lower and delayed peak  $\text{NH}_3$  volatilization compared to urea. The use of UI with MSN fertilizers reduced  $\text{NH}_3$  volatilization losses more effectively than UI usage with urea, indicating potential synergies between UI and S. The hydrolysis of MSN fertilizers was slowed by the UI under both acidic and alkaline conditions, similar to hydrolysis of urea fertilizer.

The coating of MSN fertilizers with UI+NI significantly delayed  $\text{NH}_4^+$  nitrification in a manner that was either better (with MSN11) or similar to what was observed with urea fertilizer. Coating of MSN fertilizers with UI or UI+NI delayed N leaching losses, indicating prolonged N availability in the soil.

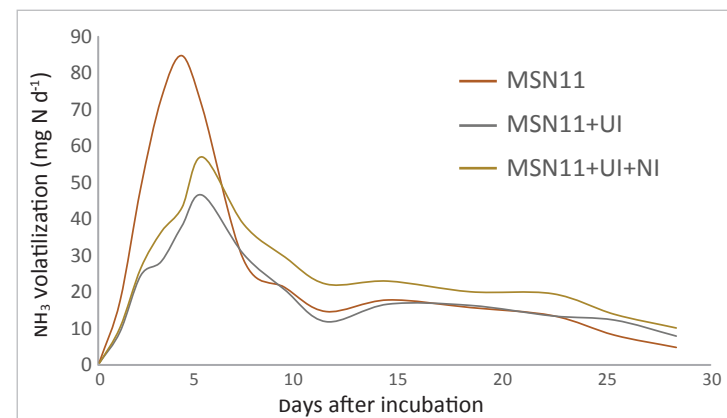
These results were corroborated by a greenhouse sorghum study where MSN fertilizers with UI or UI+NI led to higher total N uptake and higher grain yield than urea fertilizer with UI or UI+NI. MSN fertilizers also resulted in higher total S uptake by sorghum, indicating improved sulfur nutrition. Overall, the study revealed MSN fertilizers had similar or better N use efficiency due to decreased N losses, and both urease and nitrification inhibitors were effective in improving MSN fertilizers' N use efficiency.



**Figure 1.** Effect of urease and nitrification inhibitors on  $\text{NH}_3$  volatilization from urea in Brownfield soil.



**Figure 2.** Effect of urease and nitrification inhibitors on  $\text{NH}_3$  volatilization from 40-0-0-13 in Brownfield soil.



**Figure 3.** Effect of urease and nitrification inhibitors on  $\text{NH}_3$  volatilization from 11-0-0-75 in Brownfield soil.



## SOILS-SPACE TO PLACE

The Feed the Future Sustainable Opportunities for Improving Livelihoods with Soils (SOILS)-Space to Place (S2P) initiative, funded by the USAID Bureau for Resilience, Environment, and Food Security (REFS) and implemented by IFDC since 2022, continued developing improved, hyperlocalized soil and fertilizer recommendations for sub-Saharan Africa. The goal is to substantially reduce fertilizer wastage at the farm level by improving use efficiency for optimal economic returns with better, targeted soil fertility technologies and management practices. The approach enables the delivery of spatially appropriate soil fertility management recommendations, guided by soil maps (Space) combined with farm(er)-level characteristics (Place). The initiative focuses on agro-pastoral, mixed cereal-root crop, and maize mixed production systems in the anchor countries of Malawi, Tanzania, Uganda, and Zambia, with transcending boundaries in Kenya and Mozambique. Partners include ISRIC – World Soil Information, Wageningen University & Research, World Vegetable Center, International Maize and Wheat Improvement Center (CIMMYT), Food and Agriculture Organization of the United Nations (FAO), One Acre Fund, AGRA, national agricultural research institutions, U.S. universities and research institutions, and private firms, such as OCP and Meridian.

Two types of activities were initiated through SOILS-S2P in 2023:

- 1. Dissemination of existing or ready-to-go soil fertility technologies** for short- to medium-term impacts for the 2022-23 cropping season in Malawi, Tanzania, and Zambia. This activity was implemented in partnership with USAID's Southern Africa Accelerated Innovation Delivery Initiative (AID-I, led by CIMMYT) to deliver soil fertility and fertilizer related information and reached nearly 8,000 farm households in Zambia, Malawi, and Tanzania (Box 1).
- 2. Development and validation of targeted, localized soil fertility recommendations and decision support systems** for smallholder farmers. Crop nutrient response trials were conducted in partnership with national agricultural research institutions in Malawi, Mozambique, Tanzania, Uganda, and Zambia to determine yield response to

macro (NPK), secondary, and micronutrients. Focus crops included potato, maize, rice (upland and lowland), beans, soybean, groundnut, and sunflower. The trial design considers a broader spectrum of nutrient responses, which allows more precise, tailored recommendations to be made to meet the diverse soil and crop requirements across sub-Saharan Africa. A total of 814 extensive researcher-managed fertilizer optimization trials at farmers' fields and 27 intensive researcher-managed fertilizer optimization trials were conducted in Kenya, Malawi, Mozambique, Uganda, Tanzania, and Zambia across various crops and agroecological zones.

## OTHER SOILS-S2P ACTIVITIES

The SOILS-S2P partnership developed a prototype decision support tool using legacy soil maps and information, which can be accessed at <https://shiny.wur.nl/content/e878ae35-c793-40cf-ac74-8aa3804a0895/>. In addition, with assistance from USAID/Tanzania and in partnership with the Feed the Future Tanzania Sera Bora Project, a preliminary feasibility assessment was conducted on the establishment of a urea plant in Tanzania using existing natural gas resources. The initiative also collaborated with FAO for soil mapping in Zambia and will be working closely with the SoilFER program on effective decision support tool development and deployment in the country.





## BOX 1

### UNLEASHING THE POWER OF **SOIL**: SOIL SAMPLING, TESTING, AND MAPPING ACTIVITY IN ZANZIBAR

The partnership between IFDC, WorldVeg, and local collaborators in the USAID REFS-funded Space to Place and CIMMYT-led Accelerated Innovation Delivery Initiative (AID-I) project is spearheading a revolutionary transformation of the agricultural landscapes in Zanzibar. Through meticulous soil sampling, comprehensive testing, and the establishment of a soil fertility database and mapping, this collaboration combines the expertise and resources of various institutions to drive horticultural innovation and enhance soil fertility management on Zanzibar Island. Implemented in partnership with the local soil mobile testing firm Live Support Systems Limited (LSSL) and the Zanzibar Agricultural Research Institute (ZARI), this endeavor aims to empower farmers with essential knowledge about soil health and effective management practices to ensure sustainable and optimized horticultural practices. At the core of this initiative is the development of a soil map and an ISRIC-based soil data portal, serving as a centralized repository for vital soil-related information specific to Zanzibar.

By creating the soil map and data portal, this activity seeks to provide a valuable resource for farmers, policymakers, and researchers, offering crucial insights for effective soil management and agricultural planning, with a particular focus on the horticulture sub-sector in Zanzibar.





## FERTILIZER RESEARCH AND RESPONSIBLE IMPLEMENTATION – FERARI (2019-2024)

**Ghana 2019-2024 | Budget** U.S. \$7.1 million | **Donors** Mohammed VI Polytechnic University (UM6P), OCP, and institutional contributions

**Implementing Partners** UM6P, OCP, Wageningen University & Research (WUR), University of Liège, University of Ghana, Kwame Nkrumah University of Science and Technology, University for Development Studies, University of Energy and Natural Resources, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, the Ministry of Food and Agriculture (Ghana), and research institutes of the Council for Scientific and Industrial Research.

FERARI is an international public-private partnership in Ghana that integrates an on-the-ground implementation program to develop the fertilizer value chain with transdisciplinary research by M.Sc. and Ph.D. graduates, supervised by staff from internationally renowned universities, and build the research capacity at the involved institutions. The overall objective of the program is to develop a systematic science-based approach to support widespread adoption of site-specific balanced fertilizers by farmers in the less developed markets of sub-Saharan African countries, specifically Ghana, to improve their food and nutrition security.

FERARI's achievements are accumulating over time, and the results in 2023 included the following:

- Supported the government of Ghana with practicable recommendations for the implementation of crop sector policies, particularly in the Planting for Food and Jobs program and the Ghana Fertilizer Expansion Program (GFEP).
- Demonstrated the feasibility for research to guide implementation of actual activities on the ground.
- Established over 450 on-station, on-farm, and farmer-managed fertilizer response trials of maize, rice, and soybean and conducted demonstrations to about 2,000 farmers.
- Facilitated the establishment of the formally registered, multi-stakeholder Fertilizer Platform Ghana (FPG), which brings private

and public sector players together toward transforming Ghana's fertilizer sector.

