SPG COALITION

Sustainable Productivity Growth Coalition

For Food Security and Resource Conservation

COMPENDIUM OF ACTIONS AND LESSONS LEARNED

INTRODUCTION

Coalition on Sustainable Productivity Growth for Food Security and Natural Resource Conservation: 2025 Compendium of Actions and Lessons Learned

The Coalition on Sustainable Productivity Growth for Food Security and Resource Conservation (SPG Coalition), which was launched at the 2021 UN Food Systems Summit, has grown to include over 110 members, including 23 countries plus the European Commission, the Inter-American Institute for Cooperation on Agriculture, the UN Food and Agriculture Organization, research and non-governmental organizations, and private sector groups and businesses.

This diverse membership shares a vision of a world in which everyone has access to safe, nutritious, and affordable diets; farmers and farmworkers have decent incomes and safe working environments; natural resources and biodiversity are sustainably used and managed; and agriculture plays a positive role in climate change adaptation and mitigation. SPG members recognize the essential role that raising the productivity of natural resources—rather than bringing new resources into production—plays in advancing this vision. They also recognize the importance of a holistic approach to accelerating productivity growth that considers impacts and tradeoffs among social, environmental, and economic objectives. Since its creation, SPG Coalition members, together and individually, have supported a wide variety of projects to accelerate sustainable productivity growth for the transition to more sustainable, resilient, and inclusive food systems. This compendium highlights a number of these, as submitted by Coalition members.

The projects included in the Compendium encompass every region of the world. They are real-life examples of innovative, evidence-based approaches for accelerating sustainable productivity growth, inclusive of those rooted in traditional knowledge and experience; those involving innovations in social, behavioral, managerial, and institutional structures; and those incorporating cutting edge technologies. Each project report includes information on realized and potential social, economic, and environmental impacts.

The SPG Coalition provides this compendium to share best practices and lessons learned. It is our hope that the diversity of projects included here will help inspire action by governments, researchers, NGOs, and the private sector around the world.

Acknowledgment:
We would like to thank Mollie Coogan and Sara Hendery for their hard work and expertise in editing the Compendium and the Global Agricultural Productivity Initiative at Virginia Tech for overseeing the completion of this resource. We would also like to thank the Sustainable Food Systems Program of the One Planet Network for sharing their case study template as a model for the Compendium.

TABLE OF CONTENTS

CROPS

ASEAN-Japan MIDORI Cooperation Plan:

Cooperation for Sustainable Agriculture and Food Systems

At-a-glance

Objective: To strengthen cooperation between Japan and ASEAN countries to achieve sustainable agriculture and food systems by increasing agricultural productivities while reducing environmental loads
Lead countries/organization(s): ASEAN Member States (AMS) and Japan
Place: ASEAN Region

BACKGROUND AND OBJECTIVES

To achieve the goals of resilient and sustainable agriculture and food systems as well as the United Nations Sustainable Development Goals (SDGs), it is widely recognized that there is no “one-size-fits-all” solution applicable across different regions under different conditions. Countries geographically located in the Asia-Monsoon region have in common several regional particularities in terms of agricultural production: high humidity and high temperature, abundance of paddy fields, and high density of small- and medium-sized farmers. Solutions to agricultural productivity growth in this region need to consider these specific conditions. As Japan also shares these features, Japan’s “Strategy for Sustainable Food Systems, MIDORI” can provide useful technologies and innovations to address the challenges in the Asia-Monsoon region.

In this regard, Japan and ASEAN member states (AMS) agreed in 2023 on the “ASEAN-Japan MIDORI Cooperation Plan for Strengthening Cooperation towards Enhancing Resilient and Sustainable Agriculture and Food Systems for Ensuring Regional Food Security.” Under the Plan, AMS and Japan will promote their cooperation and collaboration with each other toward "building resilient and sustainable agriculture and food systems through innovation.”

ACTIONS

The specific scope of cooperation that AMS and Japan consider as important and should be addressed in each AMS are as follows:

i) Development, demonstration, and dissemination of technologies for building resilient and sustainable agriculture and food systems through innovation, such as technologies enhancing smart/digital agriculture, circular economy, biomass energy, reducing Greenhouse Gas (GHG) emissions and Integrated Pest Management (IPM);
ii) Human resource development for building resilient and sustainable agriculture, forestry, and food systems; and
iii) Other supports for implementing the ASEAN Regional Guidelines for Sustainable Agriculture in ASEAN.

Through the implementation of cooperation projects, AMS and Japan intend to strengthen and deepen their cooperation.

ICT based Water Management system

The ASEAN-Japan MIDORI Cooperation Plan was adopted at the first Meeting of ASEAN-Japan Ministers of Agriculture and Forestry (AJMAF) in 2023.

In November 2023, Japan and the ASEAN Secretariat (ASEC) held a symposium on Promoting Resilient and Sustainable Agriculture and Food Systems through Innovation to share the outlines of the Plan and the details of each cooperation project among Japan and AMS, listed in the Plan.

To implement the Plan, AMS and Japan may consider holding Ministerial and/or Senior Officials’ Meetings (SOM) on agriculture and forestry as and when necessary. In 2024, SOM-AJMAF was held in August, acknowledging the support expressed by AMS and extending gratitude to Japan for its contributions, while

noting to organize the 2nd Ministerial Meeting in 2025 to evaluate the achievements, address challenges, and outline future directions.

RESULTS

The primary results of some initial projects include:

(1) Contributing to the reduction of fertilizers through automatic plotting technology and soil diagnosis of farmland using satellite data;

(2) Contributing to the increase of productivity and up to a 25% reduction of labor hours through automatic steering technology;

(3) Launch of a project on Joint Crediting Mechanism (JCM) to promote climate change mitigation in agriculture;

(4) Promotion of climate change adaptation and mitigation measures through agricultural and rural development in the Asian Monsoon region; and

(5) Activities to establish circular agriculture through public-private partnerships to train trainers to teach cultivation techniques and to utilize food residues as fertilizer.

Expected outcomes across the three dimensions of sustainable development are as follows:

Social: Cooperation projects may reduce agricultural labor and water usage by ICT-based water management system and flood damage downstream by “Paddy Field Dam” and accelerate sustainable productivity growth (SPG) based on correct cultivation knowledge through conducting training of trainers.

Environmental: Cooperation projects may reduce application of fertilizers by easily and accurately diagnosing soil, and GHG emissions from paddy fields by AWD, while contributing to the enhancement of SPG by utilizing technologies and innovations developed by Japan.

Economic: Cooperation projects may contribute to both SPG and higher farm income, increase yields, and reduce labor hours, seedlings, and other costs through enhanced efficiency of farmwork with low-cost automatic steering tractors.

SUCCESS AND LESSONS LEARNED

Through the implementation of cooperation projects under the Plan, AMS and Japan intend to strengthen further and deepen the cooperative relationship with each other, aiming for the prosperity of the agriculture and food sector in the region by SPG while reducing environmental loads, thus enhancing accessibility of safe, affordable, diverse, and nutritious food for people in the region.

Such prosperity of the sector in the region may be the major success and lesson learned, and the initiative's success may be led by the cooperative relationship between AMS and Japan.

Cassava fields in Thailand

Recognition that AMS and Japan have similarities in weather and agricultural production conditions is also important in facilitating the application of technologies and practices, with modification and fine-tuning to be made where necessary.

Website:
www.maff.go.jp/e/policies/inter_relate/ajmcp/index.html

BNI-Enabled Crops: A Nature-Based Solution for Fertilizer Use Reduction

At-a-glance

Objective: To reduce fertilizer use through biological nitrification inhibition (BNI) technology.
Lead countries/organization(s): Japan International Research Center for Agricultural Sciences (JIRCAS), International Maize and Wheat Improvement Center (CIMMYT), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Place: India, Nepal, Japan, Mexico, and globally

BACKGROUND AND OBJECTIVES

Fertilizers are essential in ensuring high yields in modern agriculture, but they can cause negative environmental impacts, including greenhouse gas emissions and water pollution. To meet the growing demand for food in an environmentally sustainable way, it is essential to increase agricultural productivity with less fertilizer application. BNI-enabled crops are one way to achieve this by maintaining / enhancing crop yields comparable to conventional wheat varieties while requiring less nitrogen fertilizer.

The importance of fertilizer was demonstrated by the Green Revolution. The combination of chemical fertilizers and high-yielding crop seed varieties helped address food shortages facing humanity and earned Dr. Norman Borlaug the Nobel Peace Prize in 1970. However, the Green Revolution also has a downside; more than half of the nitrogen fertilizer applied to farmland is lost due to nitrification-denitrification. Nitrification, a soil-biological process in which soil bacteria convert ammonium to nitrate, leads to nitrogen leakage in farmlands. This occurs through nitrate leaching and by generating powerful greenhouse gases N_2O and NO, and causes groundwater contamination, eutrophication and climate change. Much of the nitrogen fertilizer applied to farmlands feeds soil microorganisms rather than food crops, leading to agricultural inefficiency and negative environmental impacts.

ACTIONS

Certain plants have a natural ability to produce nitrification inhibitors from their root systems – a phenomenon known as 'biological nitrification inhibition' (BNI). Enhancing this trait can address problems associated with out-of-control soil-nitrifier-activity.

JIRCAS, together with its research partners, CIMMYT and ICRISAT, is working to establish BNI-enabled crops – specifically wheat, maize and sorghum – to develop low-nitrifying and low-N_2O emitting production systems.

Recently, JIRCAS and CIMMYT have succeeded in developing BNI-enabled wheat, by introducing a chromosome-arm (Lr#N-SA, which controls the BNI-trait, i.e. the production of BNIs from root systems) from a wild wheat, *Leymus racemosus*. The new, 'elite wheat' can produce and release three times more BNIs from roots (i.e. a threefold increase in BNI capacity). This new category of high-yielding and nitrogen-efficient wheat is named 'BNI-enabled wheat'. This wheat is more efficient at suppressing nitrifying bacteria in the root zone, thus reducing nitrogen losses from wheat fields and improving nitrogen availability to the plant. The BNI trait can be easily transferred to local elite wheat varieties through back-crossing using marker assisted selection. BNI wheats require 30-50% less nitrogen fertilizer to produce similar or better grain yields than their non-BNI parental lines. Additionally, NO_3^- formation in BNI wheats is at least 30% lower and N_2O emissions are 25% lower. Our BNI-enabled wheats are currently undergoing extensive field trials in several major wheat-growing regions of the world, including the Indo-Gangetic Plain (in India and Nepal), Japan, and Mexico.

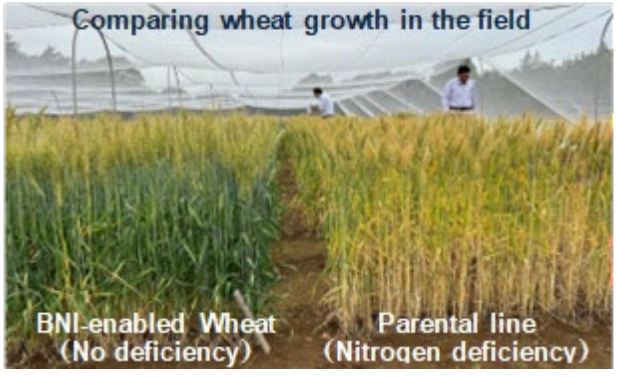


Photo credits: G.V. Subbarao, JIRCAS

RESULTS

Our multi-location trials in Japan, India and Nepal have demonstrated that BNI-enabled wheats produce higher grain yields with lower nitrogen input and require significantly less nitrogen fertilizer applications than present wheat varieties. BNI wheats can reduce nitrogen loss and improve soil-nitrogen retention, thereby enhancing nitrogen use efficiency (NUE). The reduction in nitrogen fertilizer also reduces production costs and facilitates a reduction in the environmental impact of nitrogen, i.e. NO_3^- leaching and N_2O emissions . We observed higher soil organic NUE in BNI-enabled wheat, reflecting more ammonium use in plant growth, which could not be achieved in conventional wheat varieties. The development of this new category of BNI-enabled wheat is an example of how we are addressing global food security, environmental conservation and climate change through next-generation agricultural technologies. Our activities on BNI-enabled crops, especially on BNI-enabled wheat, have been designed to support the three pillars of sustainable development.

Social: India is the world's second largest wheat producer, with grain output reaching 112 million tons in 2024. However, grain production requires massive nitrogen inputs to meet demand and ensure food security. BNI wheat technology may be the key to ensuring wheat production with less fertilizer. Since the BNI technology is seed-based, farmer adoption can be relatively easier as it may not incur additional costs and farmers are only asked to switch to their favored wheat variety that has been fortified with the BNI trait. Recent fertilizer supply disruptions in wheat-producing countries such as Nepal have led to food insecurity, so BNI wheat technology could be an option for supporting their own food security.

Environmental: Our ex-ante analysis of BNI-enabled wheat shows a global potential of an up to 16% reduction in LCA-CO_2 emissions from wheat production systems. Also, BNI-enabled wheat inhibits soil nitrification by suppressing ammonia-oxidizing archaea, resulting in lower NO_3 leaching and N_2O emissions. These results show that BNI-enabled crops can increase NUE and thus prevent food production systems from surpassing regional and planetary nitrogen boundaries.

Economic: Current efforts are focused on transferring the BNI trait into 'elite megawheat' varieties (i.e., those grown on ≥ 1 million ha) adapted to major agro-climatic regions of India, with the goal of transforming the current elite high-yielding wheat varieties into BNI-enabled high-yielding wheat varieties. Recent supply chain disruptions have exposed vulnerabilities in the global fossil fuel-fertilizer-food relationship. Reducing the use of nitrogen fertilizer through BNI-enabled crops may reduce production costs, and the labor required to apply it. It may also provide an opportunity to earn carbon credits as "genetic mitigation" through BNI-technology practices in the future.

SUCCESS AND LESSONS LEARNED

The world's first BNI-enabled crop prototype, BNI-enabled wheat, demonstrated a nature-based solution for a climate-smart and productive food system by increasing NUE through inhibition of soil nitrification. The BNI wheat technology was awarded the PNAS-Cozzalelli Prize in 2021, and our lead researcher was invited to give a TED-talk at TED2022, Vancouver, Canada.

Recognizing the significant potential impact of the BNI technology in reducing fertilizer's footprint on global food production, the Ministry of Agriculture, Forestry and Fisheries of Japan and JST-JICA supported several projects to develop BNI wheats for the IGP region (India and Nepal) and for Japan. We aim to make the BNI trait essential to modern wheat, similar to the "semi dwarf" trait introduced during the Green Revolution.

The development of BNI-enabled wheat is an important contribution to sustainable productivity growth, as it can realize equal or higher output with less fertilizer input. BNI application is also being studied intensively for a wide variety of wheat and other crops, such as sorghum and maize. Since improved productivity for these cereals has a tremendous positive impact on food production, the potential benefit of BNI technology through sustainable productivity growth is significant for reducing global hunger and poverty.

Websites:

www.jircas.go.jp/
www.cimmyt.org/
PNAS Cozzarelli Prize 2021
TED2021 "The wheat field that could change the world"

Building Community Resilience to Climate Change in Senegal

At-a-glance

Objective: To improve rural communities' resilience to climate change, especially women, in the Kedougou region of Senegal.
Lead countries/organization(s): Global Affairs Canada, Jane Goodall Institute of Canada
Place: Kedougou region, Senegal

BACKGROUND AND OBJECTIVES

The Kedougou region of Senegal is increasingly more vulnerable to climate change. Natural disasters such as prolonged droughts, erratic rainfall, floods, and soil erosion have a significant impact on the region's food security, such that 70% of the population rations to survive (Jane Goodall Institute (JGI)). As a result of Senegal's increasing vulnerability to climate shocks, adapting to efficient agricultural and forest management practices has become critical.

Within the Kedougou region, 50% of active farmers are women. Fornio, a type of heritage drought-resistant grain, is a crop that is exclusively grown, harvested, transformed, and marketed by women in the region. Women are also the primary collectors of firewood for use as fuel. Due to their active roles in production in Senegal, women are particularly adversely affected by climate shocks in the region. Thus, developing a gender-sensitive response to climate change is key to addressing its effects as well as ensuring women's greater decision-making roles (JGI).

Building Community Resilience to Climate Change in Senegal was launched in February 2020 to improve rural communities' resilience to climate change, especially women's, in the Kedougou region of Senegal.

This project works to:

- increase the use of climate-smart agricultural techniques,
- increase women's role in decision-making for sustainable livelihoods, and;
- encourage the adoption of forest protection practices by local government and community partners in ecologically vulnerable areas.

This project recognizes the intersection of climate change and gender, factors that are not mutually exclusive.