- Engaged six Ghanaian universities and two research institutes to adapt their research approach for the practical applicability of their research outcomes.
- Built a new generation of scientists in the fertilizer sector by providing research training to over 50 master's and bachelor's students and six doctoral students from Ghana and 13 master's students from across Africa.
- Facilitated the establishment of a Fertilizer Science and Soil Health master's program and an International Modeling and Mapping Center at University of Cape Coast.
- Developed advanced scientific methodologies, including soil-crop modelling and mapping methodologies and machine learning statistics, to analyze crop responses to fertilization under the data-poor conditions of Ghana.
- Provided responsible fertilizer recommendations to the government, private sector players, and Ghanaian farmers, including the addition of sulfur (S) to NPK to enhance crop yield and economic viability of fertilizer use by farmers.

Further information, including newsletters, research reports, policy briefs, and scientific publications, can be found at <https://ifdc.org/projects/fertilizer-research-and-responsible-implementation-ferari/>.





## PILOT PLANT: PROJECTS, REPAIRS, AND UPGRADES

In 2023, the pilot plant and engineering teams conducted seven projects for five industry partners. The projects included:

1. Granulation projects
  - a. Granulation of phosphate fertilizers with slow- and controlled-release characteristics.
  - b. Granulation of minerals into nitrogen fertilizers.
2. Product characterizations and evaluations
  - a. Various product characterizations and physical properties testing for multiple customers.
3. Engineering
  - a. Consulting on explosivity testing.
  - b. Feasibility studies of nitrogen and phosphate fertilizer production.

The pilot plant facilities have also undergone significant repairs and upgrades, some of which will continue into 2024 and beyond. A few examples of this include installation of new equipment, such as bucket elevators, upgrades to electrical systems and infrastructure, and improvements to the physical properties laboratory.



# SOIL HEALTH SYSTEMS & AGRICULTURAL PRODUCTIVITY



## ■ ACCELERATING FARM INCOMES **AFI**

**India** 2019-2024 | **Budget** U.S. \$2.5 million | **Donor** Walmart Foundation  
**Host Organization** International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

AFI helped peri-urban farmers of Telangana State take advantage of growing consumer demand for fresh produce in the Hyderabad metropolitan area. In 2023, AFI emphasized disseminating good agricultural practices (GAPs) and creating links between farmers and other value chain actors. The project established six additional vegetable collection centers to help farmers get better prices for their products, supported six farmer producer organizations (FPOs) in establishing solar dryers for drying C-grade vegetables and selling them through buy-back arrangements, and connected FPO representatives to financial institutions for working capital arrangements. Further, AFI made arrangements for conducting 664 farmer-field demonstrations during the upcoming Kharif (rainy) season on GAPs for vegetables, cereals, and pulses; prepared 3,000 vegetable garden kits to promote safe vegetable cultivation practices; and mentored rural agri-entrepreneurs to start businesses that support promotion of GAPs among the beneficiary farmers.

## ■ AGRICULTURAL PRODUCTION ACTIVITIES IN SIKASSO **APSA**

**Mali** 2022-2025 | **Budget** U.S. \$1.5 million | **Donor** United States Agency for International Development (USAID) | **Implementing Partners** RTI International (lead), Interchurch Organization for Development Cooperation (ICCO), Association of Professional Peasant Organizations (AOPP), Veterinarians Without Borders (VSF), Rural Polytechnic Institute of Training and Applied Research (IPR-IFRA), and the North Carolina Agricultural and Technical State University (N.C. A&T).

APSA's objective is to sustainably scale up the productivity of key value chains, leading to better consumption of nutritious food and resilience of farm households. This is achieved through a farmer-centered approach, which capitalizes on existing producer organizations to transform the production ecosystem in the Sikasso area. In 2023, the project interventions focused mainly on capacity building activities in Sikasso, Bougouni, and Koutiala regions. A total of 230 village extension agents (VEAs),

including 63 women, were trained through various technical modules, including basic knowledge of simple fertilizers, soil and water conservation technologies, composting in piles, youth-centered business development, technical agricultural practices for selected crops, application of microdosing and urea deep placement, practical farmer field schools around microdosing and urea deep placement plots, and post-harvest technologies for cereals and beans. In turn, this training cascaded, as the 230 VEAs trained a total of 47,759 farmers, including 27,075 women. Additionally, the program established 360 demonstration plots to disseminate productivity-enhancing technologies on maize, millet, sorghum, groundnut, cowpea, and forage crops.





## ■ BUILDING RESILIENCE AND INCLUSIVE GROWTH OF HIGHLAND FARMING SYSTEMS FOR RURAL TRANSFORMATION **BRIGHT**

**Uganda** 2022-2026 | **Budget** € 13 million | **Donor** Embassy of the Kingdom of the Netherlands (EKN) in Uganda | **Implementing Partners** Agriterra, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), National Agricultural Research Organization (NARO), local government offices, and community-based organizations within the Mount Elgon, Kigezi, and Rwenzori regions.

BRIGHT aims to build the resilience of 106,560 households in the Mount Elgon, Kigezi, and Rwenzori highlands to be able to absorb, adapt, and transform amid socio-economic and climatic shocks and stresses. Using the farming systems approach, farming households are at the center of BRIGHTS's interventions involving integrated farm planning, which focuses on sustainable land use at plot and community levels, as well as nutrition and market access. BRIGHT focuses on five mutually reinforcing pillars: (i) adaptive capacity, including intra-household governance capacity, to increase coping strategy options; (ii) on- and off-farm income-earning and livelihood-building opportunities; (iii) access to assets and common goods; (iv) access to communal and other social safety nets; and (v) access to markets for inputs, farm produce, and services. During the inception phase, the project embarked on a baseline study and conducted assessments on community selection, farming and household decision-making, social inclusion of gender and youth, high-potential value chains, value chain actors, and nutrition. Results of these assessments informed further refinement of the results framework to measure the impact of project interventions and will continue to guide the project's adaptive management strategy and implementation.



## ■ FEED THE FUTURE NIGERIA RURAL RESILIENCE ACTIVITY **RRA**

**Nigeria** 2019-2024 | **Budget** U.S. \$1.5 million | **Donor** USAID | **Implementing Partners** Mercy Corps (lead) and Save the Children International.

RRA facilitates economic recovery and growth in vulnerable, conflict-affected areas by promoting systemic change in market systems. The program champions interventions aimed at improving farm practices for increased productivity and incomes for farmers through engagement with value chain actors, public and private extension service providers, and others by ensuring appropriate technologies and practices are mainstreamed. In 2023, RRA mobilized and assessed 1,000 producer organizations across Gombe, Adamawa, Borno, and Yobe states. A total of 9,553 smallholder farmers (52% women) were trained on business plan development, good agricultural practices, post-harvest handling, and mechanization services. A total of 1,017 farmers (359 women) from a cluster of 35 farmer groups were trained on climate-smart agricultural practices and pre-installation, installation, and maintenance of solar-powered irrigation systems and 105 of these systems were distributed across these farmer groups to promote climate-smart irrigation practices, a sustainable and environmentally friendly alternative to traditional diesel fuel systems. Extension agents established 208 community-based agricultural training centers with demonstration plots for effective adoption and diffusion of improved agronomic practices, and this engagement reached 11,128 smallholder farmers (6,343 women). RRA facilitated the deployment of 13 tractors to promote mechanization, and 263 farmers used them to prepare 271.44 hectares of land for planting. A total of 182 jobs were created for participants serving as extension agents or private service providers.



## ■ TRIPLE RESILIENCE 3R

**Mozambique 2023-2027 | Budget** SEK 122 million | **Donor** Embassy of Sweden  
**Implementing Partners** Norwegian People's Aid (NPA), Associação Kwaedza Simukai Manica (AKSM), LevasFlor Foundation (LFF), União de Camponeses de Manica (UCAMA), União Provincial dos Camponeses de Sofala (UPC), and the International Economic Cooperation Institute (ICEI).

The 3R program aims to build and strengthen social, climate, and economic resilience in Mozambique by accelerating the shift from humanitarian aid to long-term sustainable development and increasing communities' ability to absorb, adapt, and transform in the face of recurrent shocks and stresses. The program is implemented in six districts of Sofala Province and three districts of Manica Province. During the inception phase (October to December), 3R conducted key studies and assessments to increase understanding of the regional context and define effective intervention strategies for the program. These included: (i) an environmental assessment and farming systems analysis study, (ii) a conflict assessment, (iii) a baseline study, (iv) a market system resilience index study, (v) a household resilience and vulnerability study, and (vi) an analysis to identify income diversification opportunities (on-farm, off-farm, and non-farm). The program defined its interventions through preliminary study results, identifying the best farming practices and systems to be applied per district.



## ■ FEED THE FUTURE BANGLADESH CLIMATE SMART AGRICULTURE ACTIVITY

**Bangladesh 2023-2028 | Budget** U.S. \$35 million | **Donor** USAID  
**Implementing Partner** Action for Enterprise (AFE).

The Feed the Future Bangladesh Climate Smart Agriculture Activity aims to facilitate farmers, firms, and public sector actors to increase sustainable productivity and crop diversity of smallholder farmers through a more resilient and inclusive food and agriculture production system in Bangladesh. A market assessment survey and private sector engagement workshops were conducted, and 38 firms showed interest in contributing to the project's activities. Two regional workshops were organized to engage small and medium enterprises (SMEs) in agricultural inputs and service delivery. Furthermore, 200 model villages were selected for establishment of demo plots, where 212 training sessions took place. To demonstrate location-specific advantages of climate-smart agriculture, six demonstrations were conducted specifically for pulses and oilseeds, covering a total of 30 acres. A total of 370 briquetting machine owners were selected to receive SME grants to alleviate challenges with access. Additionally, 13 field demonstrations on rice and eight on vegetables were conducted, and 11 field days were held in the Aman season. In Boro season, 151 demonstrations of climate-smart rice, vegetables, pulses, and oilseeds were conducted.



## ■ SOIL FERTILITY STEWARDSHIP PAGRIS

**Burundi 2020-2024 | Budget € 15.3 million | Donor** Embassy of the Kingdom of the Netherlands (EKN) in Burundi | **Implementing Partners** Wageningen Environmental Research and Twitezimberu.

The Soil Fertility Stewardship Project, or the *Projet d'Appui pour une Gestion Responsable et Intégrée des Sols (PAGRIS)*, is an innovative project in Burundi that seeks to achieve ecologically sustainable land management. The project has facilitated research farmers to establish plots to demonstrate good agricultural practices and technologies based on integrated soil fertility management (ISFM). The research farmers have been trained to co-create an integrated farming plan and test and implement land stewardship strategies and practices using the Participatory Learning and Action (PLA) approach. The demonstration plots aim to stimulate communities within 154 villages to replicate practices to tackle erosion and restore soil fertility. About 94,000 households have been taught to develop a plan to improve landscape management, tackle soil erosion, reach stewardship agreements, and implement ISFM practices through collective community action, covering a total of 20,000 hectares (ha). At the institutional level, PAGRIS has supported the adoption of a national policy on watershed management, which was enacted in March 2023. Each year, the project has also facilitated the distribution of approximately 10,000 metric tons (mt) of lime to about 15,000 households to tackle soil acidity.



## ■ SOIL VALUES

**Burkina Faso, Mali, Niger, Nigeria 2024-2034 | Budget € 100 million**  
**Donor** Netherlands Directorate-General for International Cooperation (DGIS)  
**Implementing Partners** SNV, Wageningen University & Research (WUR), AGRA, the World Agroforestry Center (ICRAF), the International Institute for Tropical Agriculture (IITA), ISRIC-World Soil Information, and the International Water Management Institute (IWMI).

Soil Values aims to improve the soil fertility and productive capacity of 2 million hectares of farmland in Burkina Faso, Mali, Niger, and Northern Nigeria. The program will enhance the resilience and well-being of 1.5 million small-scale food producers, with a particular emphasis on women. Additionally, dialogue with bordering corridor countries Côte d'Ivoire and Ghana will ensure regional coherence in soil fertility management and food security. Soil Values will develop mechanisms to ensure the correct economic valuation of soils, addressing spatial-temporal and stakeholder gaps.

# FOCUS ON SUCCESS: ASPEN



## INNOVATION IN THE MECHANIZATION OF FERTILIZER DEEP PLACEMENT



Fertilizers contribute to a 40-60% increase in crop productivity to feed the growing population. Foodgrain production in India has more than tripled, with only a meager increase in cropping area and use of irrigation facilities. This is because of a significant 14-fold increase in fertilizer consumption. The annual fertilizer subsidy of U.S. \$28 billion has allowed the country to become the second largest consumer, producer, and importer of fertilizers.

However, the nutrient use efficiency (NUE) in India is less than 30%, causing a 70% loss in the fertilizer applied, which has an adverse impact on soil and environmental health, as well as livestock and human health. This causes environmental pollution and climate change and leads to high economic losses of around U.S. \$15 billion annually. Broadcasting of fertilizers and the use of traditional water-soluble fertilizer sources are the key issues leading to a low NUE in the country.

As part of the Assessment of State Fertilizer Scenario and Promoting Efficient Nutrient Management (ASPEN) project, IFDC, in collaboration with the Department of Agriculture, Government of Assam, Punjab Agricultural University, Feed the Future, USAID, and National Agro Industries, has developed a seed-and-fertilizer drill.

This innovative machine transplants paddy rice and places the recommended fertilizer briquettes (NPKZnS) at the desired depth of 5-6 centimeters. The mechanization of fertilizer deep placement (FDP) is helping improve rice productivity by 30% and reduce urea use by 20%. The innovation lowers nitrogen losses due to runoff and volatilization and reduces nitrous oxide (greenhouse gas) emissions from the soil.

Large-scale adoption of this technology will help improve energy savings, buildup of soil organic matter, and carbon dioxide capture. The technology will also reduce the labor required by women, who do most of the arduous work of transplanting paddy. IFDC also envisions linking farmers who embrace this technology to carbon credits as an additional source of income. This will serve to transform Indian agriculture from a production system that is subsidy-based to an incentive-based system.



# MARKET SYSTEMS DEVELOPMENT



Over the past year, we have made remarkable strides in our agricultural journey, witnessing not just growth, but also the seamless integration of market systems development (MSD), research, and soil health into our program delivery at IFDC. Through strategic partnerships and innovative strategies, we have effectively merged research insights on soil health with our MSD initiatives, bolstering the resilience and productivity of farming systems. By embedding soil health management practices into market-oriented agricultural value chains, we are promoting sustainable production and empowering smallholder farmers, particularly women and youths, to thrive in dynamic markets. This integration has yielded tangible outcomes such as increased yields, enhanced soil fertility, and improved market access, advancing broader agricultural development objectives. As we forge ahead, our commitment to harnessing the synergies between MSD, research, and soil health remains unwavering, driving positive change and prosperity in the agriculture sector.

## ■ TOWARD SUSTAINABLE CLUSTERS IN AGRIBUSINESS THROUGH LEARNING IN ENTREPRENEURSHIP 2SCALE

**Burkina Faso, Côte d'Ivoire, Egypt, Ethiopia, Ghana, Kenya, Mali, Niger, Nigeria, South Sudan** 2019-2024 | **Budget** € 190 million (€ 62.5 million through public funding) | **Donors** Netherlands Directorate-General for International Cooperation (DGIS) and private sector and financial institution co-investment | **Implementing Partners** SNV and BoP Innovation Center.

2SCALE is an incubator and accelerator program that manages a portfolio of public-private partnerships for inclusive business in agri-food sectors and industries across Africa. The program offers support services to its business champions and partners, enabling them to produce, transform, and supply quality food products. These products go to local and regional markets, including base-of-the-pyramid consumers.

In 2023, 2SCALE launched Inclusive Agribusiness Clubs (IACs) across Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Mali, Niger, Nigeria, and South Sudan. These platforms foster sustainable, inclusive agricultural

practices by engaging relevant stakeholders in an inclusive agribusiness space. These IACs are poised to drive sustainable and equitable growth, offering valuable insights and replicable models.

2SCALE also held its 10<sup>th</sup> Anniversary event December 6-7 in Abidjan, Côte d'Ivoire. This event revealed the transformative impact of 2SCALE's public-private partnerships within the agribusiness sector in francophone countries.

Additionally, two partners, Sweet 'n' Dried and Cato Foods, based in Kenya and Nigeria, respectively, exhibited their nutritious products and shared their journeys with 2SCALE at the Micronutrient Forum in The Hague, Netherlands. The Helen Keller Foundation has since engaged Sweet 'n' Dried in a malnutrition project in Kenya. This demonstrates that business champions are maturing and seizing opportunities in the networks they build.





## ■ COMMUNAL APPROACH TO THE AGRICULTURAL MARKET IN BENIN - PHASE 3 **ACMA3**

**Benin** 2022-2027 | **Budget** € 20 million | **Donor** Embassy of the Kingdom of the Netherlands (EKN) in Benin | **Implementing Partners** CARE International Benin-Togo and KIT.