ACTIONS

The project is implemented by the Building Community Resilience to Climate Change in Senegal (BCR) team who:

- Provide training to 360 farmers from 21 villages on improved planting techniques, considering gender integration,
- Provide farmers with fonio seeds and agricultural inputs,
- including soil nutrient field test kits,
- Train women-led cooperatives on the creation and marketing of biomass briquettes (an alternative fuel made from green biomass that produces low net total greenhouse gas emissions and reduces the need to cut down forests while potentially providing additional revenue) and the use of grain/cereal husking machines.
- Train community members on forest product harvesting
- and bushfire prevention,
- Seed 28,000 indigenous plants, and;
- Promote agroforestry and the use of an indigenous tree species to enhance forest carbon sinks.

The BCR team follows up with the program participants and conducts interviews to assess the effectiveness and implementation at different junctures. At the beginning of the project, a baseline survey was conducted to gather information on the use of drought-resistant crops and climate-smart agricultural techniques. Approximately 50% of respondents reported that they used drought-resistant crops and none reported that they used climate-smart agricultural practices.

Engagement with women's groups and communities is key to this project, as it allows for the BCR team to identify women beneficiaries, catalyze fonio production, and ensure women are the primary producers of fonio. Training on improved agricultural techniques, marketing, sowing methods, purchasing, hygiene practices, storage

techniques, transforming and packaging fonio, communication, and negotiation and sales strategies is provided by Réseau des Femmes pour le Développement (REFDEV).

RESULTS

Given that the four-year project is ongoing and is in its second year of implementation, and that some elements of the project will only be implemented in year three, preliminary results include:

Social: Through consultation processes of the program, women representatives to participate in the improved agricultural techniques training were identified. These women were provided training on improved planting techniques, minimizing post-harvest loss, and improving storage techniques. Feedback from women participants has been positive, with participants reporting feelings of empowerment and improved ability to embrace networking opportunities, capacity building, and increased independence.

Environmental: Enhancing carbon sinks is a goal of this project. Tools and knowledge on climate-smart agricultural practices were shared through training and at least 147 of the women who participated in the training reported applying improved agricultural techniques. In addition, 1,037 community members (men and women) were trained on sustainable harvesting of forest products and bush fire prevention. Training was provided on ecosystem management in protected reserves for firebreak management and fire prevention. In year one and two of the program, progress has been made on strengthening relationships with communes and villages. Activities related to biomass briquettes was delayed and will begin in year three.

Economic: In addition to training on improved farming techniques, women farmers were provided fonio seeds and other agricultural inputs to facilitate income-generating activities and food security. Women were provided with the required tools to increase their efficiency, such as the provisions of tarps and basins. While still too early to measure the outcome, it is expected that these actions will contribute to improved food security for targeted households. Preliminary data shows a greater percentage of farmers are reporting produce of more than 200kg per year, increasing the likelihood that the target for increased productivity and food security set at the beginning of the project will be surpassed.

SUCCESS AND LESSONS LEARNED

Through the training, women had opportunities to meet and connect with other women. Women were provided with skills and a certificate of participation, resulting in an increased sense of pride and accomplishment.

An important lesson from the project so far is the importance of engaging with women's partners to support their participation in similar activities, as many of the activities pull women away from the home.

The project initially intended to target both men and women with fonio production support, however, after engaging with communities, it was obvious fonio is exclusively grown, harvested, transformed, and marketed by women in the region. Thus, the project team shifted to focus on support of women farmers.

Photo credits: Maraîchage Badiari

The team agreed that conservation agreements should be signed with authorities who have the most influence. Therefore, the target of signing community conservation agreements with each community and commune mayor was updated to have these agreements signed with regional and departmental Inspection des Eaux et Forêts (E&F) instead.

Websites:

https://www.jircas.go.jp/
https://www.cimmyt.org/

Climate-Smart Nutrient Management in Smallholder Cereal Production

At-a-glance

Objective: To improve nutrient-use efficiency to increase food production, enhance climate resilience, and reduce greenhouse gas emissions.
Lead countries/organization(s): International Maize and Wheat Improvement Center
Place: India

BACKGROUND AND OBJECTIVES

The use of chemical fertilizers in crop production is at the center of managing food security and environmental challenges. Increasing crop yields through increased fertilizer use is essential to meeting current as well as future food demands. Nevertheless, fertilizer application in croplands is a major source of anthropogenic greenhouse gas (GHG) – reducing GHG emissions through proper fertilizer management is essential to addressing agriculture's contributions to climate change. Moreover, excess and improper use of nutrients in crop production have large cost implications for farmers. Improving nutrient use efficiency (NUE) in croplands not only increases food production but also helps adaptation to and mitigation of climate change.

The Indian food system feeds 18% of the human population and 15% of livestock population globally, and consumes about one-fifth of global fertilizer. Proper fertilizer management in Indian food systems is of global importance both for food security and environmental sustainability. NUE of Indian food production is the lowest in the world, mainly due to blanket fertilization practices, but there are opportunities to improve NUE, increase yields and profitability, and minimize negative environmental consequences. In this initiative, we demonstrated how nutrient management through the use of digital tools, such as the Nutrient Expert (NE) decision support tool, can boost rice and wheat productivity and increase farmers' income, while reducing chemical fertilizer use and GHG emissions.

ACTIONS

NE is an easy-to-use interactive computer-based decision tool that can rapidly provide nutrient recommendation for individual farmers' fields in the presence or absence of soil testing data. NE estimates the attainable yield for a farmer's field based on the growing conditions, determines the nutrient balance in the cropping system based on yield and fertilizer/manure applied in the previous crop, and combines such information with soil characteristics to predict expected N, P, and K response in the concerned field to generate a location specific nutrient recommendation.

Led by the International Maize and Wheat Improvement Center (CIMMYT) in partnership with the Borlaug Institute for South Asia (BISA), the International Rice Research Institute (IRRI), CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Indian Council of Agricultural Research (ICAR), Alliance CIAT-Biodiversity, former International Plant Nutrition Institute (IPNI), and African Plant Nutrition Institute (APNI), researchers tested the NE decision tool against typical farmer fertilization practices using approximately 1,600 side-by-side comparison trials in rice and wheat fields across the Indo-Gangetic Plains over a period of four years. Of these, 730 and 864 trials were conducted on rice and wheat, respectively. The plot size ranged from 1,000 to 2,000 m2 in Haryana and Punjab, and from 500 to 1,500 m2 in Bihar. All practices, except fertilizer management, were similar in the comparison trials.

Although the participating farmers primarily managed the plots, researchers collected relevant crop management data, combined them with relevant soil and climatic data, and compared the outputs of farmers' fertilizing practices with NE-based fertilizer management in terms of crop yield, cost of production, net return, and environmental footprint, calculating NE-based recommendations using the Nutrient Expert® tool.

RESULTS

Project impacts on sustainable development include:

Social: The majority of participating farmers achieved yield gains and increased their farm income by adopting NE-based fertilizer recommendations when compared with farmers' existing fertilizer management practices. Although the effect of NE on crop yield increases is significantly influenced by the crop type, agro-ecology, soil properties, and farmers' current level of fertilization, adoption of this practice in all rice and wheat acreage in India would result in additional production of 8.5 and 5.4 million tons of rice and wheat, respectively, without incurring additional production costs.

Environmental: The study found that NE-based recommendations lowered GHG emissions by 12-20% in wheat and by around 2.5% in rice as compared with conventional fertilization practices. If these GHG emissions reductions of 2.5% in rice and 20% in wheat due to NE-based fertilizer management practices could be achieved in all rice and wheat areas in India, this would translate into GHG cuts of 5.2 million tons CO_2e, i.e., 0.61 million tons of CO_2e from rice and 4.63 million tons of CO_2e from wheat.

Economic: The use of the NE tool resulted in reduced N application in all cases. Estimated N fertilizer savings due to NE-based fertilizer management in rice and wheat in India will be about 1.44 million tons, which would have major implications on costs and GHG emission cuts. Adoption of the NE tool reduced phosphorus application in some cases, although potash application increased in most cases, resulting in both positive and negative impacts on total cost of fertilizer use. In cases where yield gain was obtained due to increased fertilizer use, the increase in fertilizer cost was compensated by the yield gains. Many farmers have achieved double gains, i.e. decrease in fertilizer cost as well as yield gains.

SUCCESS AND LESSONS LEARNED

Each farmer's field is different, which is why blanket fertilizer recommendations are not always effective in producing better yields. By using nutrient management tools such as NE, farmers can obtain fertilizer recommendations specific to their field and economic conditions and thus avoid under-fertilizing or over-fertilizing. In smallholder production systems of South Asia such as India, which has diverse soil conditions, nutrient recommendation based on soil tests are financially and logistically impossible. Therefore, a decision support tool such as NE could be an important factor for implementing site-specific nutrient management recommendations that account for each field's nutrient supplying capacity.