ACMA3 operates in the Collines, Donga, and Borgou departments of Benin and focuses on the sectors of maize, cassava, soybean, groundnut, small ruminants, poultry, and market gardening. ACMA3 aims to enhance food security, particularly for women and young people, by increasing income and creating jobs. The program employs three strategic axes: enhancing agricultural production, boosting processing and marketing volumes, and fostering a supportive local political environment. The program's indirect approach involves partnerships with local entities, inclusion of vulnerable groups, and facilitation of access to credit and inputs. Previous phases of ACMA have positively impacted over 93,000 people, facilitated significant sales, and promoted climate-smart agricultural practices on thousands of hectares. Future efforts will focus on enhancing leadership capacities, improving financial education, securing infrastructure sites, and tailoring information and communication technology (ICT) solutions to end users' needs for better efficiency and inclusivity.

## ■ AGROECOLOGICAL PRODUCTION AND PROCESSING OF MAIZE PROJECT **2PATM**

**Burkina Faso** 2021-2023 | **Budget** 686,424,406 CFA francs | **Donors** Agence Française de Développement (AFD) and Kreditanstalt für Wiederaufbau (KfW).

2PATM is a sub-project of the Contractual Agriculture and Ecological Transition Project (PACTE). Its general objective is to contribute to meeting the SITRAC plant's needs in quality maize through the professionalization of actors, agroecological intensification, and contract farming. 2023 was a successful year in strengthening the technical capacity of 24 facilitators and 600 producers from four farmer organizations, including 32% women and 38% youths. Despite the high cost of fertilizers, the producer network, through 2PATM, mobilized sufficient quantities of inputs for production;

in total, 304 metric tons (mt) of fertilizer, including 209.5 mt of NPK and 94.5 mt of urea, was acquired.

Through awareness campaigns, 11,202 mt of compost was produced, with a total of 3,838 ha under sound agroecological practices. Application of good practices improved maize productivity from 1.9 mt/ha to 3.75 mt/ha when using improved seed and 9 mt/ha when using SEMAX 5 hybrid seed. This improvement enabled the sale marketing of 2,314.2 mt of maize to SITRAC at 509,124,000 CFA francs. 2PATM has built five warehouses with a capacity of 11,000 mt, enabling maize to be stored under optimum conditions. Farmer organizations have also been provided with production and post-harvest equipment: 14 tricycles, four husking machines, two tractors, 12 thermo-hygrometers, and 208 tarpaulins.





## ■ PROJECT FOR THE INTENSIFICATION OF AGROECOLOGICAL GROUNDNUT PRODUCTION AND PROCESSING **PIPATA**

**Burkina Faso** 2021-2023 | **Budget** 697,045,051 CFA francs | **Donors** Agence Française de Développement (AFD) and Kreditanstalt für Wiederaufbau (KfW).

PIPATA is a sub-project of the Contractual Agriculture and Ecological Transition Project (PACTE), and its objective is to contribute to a sustainable increase in the productivity of quality groundnut free of aflatoxin and to the production of quality foods to combat malnutrition in Burkina Faso.

Satisfactory results were achieved through the capacity building of 42 facilitators, who reached 6,429 producers, including 3,428 women and 2,635 young people. These activities resulted in a 72% adoption rate of good agroecological intensification practices. PIPATA supported the acquisition of 101 mt of inputs, including 58 mt of NPK, 30 mt of improved seed, and 13 mt of Aflasafe, representing an 80% satisfaction rate.

Further, 2,691 mt of organic manure and compost were produced and used on 1,559 ha of agroecologically intensified land. This increased the average groundnut yield from 0.7 mt/ha to 1.3 mt/ha.

Major equipment and infrastructure were also acquired: eight huskers, 15 thermo-hygrometers, 10 electronic weighing scales, 100 tarpaulins, 27 tricycles, 13 seeders, five laptops, five multifunction printers, one vehicle, one aflatoxin testing device, one ceramic hot plate, two temperature probes, two covered tricycles, one printer for groundnut packaging bags, informational brochures and leaflets, four motorcycles, and two video projectors. Eight 100-mt warehouses with drying areas and an extension for the roasting and quality technical teams' offices were also built.

## ■ ACCELERATING AGRICULTURE AND AGRIBUSINESS IN SOUTH SUDAN FOR ENHANCED ECONOMIC DEVELOPMENT **A3-SEED**

**South Sudan** 2020-2025 | **Budget** U.S. \$10 million | **Donor** Embassy of the Kingdom of the Netherlands (EKN) in Juba | **Implementing Partner** KIT

A3-SEED supports the commercialization of the seed sector in South Sudan to transition from humanitarian relief to a commercial, sustainable, and adaptive agriculture sector. In 2023, 10 seed companies mobilized and registered 1,902 outgrowers, 409 (22%) of whom were women, for contract farming to produce quality seeds. These outgrowers cultivated 1,095 ha for seed production in 2023, compared to 924 ha in 2022. Further, 4,725 mt of seed was produced in 2023, for a total of 9,225 mt since the project began. Total sales to humanitarian agencies, coordinated by the Seed Trade Association of South Sudan (STASS), was 161.9 mt in 2022 and 2,398.5 mt in 2023, for a total of 2,560.4 mt, with the rest sold to farmers through agro-dealers. To get seeds to farmers through a network of village agents, 72 agro-dealers were mobilized. A total of 43,572 farmers, including 22,695 women, were reached directly on quality seed use and good agricultural practices. An additional 86,320 farmers were reached indirectly through ICT4Ag (radio jingles and talk shows) and farmer-to-farmer demonstrations. As a result, 6,225 (25%) of small-scale producers progressively decreased the yield gap. A total of 26,143 farmers applied improved farm management practices and/or technologies, and 44,137.54 ha of land was put under improved management practices and/or technologies. A total of 60 government extension workers and seed companies have been trained in quality seed production and associated agronomic practices.





## ■ INTEGRATED SEED SECTOR DEVELOPMENT IN THE SAHEL ISSD/SAHEL

**Mali, Niger 2020-2024 | Budget** € 11 million | **Donor** Embassy of the Kingdom of the Netherlands (EKN) | **Implementing Partners** IFDC (consortium lead), Sasakawa Africa Association (SAA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and KIT.

In 2023, ISSD/Sahel introduced two major innovations: first, a pre-order system to address poor planning and, second, a seed tracking and tracing system to address seed counterfeiting, poor planning, and poor sales. Additionally, a total of 85.1 mt of early-generation seeds was produced, 10.4 mt of which was pre-basic seed and 74.7 mt of which was basic seed. The private sector contributed 48% of the total volume of basic seed that was produced. A total of 308 seed companies and cooperatives benefited from the project's assistance, which aimed at strengthening their capacity to produce, distribute, and market quality seeds. As a result, 542.7 mt of certified seed was produced, and 1,564 youths and women were able to find short-, medium-, and long-term agricultural jobs in the enterprises and cooperatives assisted by the project. Promotional activities through mass media enabled ISSD/Sahel to reach around 347,584 people, and results of the study on seed adoption showed that 84,292 households adopted quality seeds through pilot producers, while 41,688 households did so through direct seed purchases at sales outlets.

## ■ HORTINIGERIA

**Nigeria 2021-2025 | Budget** U.S. \$10 million | **Donor** Embassy of the Kingdom of the Netherlands (EKN) in Nigeria | **Implementing Partners** East-West Seed Knowledge Transfer, Wageningen University & Research (WUR), and KIT.

HortiNigeria aims to facilitate the development of a sustainable and inclusive horticulture sector that contributes to food and nutrition security in Kaduna, Kano, Ogun, and Oyo states in Nigeria. HortiNigeria's targeted interventions have led to sustainable results in crop production and productivity, increased income, value addition, and market access. HortiNigeria trained more than 56,000 smallholder farmers (28% women and 74% youths) and 67 agro-dealers on eco-efficient solutions and

business management in Kaduna and Kano, piloted 18 innovations to scale up among over 1,900 entrepreneurial farmers in Ogun and Oyo states, and facilitated business linkages and partnerships. Farmers have been exposed to better production practices and technologies, which has boosted productivity by 92.6% for all targeted crops and positioned over 2,000 ha of land under sustainable agriculture for men, women, and youths. Training of agro-input dealers on eco-efficient practices has led to expansion of their businesses to provide private extension services to farmers. Dialogues on better practices and market opportunities has brought a better coordinated structure among young tech-savvy entrepreneurial farmers. Discussions and meetings with financial institutions have improved access to financial services for actors in the horticultural space. To address concerns in the policy environment, HortiNigeria held consultations with several stakeholders, fostering connections and encouraging public-private action.



## ■ RESILIENCE THROUGH AGRICULTURE IN SOUTH SUDAN **RASS**

**South Sudan 2021-2025 | Budget** U.S. \$24 million | **Donor** USAID  
**Implementing Partners** DAI (lead), CARE International, and the Waterfield Design Group.

RASS serves as a vital companion to the many humanitarian relief and recovery efforts in South Sudan. By layering, sequencing, and integrating development activities with humanitarian efforts, RASS aims to improve food security, community and household recovery, and resilience in South Sudan. To date, RASS has provided 2,585 farmers with quality certified seeds, built the multiplication capacity of 80 seed multipliers, and reached 2,712 people with gender-sensitization messaging, not including those reached through radio, town halls, and open forums.



## ■ PRIVATE SEED SECTOR DEVELOPMENT **PSSD**

**Burundi 2018-2024 | Budget** € 12 million | **Donor** Embassy of the Kingdom of the Netherlands (EKN) in Burundi | **Implementing Partners** KIT and national public and private partners.

PSSD aims to double the production and incomes of 178,000 farmer households in Burundi by ensuring sustainable access to certified seeds and agricultural advisory services. The project focuses on the development of sales strategies that are tailored to farmer household requirements; these developments include sale of seeds in micro-packs, last-mile distribution capabilities, micro-demonstration plots, consumer education-focused communication strategies, and special promotional materials tailored to farmers. A total of 122,577 smallholder farmers were trained in good agricultural practices through 17,339 community-led learning and innovation plots. Through a public and private partnership strategy, the regulatory environment for seeds in Burundi has been modified and has facilitated the registration of 107 new crop varieties: 33 varieties of fortified organic bean, 19 of hybrid maize, 11 of composite maize, 13 of potato, nine of rice, six of banana, 11 of sorghum, and five of cassava. Within the project evolution, production and use of certified seeds is increasing more and more. PSSD supported 259 private seed entrepreneurs to produce and sell 7,834.6 mt of certified seeds to 332,220 farming households.





## ■ POTATO VALUE CHAIN CAPACITY BUILDING **PCB**

**Kenya 2018-2024 | Budget € 245,000 | Donor** Embassy of Ireland in Kenya  
**Implementing Partners** Nyandarua County Government, National Potato Council of Kenya (NPCK), IPM Potato Group Kenya, Kenya Plant Health Inspectorate Services (KEPHIS), and Kenya Agricultural and Livestock Research Organization (KALRO).

PCB aims to improve the livelihoods of small-scale farmers and families through the adoption of new technologies, including certified potato seed and new potato varieties. PCB also trains farmers on good agricultural practices and improved farm management skills and it supports market access.

The project has held 12 field days across Nyandarua County, reaching 1,050 farmers, and 144 lead farmers have been trained to become customer agents as well as aggregation sale agents for IPM Kenya. Through implementation of the extension and marketing strategy by IPM Kenya, 564 farmers have been able to access certified seeds. The 144 lead farmers who were trained on post-harvest handling have in turn trained 1,813 farmers. As a result, post-harvest losses have been reduced from 8% to 4.6%.

The project trained two community-based organizations (CBOs) on aggregation, contract creation, and negotiation skills. This has enabled the CBO members to market their produce collectively, thus improving their bargaining power. Trainings on the use of market information systems such as ViasiSoko were conducted, and a total of 1,139 farmers are now using the platform to access market information.



# FOCUS ON SUCCESS: **HORTINIGERIA**



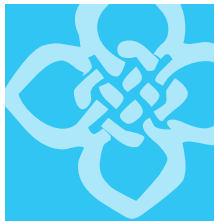
## EMPOWERING RURAL WOMEN TO SUCCEED IN NIGERIA'S HORTICULTURE SECTOR



Rural women are the backbone of many communities, particularly in developing countries. They are often responsible for a variety of tasks, from managing households and raising children to farming the land. Their role in agriculture is significant, as they contribute to food production, food security, and the overall well-being of their families and communities.



Despite being indispensable, rural women encounter numerous challenges. Access to education, healthcare, and economic opportunities can be limited, and traditional gender roles often perpetuate inequality. Discrimination, a lack of land ownership, and limited access to resources continue to hinder their progress.



The HortiNigeria program is committed to promoting inclusivity in the horticulture sector, with the specific aim of involving 50% youth and 40% women in all of its components. As a result, this initiative has become a catalyst for empowering women in selected local government areas within Kano and Kaduna states in Nigeria. More than 20,000 women have received training in seedling production for various crops within the value chains of tomato, pepper, onion, okra, sweet corn, watermelon, cabbage, and cucumber.

This training was part of an event known as "HerHortiVantage," which focused on empowerment and income generation, imparting the valuable lesson that participation in agriculture is not limited to farming, as there are several income-generating activities that do not require extensive land use and can be pursued from the comfort of their homes.

Women in Kano and Kaduna have come together in groups to commence seedling production as a viable business opportunity, giving them a sense of identity and purpose. Additionally, participants also initiated the process of opening bank accounts to manage their profits.

These women have set ambitious goals for their future endeavors. Some aspire to venture into raising livestock, and others intend to expand their involvement in farming on a larger scale. Still, some women plan to

continue producing seedlings, serving as suppliers to nearby seed off-takers and farmers. This initiative is not only empowering rural women, but also fostering a spirit of entrepreneurship and self-sufficiency among them.

Mallama Hadiza Ali Rabo, leader of the Nasara Women's Group, said, "Our plan is to plant seedlings, harvest, and repeat the process until it is bountiful. We want our children to go to school and have adequate school supplies. Now that we have the knowledge to reinvest, we won't just spend the money we receive. Through the group, we manage time efficiently, as we take turns looking after the seeds."

The goal of the HortiNigeria program is to build a sustainable and inclusive horticulture sector to boost food and nutrition security, and rural women are playing a crucial role in ensuring this is successful.



# ENABLING IMPACT

One of the four pillars of IFDC's work is to enable impact. Through its project interventions, IFDC seeks to create a favorable environment for making profitable investments in fertilizer and soil health and aims to sustainably increase agricultural productivity. Achieving these goals will translate to efficient markets, higher incomes, and improved food security, hence contributing to better lives for current generations of smallholder farmers while preparing to pass on healthier soils to future ones.

## ■ AFRICA FERTILIZER

**Africa-wide** (ongoing) | **Budget** U.S. \$1.5 million

**Implementing Partners** African Union, Argus, Development Gateway: An IREX Venture, Food and Agriculture Organization of the United Nations, International Fertilizer Association (IFA), International Food Policy Research Institute (IFPRI), U.S. Agency for International Development (USAID), West African Fertilizer Association (WAFA), and the Nigeria private sector, among others.

As the premier source of fertilizer statistics and information in Africa, the AfricaFertilizer initiative has been collecting, processing, and publishing fertilizer production, trade, and consumption statistics for the main fertilizer markets in sub-Saharan Africa (SSA) since 2009. Working with various partners, AfricaFertilizer has expanded its product offerings to cover 18 countries in SSA. The project has continued issuing several publications, including the annual Register of Fertilizer Manufacturing and Processing Facilities, which monitors and maps operational fertilizer plants throughout SSA. AfricaFertilizer has also continued publishing fact sheets, country overviews, and highlights. Fertilizer data and statistics were validated at 17 country validation workshops held in West and East Africa. Twelve monthly editions of the Africa Fertilizer Watch were published to examine the fertilizer sector's response to availability and affordability issues as well as geopolitical shocks from the Russia-Ukraine conflict. Additionally, AfricaFertilizer disseminated 12 editions of the FertiNews e-newsletter on fertilizer statistics, market conditions, and general fertilizer news as well as 13 country fact sheets and overviews to partners and donors.





## ■ FEED THE FUTURE ENHANCING GROWTH THROUGH REGIONAL AGRICULTURAL INPUT SYSTEMS (EnGRAIS) PROJECT FOR WEST AFRICA

**ECOWAS Member States, Chad, and Mauritania** 2018-2026

**Budget** U.S. \$23 million | **Donor** USAID/West Africa Regional Mission

**Key Partners** Economic Community of West African States (ECOWAS), West African Economic and Monetary Union (UEMOA), the Permanent Interstate Committee for Drought Control in the Sahel (CILSS), West and Central African Council for Agricultural Research and Development (CORAF), West African Fertilizer Association (WAFA), and the Network of Farmer Organizations and Agricultural Producers of West Africa (ROPPA).