Given the magnitude of potential implications in terms of increasing yields, reducing fertilizer consumption and GHG emissions, governments need to consider scaling out NE-based fertilizer management by enabling policies and institutional arrangements. Implementation of NE at field level requires some level of technical knowledge to run this tool via computer or smartphone. Given this requirement, the technology is best scaled-up through the network of government extension systems, leader farmers, and civil society organizations working directly with farmers.

Photo Credits: Petr Kosina/CIMMYT and Dakshinamurthy Vedachalam/CIMMYT

Websites:

https://www.cimmyt.org/

https://www.nature.com/articles/s41598-020-79883-x

https://www.cimmyt.org/news/digital-nutrient-management-tool-reduces-emissions-improves-crop-yields-and-boosts-farmers-profits/

Delivering Rust-Resistant Soy for Africa

At-a-glance

Objective: To safeguard burgeoning African soy production by producing disease- and climate-resilient, high-performing regional varieties.
Lead countries/organization(s): 2Blades, ILRI, KALRO, IITA
Place: Nairobi and Busia, Kenya

BACKGROUND AND OBJECTIVES

2Blades, a non-profit ag-bio-tech company based in the United States, has for 17 years prioritized solving Soybean Rust (SBR), the greatest disease threat to soybean. Soybean is the world's most important grain legume in terms of total production, international trade, and income. SBR is a fast-moving, global disease, causing crop losses of up to 90% within just three weeks of infection. Existing genetic resistance within soy is failing, as are chemical controls which incur financial and environmental costs.

To date, 2Blades' work has been with commercial seed companies for North and South American markets. Yet the greatest expansion of soybean cultivation today is happening in Africa, where soybean demand is projected to more than double by 2050. Like Brazil, the tropical areas of sub-Saharan Africa are well-suited for soybean cultivation. There is enormous demand for soy in food and feed, and its climate tolerance, economic returns, and ability to improve soil nitrogen has made it a priority crop in multiple African countries.

As countries such as Kenya take steps to bolster domestic soybean production, SBR has already become the leading cause of yield loss in Africa, and it poses a significant threat to the industry's future development. 2Blades is now leveraging its tools, materials, and expertise on SBR to partner and advance SBR-resistant soy for Africa, supporting strategic plans to promote and protect local soybean sectors. Its dual-market strategy uniquely facilitates access to the latest innovations against SBR for smallholder farmers.

ACTIONS

2Blades has initiated a focused effort in Kenya to deploy novel, durable sources of SBR resistance in regionally adapted varieties of soy. 2Blades has overcome the limited pool of available resistance within soy by scanning our large collection of related legumes. By introducing resistance gene stacks with multiple modes of action, we have already created safe, long-lasting resistance to pathogens in wheat, and we are now replicating that approach for SBR and other diseases and pests in soy. The following actions are currently underway:

- Assembling a set of genes with effective resistance to SBR: We are expanding a repertoire of SBR-resistant genes – including three validated and four candidate genes – to produce a curated set of the best genes with different modes of action.
- Assessing and monitoring pathogen strains in the field: We are expanding our collection of African SBR strains by establishing field sites for live monitoring of strains in soy fields. We will assemble information and tools for field-based pathogen assessment, track pathogen diversity and virulence, and combine that information with weather data for modeling of pathogen spread.
- Transforming resistance into regionally preferred germplasm: We have partnered with the Kenya Agricultural and Livestock Research Organization (KALRO) and the International Institute of Tropical Agriculture (IITA) to obtain and assess high-performing regional soy varieties from their breeding programs. We have established that most of these varieties are highly susceptible to SBR. We will introduce resistance genes from soy relatives into these soy lines and test for SBR resistance in the greenhouse and field. In this way, we can protect yields directly in farmer-preferred varieties, and avoid the linkage drag and need for back-crossing in conventional breeding.
- Capacity building and training: 2Blades has partnered with IITA to support SBR research and fieldwork of an African student at the University of KwaZulu-Natal in South Africa.

RESULTS

2Blades has developed research materials, knowledge, and field-validated SBR resistance in Brazil, where adoption of resistant varieties will avoid crop losses and reduce large-scale reliance on fungicides. Advancing products for Africa will expand these benefits with further social, environmental, and economic returns. Expected outcomes across the three dimensions of sustainable development are as follows:

Social: Soybean is a key crop for smallholders. High in protein and oil, it is a quality source of nutrition for people, livestock, and aquaculture, and builds soil nitrogen. Protecting the expanding cultivation of soybeans against the threat of SBR can benefit the nutrition and well-being of whole communities. With ILRI, KALRO, IITA, the Demand-Led Breeding group (serving a significant proportion of women) and the International Service for the Acquisition of Agri-biotech Applications AfriCenter, we will engage with Kenyan smallholders, assess market needs, work with seed authorities and regulatory agencies, and communicate about SBR.

Environmental: Fungicides are used for controlling SBR, with more than $2 billion spent annually in Brazil alone. In Africa, high cost, limited availability, and poor quality can make fungicides a poor option for growers, and an undesirable burden on people and soils. Moreover, this line of defense is failing, and genetic resistance offers a simple, built-in defense in a familiar seed package. SBR resistance confers climate protection against the expanding range of SBR, and the avoidance of failed crops spares land and reduced greenhouse gas (GHG) emissions.

Economic: Regional soybean production can reduce import costs and provide a strong income for smallholders. No data yet exist for disease traits, but insect resistance (Bt) in cotton improved yields per acre 24% by reducing pest damage, and improved profit among smallholders in India by 50%. Bt corn is estimated to have produced cumulative economic benefits of nearly $7 billion in the US Midwest.

SUCCESS AND LESSONS LEARNED

As a nonprofit organization, 2Blades pursues a mission to advance agricultural innovations from lab to field through a dual-market approach. Our model creates value for commercial farming and smallholder agriculture in developing countries. For example, in Kenya and Uganda, field testing of disease-resistant potatoes has produced 3-5x higher yields.

Through partnerships with Corteva and Bayer Crop Science, 2Blades has sourced and validated multiple genes for resistance to SBR from other legumes. The effort has produced high-quality, peer-reviewed publications, successful field trials in Brazil, and products in the pipelines of both companies. Our efforts have produced a new, viable solution for SBR, laying the foundation for our work in Kenya.

A key lesson from this initiative is that access and adoption in the parts of the world where SBR-resistant soy are most needed requires a comprehensive, long-term strategy that engages non-profit, for-profit, and government partners. Partners must be committed to advancing the latest agricultural discoveries in plant science into products for smallholder farmers. Yet presently, the innovation chain for African agriculture is fragmented. Scientific advancements alone are insufficient; achieving meaningful impact requires both partnerships along the innovation chain and a strong, enabling environment to reach smallholder farmers and local communities.

Developing Vegetable Production to Meet Evolving Market Expectations in the Philippines

At-a-glance

Objective: To improve the capacity of selected vegetable producers to better meet consumer expectations in terms of quality, food safety, nutritional value, and price.
Lead countries/organization(s): Australian Centre for International Agricultural Research, Applied Horticultural Research, Visayas State University
Place: Smallholder vegetable farms in the Southern Philippines

BACKGROUND AND OBJECTIVES

On average, Filipinos eat less than 25% of the World Health Organization's recommended intake of vegetables. Reasons include availability, affordability, cultural and dietary factors, and the negative perception of vegetable quality and safety.

It is common to find pesticide residues and microbial contamination above permissible limits in vegetables, soil, and water in the Philippines. Vegetable farmers are poorly trained in the appropriate application of pesticides and continue to use unsafe pest control practices involving broad-spectrum and persistent insecticides. This leads to excessive pesticide residues on harvested crops and exposes farm workers to pesticide poisoning. Aware of these issues, consumers are increasingly interested in purchasing vegetables that are certified safe to eat.

The Government of the Philippines has promoted the use of a national Good Agricultural Practice standards, called PhilGAP. This certification program outlines on-farm and postharvest practices required to produce vegetables that are safe to eat, of good quality, and produced with consideration of worker health and safety and the environment. However, the uptake of PhilGAP by farmers has been slow.

A scaled Good Agricultural Practice (GAP) system, easily implemented by farmers, could be a better solution. If linked with the right markets, and supplied with certified safe-to-eat produce, this system could attract a premium price for high quality vegetables.

ACTIONS

The Australian Centre for International Agricultural Research, Applied Horticultural Research, and Visayas State University in the Philippines are developing six pilot value chains in the Southern Philippines to supply safe-to-eat vegetables to higher value markets.The following components support the value chains:

Stepped GAP training and farmer assistance
A new approach to PhilGAP training breaks the full certification into four steps, which cover PhilGAP accreditation, crop management, business management, and compliance. The training addresses barriers to implementation by starting with easily implementable practices that have benefits for farmers and those which the market is most interested in (e.g. food safety and quality). Farmers are provided with follow-up support to help adopt the practices on their farms.

Food safety research
Microbial contamination and pesticide residues are tested on farms and in supply chains. Interventions are trialed to help reduce and manage these risks, such as the potential for persistence of human pathogens from animal manures and irrigation water.

Socio-economic research
Market and consumer studies are undertaken to identify opportunities for GAP-certified produce, as well as new vegetable crops and varieties. Farmers are linked to new markets through market matching forums with the buyers, and support is provided to establish the value chain.

Agronomic research
Agronomy trials are used to test the production of new high-value vegetable crops and varieties and resolve production issues that arise in the pilot value chains.

Communication with government
Research results are shared with key players in the policy arena to integrate findings with the Government of the Philippines' PhilGAP training program.

RESULTS

The project has identified a pathway for the sustainable adoption of PhilGAP-compliant vegetable production in the Philippines. Vegetable farmers are now producing safe-to-eat vegetables and receiving price premiums and opportunities to link to higher value markets.

Social: PhilGAP requires farmers to use pesticides safely and use an integrated approach to pest management, ultimately reducing farmer exposure to potentially harmful pesticides. The project is improving the supply of safe-to-eat vegetables, which will benefit consumer health. Capacity-building of researchers, trainers, and farmers in the Philippines provides an ongoing source of skills and knowledge related to GAP. Wherever possible, the involvement of women and youth is supported in the project, and many of the pilot farmers are female.

Environmental: One of the four pillars of the PhilGAP standard is environmental management. Farmers are required to adopt practices for improved soil management and conservation, sustainable use of fertilizers, efficient use of water, improved waste management, and energy efficiency.

Economic: Pilot farmers have achieved a 48% price premium on average compared to traditional markets for PhilGAP-produced vegetables. An emerging onion industry was identified through the project, and is now commercial in tropical lowland areas, where onions are not typically grown. The PhilGAP standard requires farmers to maintain good production records, which are now used by farmers to evaluate profitability of crops and make better financial decisions.

SUCCESS AND LESSONS LEARNED

Six pilot value chains have been established in Leyte and Mindanao, Philippines. Many of the 130 farmers involved are now earning 48% higher prices on average compared to traditional markets and are maintaining sustained linkages to markets, including supermarkets, concessionaires, hospitals, fast food chains, and public market stalls. The farmers are increasing their supply of high-quality vegetables produced with PhilGAP protocols.

Some of the key lessons learned are that farmers need to see financial incentives to encourage changed behaviors in technology use, and that farmers often learn best from other farmers. Working with lead farmers who are willing to adopt new practices and investigate new markets has been useful in demonstrating to other farmers the benefits of adopting PhilGAP protocols.

The stepped approach to PhilGAP training has successfully encouraged the adoption of practices required to produce vegetables that are safe to eat, of good quality, and produced with consideration of worker health and safety and the environment.

The Department of Agriculture's Agricultural Training Institute is working towards using the stepped approach in some of their PhilGAP training programs.

Empowering Smallholder Farmers Across the Asia Pacific

At-a-glance

Objective: To increase smallholder farmer access to sustainable crop protection technologies and agronomic advice to improve their yields, grow their incomes, and enhance their quality of life.
Lead countries/organization(s): FMC Corporation
Place: Pakistan, India, Philippines, Malaysia

BACKGROUND AND OBJECTIVES

Smallholder farmers are a vital part of the food production system globally and are responsible for producing up to one-third of the world's food supply. They are an increasingly important farmer segment in Asia Pacific, contributing to both economic stability and food security within the region. At the same time, these smallholders often lack access to the latest advancements in sustainable crop protection and support due to a variety of factors, including size of their operations, location, and cost of inputs.

Recognizing the needs and challenges of smallholder farmers in the region, FMC Corporation launched a three-year initiative to improve smallholder productivity through technology, knowledge-building, and community engagement. Engagement with these farmers is centered around good farming practices and the safe, responsible, and sustainable use of crop protection products. This includes education and training on newer, more sustainable technologies, how to select the appropriate products for their needs, proper use rates, application techniques and timing, identifying counterfeit products, connecting with FMC-recommended retailers, financing, and more.

The first phase of the initiative targets smallholder farmers from marginalized farming communities in Pakistan, India, and the Philippines. Average land holding for this segment of farmers is <4 hectares, which is generally below the industry standard customer base. For this reason, these smallholders have historically been overlooked. The goal is to engage and ultimately improve the sustainable productivity of ~120k smallholder farmers by the end of the three-year initiative.

ACTIONS

FMC's approach to improving smallholder productivity through this initiative is focused on three key actions: 1) establishing FMC Model Villages, 2) expanding geographical reach into new farmer segments, and 3) executing "productivity challenges."

The initiative's approach is based on local needs, conditions, and farming practices. For example, in India, where FMC already has a significant presence and strategic partnerships, the company is launching the Sustainable, Transformational Initiative towards Development – or STRIDE –program. The program will establish local farm economies supported by farmer services (financial and mechanical), agronomic advisory services, training and upskilling, community investments, and model plots for demonstration of the latest advancements in sustainable crop care. Demonstrations will introduce farmers to modern crop protection solutions, including new mode-of-action pesticides that are more targeted and help farmers manage resistance, as well as biological products and digital and precision technologies.

One of the key program elements centers around productivity challenges. In the Philippines, FMC has been running a "productivity challenge" (200 Cavan or 10MT Challenge) with rice farmers since 2019. Rice is a staple food in many Asian countries and serves as a primary source of income for farmers and agricultural workers. The challenge provides farmers with tools and training on crop protection products and proper timing, dose rate, and application techniques to increase their crop yields from a national average 4-5MT to 10MT. As part of an integrated pest management program, farmers participating in the challenge use Prevathon® insect control powered by Rynaxypyr® active. Rynaxypyr® active is a newer, highly targeted mode-of-action insecticide effective against destructive rice insects.

Over the course of the growing season, FMC teams support and advise challenge participants with targeted solutions to improve field productivity. In addition to guidance on specific inputs, teams advise farmers on the proper use of crop protection products, including proper timing, dose rate, safe handling, and disposal.

RESULTS

Project impacts on sustainable development include:

Social: FMC's productivity challenges have improved both the productivity and profitability of smallholder farmers. With the additional income, farmers have been able to improve their health and nutrition, support their children's education, build homes for their families, and achieve a better quality of life.

Farmer safety is another important goal/outcome of our engagement with farmers in the region and around the world. Product stewardship is an essential component of the initiative, and farmers are trained on proper handling and application of crop protection products, disposing of leftover products and empty containers, and use of personal protective equipment (PPE).

Environmental: Product stewardship is a critical part of FMC's approach to smallholder engagement. As part of the 200 Cavan Challenge, for example, farmers were introduced to sustainable crop protection solutions and trained on how to properly apply them to prevent misuse or overapplication that may be harmful to the environment on and around the farm. Stewardship principles also include the safe handling and disposal of product containers to ensure products don't leach into local waterways or impact the surrounding ecosystem.

Economic: In 2021, 90% of the farmers who participated in the third season of the 200 Cavan Challenge increased yields compared to their previous harvest. About half were able to achieve the 200 Cavan (10MT) yield. For comparison, the average yield of the country is just 4-5MT. On average, participants saw a 50% increase in yields, which can be life-changing for many smallholder farmers. The income growth of these individual farmers ultimately contributes to the economic development of the broader farming community.

SUCCESS AND LESSONS LEARNED

It has been inspiring to see farmers who have been producing their whole lives access for the first time good agricultural practices that optimize the use of inputs and more than double their outputs in just one crop season.

Through this initiative, FMC is also playing a role in supporting the Philippines Department of Agriculture's rice resiliency initiative, which aims to increase the country's rice production to feed a growing population. The learnings from the productivity challenges are being applied to FMC's overall approach to empowering smallholder farmers across the Asia Pacific region, and in particular, the three-year initiative launched in 2022. Future yield improvement projects will focus more on low-yielding areas of the region. In addition, the team will look to expand collaboration with local government and stakeholders who can provide information on key areas of need as well as support to farmers to ensure the program and its impacts can be sustained for the long-term.