On November 1, 2022, EnGRAIS submitted a technical application to USAID for a three-year cost extension of the project. Effective February 20, 2023, EnGRAIS received an additional U.S. \$9 million to continue project implementation and support until February 2026. Thanks to the additional funds, regional stakeholders continued to fill gaps where needed and scale up efforts to ensure the availability and appropriate use of fertilizers and complementary inputs, supplied by a vibrant private sector at an affordable cost to millions of smallholder farmers in West Africa. In 2023, EnGRAIS marked significant milestones with the successful launch of the West African Committee for Fertilizer Control (WACoFeC) and successfully held the committee's first statutory meeting, reinforcing regional efforts for fertilizer quality control. Additionally, the project played a pivotal role in supporting ECOWAS to draft and endorse the Lomé Declaration on Fertilizer and Soil Health, providing a clear roadmap for its implementation. A memorandum of understanding (MOU) with CILSS was also established to integrate fertilizer information into early warning systems for food security in West Africa. Moreover, a three-year MOU was signed between IFDC and WAFA, allowing EnGRAIS to continue strengthening private sector fertilizer stakeholders for high-quality, affordable fertilizer and a more resilient fertilizer sector in West Africa.



## ■ FEED THE FUTURE SENEGAL DUNDËL SUUF PROJECT

**Senegal** 2019-2026 | **Budget** U.S. \$13 million | **Donor** USAID

**Implementing Partners** Senegalese Institute of Agricultural Research (ISRA), National Agricultural and Rural Advisory Agency (ANCAR), producer organizations, and the fertilizer private sector organized under the Association of Fertilizer Professionals in Senegal (APESEN).

Dundël Suuf is being implemented in Senegal to address issues related to the use of inappropriate fertilizer formulas, low adoption of improved fertilizer technologies, poor quality control, and an ineffective subsidy program. During 2023, the project continued the large-scale dissemination of urea deep placement (UDP) and microdosing (MD) technologies as well as the development and testing of new fertilizer formulas. Overall, 173,900 participants (54% women and 17% youth) were trained on application of UDP and MD technologies, 148,680 of whom actually applied the technologies on 20,509 hectares. Also, in addition to the 16 new NPK fertilizer formulas developed and already being tested on rice, millet, and groundnut in collaboration with ISRA, 12 new formulas were developed for testing on vegetable crops and maize. Nine regional policy dialogue platform meetings have been facilitated to enable stakeholders to discuss issues related to fertilizer access, including subsidy program reform. In addition, six regional workshops were organized to share the results of project activities. Moreover, 13 undergraduate students were welcomed for internships.



## ■ FERTILIZER SECTOR REFORM SUPPORT PROJECT IN NIGER **PARSEN**

**Niger** 2018-2024 | **Budget** U.S. \$4.5 million | **Donors** Millennium Challenge Corporation (MCC)/Millennium Challenge Account (MCA)-Niger and Nigerien Association of Fertilizer Importers and Distributors (ANIDE).

PARSEN provided technical assistance to the implementation of Niger's Fertilizer Sector Reform Plan, which is expected to significantly improve the use of fertilizers supplied by a vibrant domestic private sector. The project supported the reform bodies, Niger Fertilizer Market Observatory (OMEN) and the Technical Committee for Fertilizers in Niger (COTEN), in monitoring the fertilizer market and managing the fertilizer sector, the Common Fertilizer Fund, the organized private sector under ANIDE, and the quality control system.

To facilitate fertilizer accessibility, a traceable smart subsidy system has been tested and scaled up with great success through two operations in 2019 and 2022. A third operation is underway in 50 communes across Niger, including 35 communes from the second operation and 15 new ones. For this latest operation, the subsidy program is targeting the 32,000 beneficiaries who have already been registered during the previous operations. Of these beneficiaries, 21,576 (67%) have now received fertilizer, which comes in 50-kilogram bags for 5,000 CFA francs, compared to 25,000 CFA francs on the market. This significantly improved the availability of fertilizer and its accessibility in the regions. Overall, the targeted subsidy has had a leverage effect that has positively and significantly contributed to food and nutrition security and poverty reduction.

## ■ NIGER RICE VALUE CHAIN PROJECT

**Niger** 2019-2024 | **Budget** U.S. \$730,125 | **Donor** Islamic Development Bank (IsBD) | **Implementing Partners** Ministry of Agriculture and Livestock (MAG/EL), National Office of Hydro-Agricultural Developments (ONAHA), National Institute of Agronomic Research of Niger (INRAN), Service Delivery Center (CSP), and farmer organizations.

The Niger Rice Value Chain Project aims to contribute to reducing rice imports and strengthening economic growth in the country by improving production, processing, and marketing of rice. As a technical partner, IFDC is providing support services for the implementation of the program by conducting farmer field schools on urea deep placement, training on good rice-growing practices, and establishing soil fertility maps and recommendations of new fertilizer formulas for rice fields in the regions of Dosso, Niamey, and Tillabéry. As of 2023, 890 farmers have been trained, 89 field plot demonstrations have been conducted using the farmer field school approach, and three soil fertility maps have been produced for the rice fields of Dosso, Niamey, and Tillabéry.





## ■ INTEGRATED RURAL DEVELOPMENT IN THE GAOUAL, KOUNDARA, AND MALI REGIONS OF GUINEA **PDRI/GKM**

**Guinea** 2019-2025 | **Budget** € 830,000 | **Donor** Islamic Development Bank (IsDB) | **Implementing Partners** Ministry of Agriculture and Livestock (MAG/EL), Guinea Agronomic Research Institute (IRAG), Rural Promotion and Agricultural Extension Service (SERPROCA), and farmer organizations.

PDRI/GKM aims to increase agricultural production and build agricultural and rural infrastructure in the prefectures of Gaoual, Koundara, and Mali in Guinea. IFDC is a technical partner for the implementation of the project, and its interventions focus mainly on capacity building of stakeholders in integrated soil fertility management and agribusiness and training farmers on UDP technology through the farmer field school approach. As of 2023, 279 people have been trained, including 36 project staff and partners and 243 farmers, and three farmer field schools have been established to demonstrate UDP technology.

## ■ RICE VALUE CHAIN DEVELOPMENT PROJECT **PDCVR-G**

**Guinea** 2019-2025 | **Budget** U.S. \$943,100 | **Donor** Islamic Development Bank (IsBD) | **Implementing Partners:** Ministry of Agriculture and Livestock (MAG/EL), Guinea Agronomic Research Institute (IRAG), Rural Promotion and Agricultural Extension Service (SERPROCA), National Soil Service (SENASOL), and farmer organizations.

PDCVR-G aims to reduce rice imports and boost economic growth by improving rice production, processing, and marketing in Guinea. As a technical partner, IFDC is providing support services for program implementation by conducting farmer field schools on UDP technology, training farmers in good rice-growing practices, and establishing soil fertility maps and recommendations of new fertilizer formulas for rice fields in Lower and Upper Guinea. As of 2023, a total of 300 producers and project partners have been trained, and three demonstration plots have been established.



■ UKAMA USTAWI CLIMATE-SMART FOOD SYSTEMS ACCELERATOR **CFSA**

**East & Southern Africa 2022-2024 | Budget** U.S. \$710,000 | **Donor** CGIAR  
**Implementing Partners** CGIAR Research Centers: International Water Management Institute (IWMI), Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), WorldFish, International Livestock Research Institute (ILRI), International Institute of Tropical Agriculture (IITA), International Food Policy Research Institute (IFPRI), and International Maize and Wheat Improvement Center (CIMMYT).

The Ukama Ustawi CFSA program is a science-driven accelerator designed to support agribusinesses in scaling climate-smart innovations that address pressing challenges in the region’s food systems. By combining investment readiness with tailored science-based technical assistance, CFSA provides agribusiness companies with the necessary tools and knowledge to become more commercially viable and sustainable. This approach promotes sustainable farming practices that can enhance food production while mitigating the impact of climate change by providing a de-risking grant of up to U.S. \$20,000, based on the agribusiness scaling plan. To date, 10 agribusinesses have raised U.S. \$11.7 million in financing.



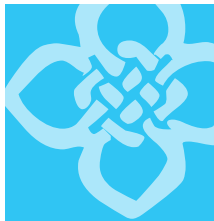
## FOCUS ON SUCCESS: DUNDËL SUUF



In Orkadiéré, a village located about 70 kilometers from Matam, Sadio Ba, an okra producer, tells us about his adventure using the microdosing technology. In 2019, Ba decided to visit one of his friends living in Mboro. Once there, he discovered that his friend was involved in the production of other crops, in addition to okra, as well as livestock and fish farming. Back in his village, having such a farm had been Ba's dream, but unfortunately, he did not have the means to make it happen.



During the 2021-22 rainy season, Ba was selected as a beneficiary by the Regional Directorate of Rural Development (DRDR) of Matam as part of the Feed the Future Senegal Dundël Suuf project for scaling up the microdosing technology. He planted 1 ha of okra with this fertilization technology.