Websites:

https://www.fmc.com/en

Environmental Benefits of the World's First Genetically Engineered Wheat

At-a-glance

Objective: To analyze the environmental impacts of Argentina's new genetically engineered, drought-tolerant wheat.
Lead countries/organization(s): The Breakthrough Institute
Place: Global

BACKGROUND AND OBJECTIVES

Climate change is threatening crop production through changes in temperature, precipitation, and pest and disease damage, all of which can decrease crop yields. Geopolitical concerns only add to this uncertainty; for example, the Russian invasion of Ukraine is threatening the global wheat supply. In order to maintain yields, technological advances and improvements to production must be developed. As the speed of climate change quickens, tools like genetic engineering and genome editing will enable faster adaptation .

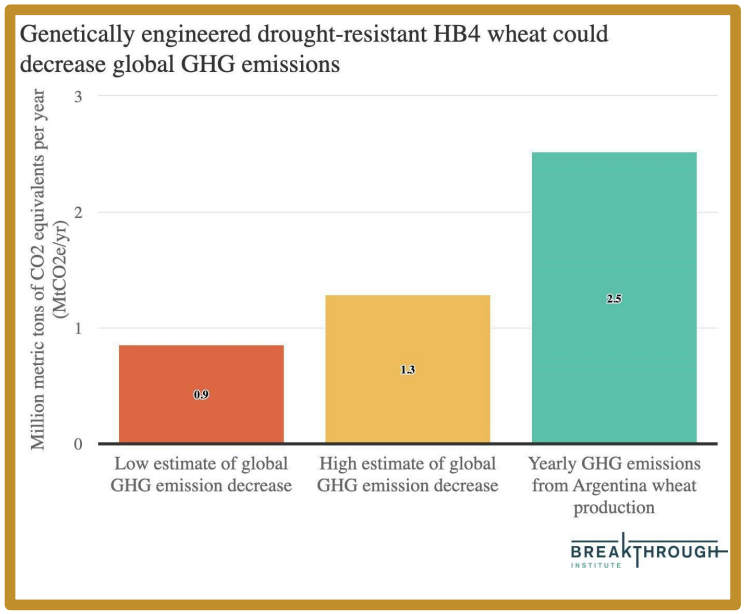
In October 2020, Argentina became the first country to approve a genetically engineered wheat variety – the drought-tolerant HB4 wheat – for cultivation and consumption. Production rapidly expanded. The Breakthrough Institute analyzed the potential environmental impacts of widespread HB4 wheat cultivation and demonstrated how other countries' choices will determine the scale of these impacts.

ACTIONS

The increased yield potential of HB4 wheat can already be observed in initial planting seasons within Argentina. HB4 wheat developer Bioceres found that the trait increases yields by up to 20% compared to other similar varieties that are not genetically engineered for drought resistance. A larger-scale set of plantings spread across Argentina in the 2021-2022 season provided additional data. The average yield benefit of HB4 wheat across all conditions in the 2021-2022 season was 13%.

According to Bioceres, farmers have been satisfied with HB4 wheat, with satisfaction rates ranging from 60 to 100% in regions where it increased yields the most.

The Breakthrough Institute estimated the extent to which growing drought-tolerant HB4 in a significant portion of Argentina's wheat-growing area could reduce global greenhouse gas emissions using the Carbon Benefits Calculator (Searchinger et al. 2018). This method assesses how changes in agricultural production in one location, such as an increase in yields, affects emissions, land use change, and carbon sequestration elsewhere.



RESULTS

The analysis estimates that growing drought-tolerant HB4 wheat in one-third of Argentina's wheat-growing area could reduce global greenhouse gas emissions by at least 0.86 million metric tons of CO2-equivalents per year (MtCO2e/ yr) if yields increase 13%, and up to 1.29 MtCO2e/yr if yields increase 20%. These greenhouse gas emissions savings are equal to 34% and 51% of the yearly on-farm emissions from Argentina's wheat production, respectively.

Social: With potential yield increases of 20%, the production of HB4 could significantly help address food insecurity, and thus, major global nutrition gaps. Many countries are currently in the process of deciding whether or not to import HB4 wheat or grow it domestically. Their decisions matter because wheat is the staple crop for 35% of the world's population and provides 20% of food calories worldwide, but climate change is threatening its production. Increasing yields is key to meeting growing food demand without farmland expansion.

Environmental: As Argentina's wheat yields have decreased, there has been an expansion in the area planted. This is a pressure faced worldwide – in order to meet the growing global demand for crop products like wheat, there must be an increase in yield or the total area cultivated. On a global scale, such farmland expansion leads to deforestation, which releases greenhouse gases, negatively impacts biodiversity, and impairs ecosystem services like water filtration. Since 2000, 102 million hectares of land globally—nearly the size of Egypt—have been converted from native vegetation to cropland (not including pasture and rangeland). HB4's ability to grow more crops with less water will help reduce land use, thus reducing greenhouse gas emissions and preserving biodiversity by limiting deforestation.

Economic: If more countries allow farmers to grow genetically engineered drought-tolerant HB4 wheat, even more cropland expansion and greenhouse gas emissions can be avoided, while also contributing to increased food security and reduced risk of global grain supply shocks. For now, the global wheat trade can somewhat balance low production years in some countries. In 2020-2021, Argentina experienced low yields, and other major exporters were split between shortfall and surplus, meaning that global production remained consistent. But as the impacts of climate change on agriculture increase worldwide, a favorable balance between high and low production globally in a given year becomes less likely. Geopolitical concerns, such as the Russian invasion of Ukraine threatening the global wheat supply and increasing wheat prices, only add to this uncertainty. In addition to countries' decisions about whether to grow HB4 wheat domestically, their decisions about whether to import it also impacts the extent of global cultivation and thereby the food security and environmental benefits that could come from the wheat.

SUCCESS AND LESSONS LEARNED

Genetically engineered drought-resistant HB4 wheat could significantly abate global GHG emissions, ultimately safeguarding human, animal, and environmental health.

Breakthrough's analysis is based on the 2020-2021 wheat production year in Argentina because this year had the lowest yields of the last five years, due in-part to drought. The lessons from Argentina's experience and environmental impacts estimated in Breakthrough's analysis will be important to consider as other countries decide whether they want to follow suit.

Website:
https://thebreakthrough.org/issues/food-agriculture-environment/the-worlds-first-genetically-engineered-wheat-is-here

Farmer Options for Crops Under Saline Conditions (FOCUS) in the Mekong Delta

At-a-glance

Objective: To provide crop and soil management options to support farmer transition to systems that mitigate conditions of climate change.
Lead countries/organization(s): Charles Sturt University, Can Tho University, Institute of Agricultural Science, Australian Centre for International Agricultural Research
Place: Vietnam – Mekong Delta

BACKGROUND AND OBJECTIVES

The Vietnamese Mekong River Delta (MRD) occupies more than 40,000 km^2, is home to more than 21 million people, produces 50% of the nation's food and more than 60% of the national export value. The MRD is relatively flat and low, with an estimated mean elevation of approximately 0.8m above sea level. Climate change-induced sea level rise, changes to seasonal rainfall patterns and competition for upstream water use and storage results in decreased freshwater availability and saline intrusion during the dry season in the MRD. These conditions cause regular failures of rice crops in the spring dry season, accounting for a significant loss of income to thousands of farmers. It is predicted that such losses will increase in frequency, magnitude and spatial extent into the future.

An integrated research project was developed to provide farmers and supporting Department of Agriculture and Rural Development (DARD) staff with improved soil management techniques and profitable alternative crop options to grow in the dry season. The improved production resilience will support food security in rice crop rotations. It is essential that these options be marketable and profitable for rural communities to be sustained or improved as they face conditions of climate change.

ACTIONS

A five-year research project beginning in 2020 was implemented based on co-design with DARD staff, farmers, researchers, agricultural production companies and government agencies responsible for policy and rural development. The project comprises 5 themes:

- Crop production
- Socioeconomic Impacts
- Gender studies
- Spatial applications
- Training activities

The extent and impact of salinity and water scarcity in provinces of the mid/lower Mekong Delta was captured via remote-sensed crop data, infield measurements, household surveys and key informant interviews.

Crop species and cultivars that were suitable for the observed conditions experienced in the Delta were selected using greenhouse studies before field validation at several replicated field sites in three provinces.

Soil management options were tested in greenhouse and field trials to optimise the practices, quantify their production benefits and assess economic outcomes. Examined management options include the use of raised beds, rice straw mulch, biochar, simple and low-cost "chameleon" soil water sensors and the alteration of cropping calendars.

The onsite outcomes of field experiments are being incorporated into predictive spatial modelling. With this information, land use suitability to crops as climate change progresses can be anticipated and the implications this may have to food production and rural livelihoods may be proactively realized by communities.

Gender studies were used to build an understanding of the role of gender in on farm decision-making and operations. This information is being used to tailor training materials and activities to target specific needs of gender groups.

RESULTS

The FOCUS project has demonstrated that diversification using upland crops in rotation with rice production can increase productive resilience during climate change. Features of suitable crops to grow in the spring/dry season of the Mekong Delta include tolerance to salinity, high water use efficiency, and/or short duration of growth to maturity. Successful production can occur with any two of these three features. Field trials have shown that maize, redbeet, cowpea and quinoa can be grown under conditions where rice may have failed.

Social: In the absence of alternative crops to rice, fields are left fallow so that impending salinity and drought can be avoided. The ability to maintain time with family is highly valued in Vietnamese culture. However, farmers experiencing salinity-caused crop loss are driven to seek off-farm work to provide household income and therefore must sacrifice parts of their cultural values. The provision of suitable crops that can tolerate or avoid the hostile conditions of climate change allow farmers to remain profitable on their farms and not have to travel for work. Scheduling irrigation with the use of simple and low cost “chameleon” soil water sensors decreases the frequency of irrigation meaning the farmers’ time can be spent on other tasks or with family.

Environmental: The use of rice straw mulches results in less evaporation loss of water from irrigated crops. Not only does this preserve valuable freshwater resources in the dry season, but moisture retention in soil can decrease the concentration of salt present in the rootzone thereby decreasing the harmful effects of salinity on crops. Field trials demonstrated that a 50% decrease in water use can be realised without a loss in yield when mulches and chameleons are used.

Additionally, using mulch with crops enhances soil microbiological function to decrease fertiliser requirements and increase yield of subsequent rice crops. The greenhouse gas emissions from these systems are now being studied by the project team.

Economic: Whilst there is no current market for quinoa in Vietnam, maize, cowpea and especially redbeet provide favourable economic outcomes for farmers in local markets. Redbeet provides economic returns more than ten times greater than rice.

Photo Credits: Jason Condon, Charles Sturt University

SUCCESS AND LESSONS LEARNED

The FOCUS project has demonstrated that it is possible for farmers to maintain income and food security in the face of climate change with the integration of alternative crops in rice production systems.

There is strength in co-design of research programs that genuinely engage representatives of stakeholders including researchers, institutes, governments and end users.

Climate change and its effects on farming systems is dynamic. Research to improve the resilience of farming systems for food security must be adaptable. Changes in weather, market conditions, or farmers’ responses should be expected and accounted for in new rice crop management recommendations.

Website:
https://www.aciar.gov.au/project/slam-2018-144

Feed the Future Nepal Seed and Fertilizer (NSAF)

At-a-glance

Objective: To build competitive and synergistic seed and fertilizer systems for inclusive and sustainable growth in agricultural productivity, business development, income generation, and scaling improved seed and fertilizer technologies to 120,000 smallholder farmers in Nepal.
Lead countries/organization(s): U.S. Agency for International Development (USAID), CIMMYT
Place: 21 Feed the Future districts and five earthquake-affected districts in Nepal

BACKGROUND AND OBJECTIVES

The Feed the Future Nepal Seed and Fertilizer (NSAF) project (2016-2022) contributes to Feed the Future's goal of sustainably reducing global poverty and hunger and USAID Nepal's Country Development Strategy for Nepal (2020-2025). The project aims to strengthen the country's seed and fertilizer systems by enhancing public, private, and community capacity and roles in the seed and fertilizer value chain. To do this, NSAF provides technical and business development services; improves private sector access to improved seeds, new fertilizer products, and research knowledge developed out of national and international research institutes; and enhances public-private partnerships and coordination to scale seed and soil-management innovations for 120,000 smallholder farmers, while establishing a seed and fertilizer information system at the national level. The project is implemented in both the seed and fertilizer sectors.

ACTIONS

NSAF's inclusive market systems approach increases farmers' access to improved seeds, fertilizers, and extension services by strengthening public-private sector partnerships. The NSAF project provides policy support to Nepal's Agriculture Ministry to improve seed and fertilizer supply systems. Through the national research system, new seed technologies (including hybrid varieties) and fertilizer innovations, combined with improved capacities of intermediary service providers (agro-dealers, extension workers, and other development partners), have expanded farmers' access to improved technologies and agricultural inputs. Better seeds, the judicious use of appropriate fertilizers, and timely knowledge through extension services can improve crop productivity and farmer incomes. The NSAF program introduces best practices in crop management through integrated soil fertility management (ISFM), including integrated use of improved seeds, mineral fertilizers, and organic inputs.

In the fertilizer sector, NSAF develops site-specific fertilizer recommendations for cereals and vegetables through digital soil maps (DSM). IFDC, through international experts, assists in the design and promotion of balanced fertilization strategies and extension packages that teach the 4Rs (right source, right rate, right time and right placement) of plant nutrient stewardship in Nepal. These inclusive activities, which strengthen the capacity of women and youth in agriculture, improve fertilizer use efficiency and crop productivity, and increase farmers' access to fertilizers through linkages with private-sector-led fertilizer supply systems.

NSAF activates linkages between farmers and agri-input suppliers so that farmers receive both the appropriate inputs and the correct technical information. NSAF's innovative extension tools include information and communications technology (ICT) platforms, such as SMS messaging, mobile applications, and digital vouchers for agricultural inputs, to raise farmers' awareness on the correct use of agricultural inputs, increasing efficiency of inputs.

NSAF links farmers with agribusiness, e.g., seed companies and feed millers, so that farmers can sell their products directly from the field without involving a

middleman. For example, NSAF strengthens agribusinesses' and agro-dealers' capacities to deliver technical messages to others in the agriculture value chain; one way this is accomplished is through the organizing of extension events such as technology demonstration plot visits and farmer field days.

RESULTS

Project impacts on sustainable development include:

Social: NSAF has disseminated good agricultural practices to 123,851 smallholder farmers, including 60,634 women farmers. At the field level, NSAF trained community volunteers on providing and disseminating technical services to farmers, which increased famers' trust in improved technologies and expedited technology dissemination. Of the total number of training participants, 49% were women. NSAF also trained other marginalized groups of farmers, including those from lower castes, those who were resource-poor, and youth.

Environmental: 24,750 farmers adopted climate-adaptive technologies, such as stress-tolerant crop varieties and climate-smart fertilizers, with the potential to mitigate greenhouse gas emissions.

Economic: Farmers adopted improved agricultural practices on 68,999 ha of land. Due to the increased yields from NSAF commodity crops (rice, maize, lentil, tomato, cauliflower and onion), the total annual profit (2020-21) was $59,801,991. Crop productivity increased by 10-30% due to adoption of improved agricultural practices. NSAF has also facilitated the Nepal Agricultural Research Council to develop Zn-enriched maize varieties, which supports the country's nutritional security.

Photo Credits: IFDC

SUCCESS AND LESSONS LEARNED

The improved agricultural practices promoted by the NSAF project effectively increased farmers' resilience to plant threats, improved crop productivity, and enhanced incomes, enabling them to more promptly respond to erratic climate events. Private sector involvement in subsidized fertilizer distribution has increased farmers' access to fertilizers.

Innovative extension strategies, including an ICT platform with digital vouchers for agricultural inputs, has increased adoption of the 4Rs of nutrient stewardship and has led to balanced fertilization.

NSAF's digital soil maps have become the foundation for soil fertility management, related research, and extension works. With project facilitation, the national research system has moved from a blanket approach to fertilizer management to a site-specific approach for new recommendations.

For commercial farmers, NSAF has developed a commercial model of maize cultivation that links farmers with feed millers, which ensures farmers that their crops will be sold at a fair price. Thanks to NSAF interventions, farmers can now sell their product directly to millers, avoiding middle-men or brokers. This could be a good future model for promoting the commercial production of crops.