Ba is pleased with the choice he made. Since learning about microdosing, his yields have continued to rise, while the amount of fertilizer used has decreased compared to his traditional fertilization practice.

"Microdosing is both economical and profitable. Instead of the 600 kg/ha I normally use with broadcast fertilizer, I only needed 219 kg/ha with microdosing. In addition, my yield went from 9 to 14 mt with microdosing because the fertilizer acts directly on the plants. With microdosing, I have decreased the amount of fertilizer used and increased my yields."

With the savings on fertilizer and the income from selling okra, Ba is realizing his dream. "Support from the Dundël Suuf project has allowed me to invest my income from growing okra in other crops, such as watermelon and eggplant, but I have also increased my okra production. In addition, the profits generated by okra have contributed to the establishment of a poultry business," he shares.

Ba invested 370,000 CFA francs (about U.S. \$624) in constructing a chicken house and 90,000 CFA francs (about U.S. \$152) in purchasing chickens and three bags of feed at 20,000 CFA francs (about U.S. \$34) each.

Satisfied with microdosing, Sadio Ba recommends that all farmers apply microdosing. He says he is ready to train other producers in the area to take advantage of this technology.



# PRESENTATIONS & PUBLICATIONS

The following technical publications and presentations are a representation of the work of our highly skilled researchers and field experts accomplished in 2023. These, and much of our other research, can be accessed at [hub.ifdc.org](http://hub.ifdc.org).

## PUBLICATIONS

- Adzawla, W., E.D. Setsoafia, S. Amoabeng-Nimako, B. Kwesie, W.K. Atakora, O., Camara, M. Jemo, and P.S. Bindraban. 2023. *Fertilizer Use Efficiency and Economic Viability of Fertilizer Use by Farmers in Ghana*. IFDC FERARI Policy Brief No. 11.
- Akter, M., M.H. Kabir, M.A. Alam, H.A. Mashuk, M.M. Rahman, M.S. Alam, G. Brodie, S.M.M. Islam, Y.K. Gaihre, and G.K.M.M. Rahman. 2023. "Geospatial Visualization of Ecological Risk Assessment of Heavy Metals in Rice Soil of Newly Developed Industrial Zone in Bangladesh," *Sustainability*, 15(9):7208. <https://doi.org/10.3390/su15097208>
- Aremu, T.B., C.Y. Freeman, A. Laamari, Y. Iddrisu, W.K. Atakora, and P.S. Bindraban. 2023. "Informing the Design of a Multistakeholder Platform in Ghana using Stakeholder Analysis and Social Network Analysis," *Outlook on Agriculture*, 52(2):126-139. <https://doi.org/10.1177/00307270231165323>
- Bindraban, P.S., W. Atakora, W. Adzawla, K. Anselme, M. Asante, V. Avornyo, M. El-Gharous, R.A. Gyamfi, H. Sakyi, A.F. Kwarteng, P. Ofori, and H. Sakyi. 2023. *FERARI Research Demonstrates Addition of Sulphur to NPK Increases Maize Yields in Ghana*. IFDC FERARI Policy Brief No. 10.
- Chahar, M., R. Majumdar, R. Joon, J. Gogoi, and Y.S. Saharawat. 2023. "Nursery Management for Transplanted Crops," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Chahar, M., R. Majumdar, R. Joon, J. Gogoi, and Y.S. Saharawat. 2023. "Nutrient Management Practices in Rice, Vegetables and Mustard Crops," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Chongo, M., J. Wendt, M. Ngunjiri, M. Hafidi, and M. Jemo. 2023. "Agronomic Efficiency of Activated Rock Phosphate Granules on Maize Plants Treated with Mycorrhiza in a Calcareous Vertisol of Kenya," *Journal of Soil Science and Plant Nutrition*, 23:2687-2693. <https://doi.org/10.1007/s42729-023-01225-3>
- Dimkpa, C., W. Adzawla, R. Pandey, W.K. Atakora, A.K. Kouame, M. Jemo, and P.S. Bindraban. 2023. "Fertilizers for Food and Nutrition Security in Sub-Saharan Africa: An Overview of Soil Health Implications," *Frontiers in Soil Science*, 3:1123931. <https://doi.org/10.3389/fsoil.2023.1123931>
- Fugice, J. 2023. "EnGRAIS Lab Assessment Validation: West African Committee for Fertilizer Control (WACoFeC) Implementation of Harmonized Regional Fertilizer Regulation."
- Gaihre, Y.K., W.D. Bible, U. Singh, J. Sanabria, and K.R. Baral. 2023. "Mitigation of Nitrous Oxide Emissions from Rice-Wheat Cropping Systems with Sub-Surface Application of Nitrogen Fertilizer and Water Saving Irrigation," *Sustainability*, 15(9):7530. <https://doi.org/10.3390/su15097530>
- Habib, M.A., S.M.M. Islam, M.A. Haque, L. Hassan, M.Z. Ali, S. Nayak, M.H. Dar, and Y.K. Gaihre. 2023. "Effects of Irrigation Regimes and Rice Varieties on Methane Emissions and Yield of Dry Season Rice in Bangladesh," *Soil Systems*, 7(2):41; <https://doi.org/10.3390/soilsystems7020041>
- Islam, S.M.M., Y.K. Gaihre, Md. R. Islam, A. Islam, U. Singh, and B.O. Sander. 2023. "Effects of Integrated Plant Nutrition Systems with Fertilizer Deep Placement on Rice Yields and Nitrogen Use Efficiency under Different Irrigation Regimes," *Heliyon*, 9:e23110. <https://doi.org/10.1016/j.heliyon.2023.e23110>
- Kayumba, J., J. Wendt, A.R. Cyamweshi, P.C. Ndayisaba, S. Kuyah, M. Ngunjiri, J. Rutebuka, and L.N. Nabahungu. 2023. "Urea Briquettes Combined With a Fertilizer Blend Reduces Fertilizer Costs and Improves Yields of Irrigated Rice in Rwanda," *Agronomy Journal*, 115:1202-1213. <https://doi.org/10.1002/agi2.21324>
- Kouame, A.K.K., P.S. Bindraban, I.N. Kissiedu, W.K. Atakora, and K. El Mejahed. 2023. "Identifying Drivers for Variability in Maize (*Zea mays* L.) Yield in Ghana: A Meta-Regression Approach." *Agricultural Systems*, 209:103667. <https://doi.org/10.1016/j.agsy.2023.103667>
- Kumar, K., C.M. Parihar, H.S. Nayak, S. Godara, G. Avinash, K. Patra, D.R. Sena, K.S. Reddy, T.K. Das, S.L. Jat, M.K. Ghatala, U. Singh, and Y.S. Saharawat. 2023. "Enhancing Maize Yield in a Conservation Agriculture-Based Maize-Wheat System through Efficient Nitrogen Management," *Indian Journal of Agricultural Sciences*, 93(4):420-424. <https://doi.org/10.56093/ijas.v93i4.133484>
- Pavuluri, K., J. Fugice, W. Bible, and U. Singh. 2023. "Evaluation of Urea Elemental Sulphur and Nitrogen Inhibitors."

- Phulara, G., J.J. Gaihre, Y.K. Gaihre, and L.P. Amgain. 2023. "Site-Specific Fertilizer Management through Nutrient Expert: Productivity, Profitability and Efficiency of Wheat," *Journal of Tikapur Multiple Campus*, 6(1):204-219. <https://doi.org/10.3126/jotmc.v6i01.56385>
- Pierre, J.F., U. Singh, E. Ruiz-Sánchez, and W. Pavan. 2023. "Development of a Cereal–Legume Intercrop Model for DSSAT Version 4.8," *Agriculture*, 13(4):845. <https://doi.org/10.3390/agriculture13040845>
- Roy, P., R. Bhattacharyya, R. Singh, N.K. Sharma, G. Kumar, M. Madhu, D.R. Biswas, A. Ghosh, S. Das, A.M. Joseph, T.K. Das, S.N. Kumar, S.L. Jat, Y.S. Saharawat, and P. Jha. 2023. "Impact of Agro-Geotextiles on Soil Aggregation and Organic Carbon Sequestration under a Conservation-Tilled Maize-Based Cropping System in the Indian Himalayas," *Frontiers in Environmental Science*, 11. <https://doi.org/10.3389/fenvs.2023.1309106>
- Saharawat, Y.S., and M. Chahar. 2023. "Assessment of Fertilizer Sector in Assam State," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Saharawat, Y.S., and M. Chahar. 2023. "Existing Nutrient Management and Crop Production Practices in Assam," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Saharawat, Y.S., and M. Chahar. 2023. "Fertilizer Policy Assessment- Central and State Level in India," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Saharawat, Y.S., and M. Chahar. 2023. "Needs Assessment of Stakeholders in Fertilizer Value Chain in Assam State," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Saharawat, Y.S., M. Chahar, R. Majumdar, R. Joon, and J. Gogoi. 2023. "Fertilizer Deep Placement – Procedure and Advantages," Assam Agribusiness and Rural Transformation-ARIAS Society.
- Saharawat, Y.S., R. Paroda, U. Singh, and B. Mal. 2023. "Policy, Research and Development Guidelines on the Roadmap for Enhancing Fertilizer Use Efficiency for Sustainable Soil Health in a Farm to Fork (F2F) approach," Trust for Advancement of Agricultural Science.
- Saharawat, Y.S., and U. Singh. 2023. "Innovations in Mechanization of Fertilizer Deep Placement," <https://ifdc.org/2023/04/18/innovations-in-the-mechanization-of-fertilizer-deep-placement/>



- Sharma, S., R. Pandey, C. Dimkpa, A. Kumar, and P.S. Bindraban. 2023. "Growth Stage-Dependent Foliar Application of Iron Improves its Mobilisation Towards Grain and Enhances Fe Use Efficiency in Rice," *Journal of Plant Growth Regulation*, 42:5628-5641. <https://doi.org/10.1007/s00344-023-10944-x>
- Snapp, S., T.B. Sapkota, J. Chamberlin, C.M. Cox, S. Gameda, M.L. Jat, P. Marennya, K.A. Mottaleb, C. Negra, K. Senthilkumar, T.S. Sida, U. Singh, Z.P. Stewart, K. Tesfaye, and B. Govaerts. "Spatially Differentiated Nitrogen Supply Is Key in a Global Food–Fertilizer Price Crisis," *Nature Sustainability*, 6:1268-1278. <https://doi.org/10.1038/s41893-023-01166-w>
- Thapa, G., Y.K. Gaihre, D. Choudhary, and S. Gautam. 2023. "Does Private Sector Involvement Improve the Distribution Efficiency of Subsidized Fertilizer? A Natural Experiment from Nepal," *Agricultural Economics*. <https://doi.org/10.1111/agec.12768>
- Vanlauwe, B., A. Tilahun, A. Bationo, P.S. Bindraban, H. Breman, R. Cardinael, A. Couedel, P. Chivenge, M. Corbeels, A. Dobermann, G. Falconnier, W. Fatunbi, K. Giller, R. Harawa, Mercy Kamau, R. Merckx, C. Palm, D. Powlson, L. Rusinamhodzi, J. Six, U. Singh, Z. Stewart, M. van Ittersum, C. Witt, S. Zingore, and J.J.R. Groot. 2023. "Fertilizer and Soil Health in Africa. The Role of Fertilizer in Building Soil Health to Sustain Farming and Address Climate Change," IFDC. <https://hub.ifdc.org/handle/20.500.14297/2085>

## PRESENTATIONS

- Agegnehu, G., F. Bulo, G. Desta, T. Amede, J. Wendt, M. Demiss, G. Legesse, L. Nagarajan, U. Singh, Z. Stewart, A. Van Rooyen, and R. Harawa. 2023. "Evaluation of Yield-Limiting Nutrients for Teff and Wheat under Different Landscape Positions in Ethiopia," ASA, CSSA, SSSA International Annual Meeting, St. Louis, Missouri.
- Bulo, F., L. Nagarajan, M. Demiss, and U. Singh. 2023. "Soil Health and Soil Fertility Management for Greater Yields and Profitability in Sudan," Sustainable Agrifood Systems Approach for Sudan (SASAS) Partners Planning Meeting, Khartoum, Sudan, February 28-March 2.
- Clark, C., U. Singh, M. Wilson, L. Nigon, and W. Hohenstein. 2023. "NextGen Fertilizer Challenges: Overview of Performance from New Technologies in the Field," Commodity Classic, Orlando, Florida, March 10.
- Demiss, M., U. Singh, J. Fugice, Z.P. Stewart, and L. Nagarajan. 2023. "Effect of Waterlogging Duration on Teff [*Eragrostis tef* (Zucc.) Trotter] Yield and Nutrient Uptake," ASA, CSSA, SSSA International Annual Meeting, St. Louis, Missouri.
- Dodla, S., P.E. Egbedi, J.J. Wang, R. Parvej, and B. Tubana. 2023. "Evaluation of Sugarcane Bagasse Biochar on Soybean Production under Different Irrigation Regimes," ASA, CSSA, SSSA International Annual Meeting, St. Louis, Missouri.
- Gaihre, Y.K., A.M. Abdullah, A. Sayed, L. Nagarajan, U. Singh, and K. Pavuluri. 2023. "Optimizing Sulfur Fertilizer for Increasing Maize Yield and Farm Profit in Bangladesh," ASA, CSSA, SSSA International Annual Meeting, St. Louis, Missouri.
- Nagarajan, L., P. Annequin, and U. Singh. 2023. "IFDC Bridges the Gap Between, Research, Farms, and Markets to Achieve Impact at Scale," G7 Experts' Working Group on Fertilizers (EGF), March 3.
- Nagarajan, L., and U. Singh. 2023. "SOILS Consortium and Space to Place Vision of Data Sharing and Decision Support Tool Development and Use," Workshop for Harmonization of Fertilizer DST for Ethiopia, Addis Ababa, Ethiopia, September 20.
- Nagarajan, L., Z. Stewart, and Space to Place Staff. 2023. "SoilFER and Space to Place Projects Launch Event and Stakeholder Meeting," USAID, FAO, IFDC, ISRIC, and Zambian National Agricultural Research System, Lusaka, Zambia, October 18-20.
- Pavuluri, K., M. Miller, P. Annequin, and J.J.R. Groot. 2023. "An Overview of Research and Program Activities at IFDC," IFA Conference, Prague, Czech Republic, May 22-24.
- Saharawat, Y.S. 2023. "Increasing Cropping Intensity in Assam: Role of Fertilizer," Farmer Commission Government of Assam Meeting, Assam, January.
- Saharawat, Y.S. 2023. "Scale Appropriate Mechanization for Nutrient Management," International Conference on Innovations for Transforming Dryland, ICRISAT Hyderabad, India, February 21- 23.
- Saharawat, Y.S. 2023. "Innovations in Fertilizer Management and Mechanization in Maize-Based Cropping Systems," 66th Annual Maize Workshop, GB Pantnagar University of Agricultural and Technology, Pantnagar, India, April 12-14.
- Saharawat, Y.S. 2023. "Vision of Fertilizers in India," September 28-29.
- Saharawat, Y.S. 2023. "International Panel member of Millets 2023 International Conference," CCS HAU Hisar, India.
- Saharawat, Y.S. 2023 "Decoding the Nitrogen and Tillage Nexus: Modeling of Growth Pattern and N Dynamics of Wheat in a Long-Term Conservation Agriculture Based Maize-Wheat System using the DSSAT-CSM Model."
- Saharawat, Y.S. 2023. "Fertilizer Innovation Centre-India," October 1.
- Saharawat, Y.S., and U. Singh. 2023. "Fortification Technology: IFDC Initiatives," Global Micronutrient Summit 2.0, New Delhi, India, October 6.
- Singh, U., and Y.S. Saharawat. 2023. "Innovations in New Fertilizers Development," FAI Programme on Fertilizers and Food Security: Challenges and Way Forward, Hyderabad, India, January 16-17.
- Singh, U., and Y.S. Saharawat. 2023. "Fertilizer and Soil Health Technologies for Target Ecologies of India," Hyderabad, India, January 18.
- Singh, U. 2023. "Fertilisers: Exploring Alternatives to Traditional Synthetic Fertilisers," CSA Teach-In for FCDO, United Kingdom, March 2.
- Singh, U. 2023. "Utilizing Local Resources for Decentralized Phosphate Fertilizer Production," CRU Phosphates 2023 Conference and Exhibition, Istanbul, Turkey, March 1.
- Singh, U. 2023. "Innovations in Innovations in Nutrient Management and Next Gen Fertilizers," Society for Fertilizers and Environment, India, March 25.
- Singh, U. 2023. "Innovations in Fertilizers: Global Perspectives." Stakeholders Dialogue on Enhancing Fertilizer Use Efficiency for Sustainable Soil Health," New Delhi, India, September 28.
- Wendt, J. 2023. "Sulfur, Zinc, Boron: Why Micronutrients are Important," Argus Fertilizer Africa Conference, Nairobi, Kenya, February 9.





Developing Agriculture from the Ground Up

46 David Lilienthal Drive  
Muscle Shoals, Alabama 35661 USA  
+1 (256) 381-6600

Circular IFDC S-47  
ISSN-1536-0660  
**August 2024**