Website:
https://ifdc.org/projects/feed-the-future-nepal-seed-and-fertilizer-nsaf-project/

From the Southernmost Rice Region in the World: Innovation Grows Climate-Smart Rice

At-a-glance

Objective: Rice growers increase sustainable productivity and profits by adopting innovative rice systems that precisely manage water and other inputs, reduce methane emissions, and increase rice output.
Lead countries/organization(s): Chile's National Agricultural Research Institution (INIA) and the Inter-American Institute for Cooperation on Agriculture (IICA)
Place: Central valley of Chile, regions of Maule and Ñuble

BACKGROUND AND OBJECTIVES

Rice is one of the most important staple grains; it is consumed around the world and feeds more than half the world's population. Profitable rice cultures today must survive on less land with less labor and more precise use of inputs such as fertilizer and water. Rice production must become more efficient, environmentally friendly and more equitable, while reducing methane emitted from production practices.

Conventional rice production requires significant amounts of water. A megadrought that has lasted more than a decade in the central valley of Chile, where the country's main rice production areas are located, threatens the agricultural sector. Climate change presents great challenges for productivity. The rice produced in the 25,000 hectares cultivated in Chile supplies only half of the national needs, and there are goals to produce more. However, production is threatened by water shortages.

To respond to these challenges, Chile's National Agricultural Research Institution (INIA) and the Inter-American Institute for Cooperation on Agriculture (IICA) have been working jointly since 2016 to help the growers of Maule and Ñuble – two rice-abundant regions in Chile – increase productivity by supporting innovations in the management of water resources and other elements of rice production.

ACTIONS

Over a decade ago, Chilean rice producers used traditional rice sowing methods, that required large amounts of water and fertilizer. When the region faced a historic drought that commenced in 2010 and continued through 2018, a group of rice growers worked with INIA and IICA in 2017 to analyze their water use. As a result, they switched to a new minimum tillage system and began using practices such as dry direct seeding – a method in which rice is planted directly into soil rather than transplanting seedlings into standing water.

These rice growers joined participatory research and innovation groups where they collaborate to learn sustainable processes. They regularly participate in training in genetics, weed control, irrigation, mechanization and monitoring for plant development.

The group establishes innovation plots where they pilot new crop varieties, water and soil management, and agricultural practices. The farmers tested a system that saves water up to 50%, called System of Rice Intensification (SRI). The success of SRI depends on the implementation of practices including changes in conventional production methods; the use of precise land leveling; suitable cultivars; good practices to establish young rice plants; improved water management; and effective and efficient weed and nutrient management. Implementation of SRI reduces the methane emissions of rice cultivation through alternate wetting and drying (AWD), in which fields are not under water constantly.

The methodology is coordinated by the INIA of Chile and the Inter-American Institute for Cooperation on Agriculture (IICA), as part of a project supported by the Foundation for Agricultural Innovation (FIA).

RESULTS

Project impacts on sustainable development include:

Social: Grower and participatory innovation groups discuss irrigation and temperature, data and measurements, monitor test costs, and analyze daily expenses to predict results.

Environmental: Using improved varieties, the rice matures earlier (120 days versus 165 days), requiring less water, (on average, 50% up to 60% using drip irrigation) and requires less agrochemical inputs. The reduction in water also produces less methane as this greenhouse gas forms during longer periods of water irrigation. With alternate wetting and drying, less water is required, and less methane is emitted.

Economic: By adopting climate-smart practices, rice production can become more resilient to climate variability and extreme weather events, leading to more stable yields. This stability helps maintain a steady supply of rice, reducing the volatility of food prices for consumers, as well as reducing the cost of production since less agrochemicals are used.

Photo: Rice growers in Chile examine rice from different plots of land using differing production practices.

SUCCESS AND LESSONS LEARNED

Fernando Barrera, an extension specialist for IICA in Chile, noted of the SRI process, “the key for success when proposing such a significant transformation is to co-innovate with farmers, learning and adjusting as we go along. We do this through participatory research and innovation groups, which have proven very important, because farmers participate actively alongside researchers and extension agents to identify problems, design solutions and participate in monitoring and evaluation.” Through co-innovation, growers can reduce exposure to risk and uncertainty and reduce the complexity of learning new practices by comparing results and learning from others. In addition, this method is based on principles rather than specific practices. This allows farmers to make the changes they feel comfortable with, observe results and continue to innovate over time rather than requiring they change all their practices at once.

The Maule and Ñuble regions of Chile provide concrete examples of the economic benefits of Climate-Smart Rice production. Through increased yields, reduced costs, lower emissions and improved community wellbeing, these regions illustrate how adopting sustainable agricultural practices can lead to significant economic and social gains. By adopting practices such as SRI, rice production in these regions of Chile serves as a model for sustainable rice production in other parts of Chile and the world.

Website:
https://ifdc.org/projects/feed-the-future-nepal-seed-and-fertilizer-nsaf-project/

Genetically Modified Crops & Carbon Sequestration in the Canadian Prairies

At-a-glance

Objective: To determine the relationship between farmer adoptions of herbicide-tolerant cropping systems beginning in 1995 and increased soil carbon sequestration from reductions in tillage and summerfallow.
Lead countries/organization(s): University of Saskatchewan, Department of Agricultural and Resource Economics, CropLife Canada & Research Chair Partners
Place: Saskatchewan, Canada

BACKGROUND AND OBJECTIVES

In the latter part of the 20th century, farmers began adopting sustainable management practices, including no-till and continuous cropping in place of frequent tillage and summerfallow. These changes have positively impacted the environmental footprint of crop production by decreasing greenhouse gas (GHG) emissions, improving soil quality, and improving soil carbon sequestration. Though previous research suggested that soil carbon storage would reach capacity 10-20 years after a change in land management, recent research indicates that through continuous sustainable management, soil organic carbon (SOC) levels can continue to increase beyond 20-30 years.

There is a complementary relationship between adoption of herbicide-tolerant (HT) canola and conservation tillage. Though improvements in equipment and input technologies play an important role, mounting evidence suggests that sustained land-use changes would not be possible without genetically modified (GM) HT crops.

Efficiently controlling weeds without damaging crops was challenging for farmers in the early 1990s. The introduction of GMHT cropping systems in 1995 allowed farmers to rely on more environmentally benign chemicals, such as glyphosate, reducing fossil fuel use and minimizing tillage and summerfallow, which contributed to reduced net GHG emissions.

The environmental contributions of farmer adoption of conservation cropping practices, and the role played by various technologies, are not often recognized in environmental policy discussions. Furthermore, discussions of the speculative risks surrounding these technologies sometimes outweigh their benefits. Thus, the objective of this research was to quantify how agricultural carbon sequestration has changed since reductions in tillage and summerfallow amid the introduction of GMHT crops in 1995.

ACTIONS

Data was collected through an online survey of Saskatchewan crop farmers between November 2020 and April 2021. The survey asked farmers about their land management practices during 1991–94, prior to the introduction of GMHT canola, and from 2016-19. Farmers provided details on their seeding, fertilizer, tillage, spraying, and harvest operations on one specific field in each year under study. An additional questionnaire asked farmers to comment on how the adoption of HT crops and glyphosate impacted changes in their land management practices.

The change in carbon sequestration was quantified using a carbon accounting framework adapted from the Prairie Crop Energy Model and using a specific equation. The emission factors included were developed by Agriculture and Agri-Food Canada for Canada's National GHG Inventory Reporting. Emission factors were separated into the semi-arid and subhumid regions of Saskatchewan based on climate and moisture conditions.

All soils were assumed to have equal sequestration potential. Due to the uncertainty in the interaction between carbon sequestration from reductions in tillage and from reductions in summerfallow, the resulting changes in SOC from the two practices were presented separately.

To estimate a range of economic values (in 2019 C$) for the change in SOC levels, four carbon pricing scenarios were applied: the Nori online carbon removal marketplace, the 2019 Canadian federal carbon tax, a cap-and-trade system modelled after Alberta's Emission Offset Registry, and the Canadian social cost of carbon (SCC).

1. Nori Carbon Marketplace: $19.86/tonne CO2 equivalent (t CO2e)

2. Carbon tax: $20/t CO2e
3. Cap-and-trade: $30/t CO2e
4. SCC: $45.89/t CO2e

RESULTS

The survey was successfully completed by 127 Saskatchewan farmers, 64 of whom farmed during 1991-94 and 126 who farmed during 2016-19. Survey results show that between 1991-94 and 2016-19, summerfallow management decreased from 44% of hectares to 1%. No-till (NT) management increased from 14% to 55% of hectares, minimum tillage (MT) increased from 35% to 42%, and conventional tillage (CT) decreased from 51% to 3%.

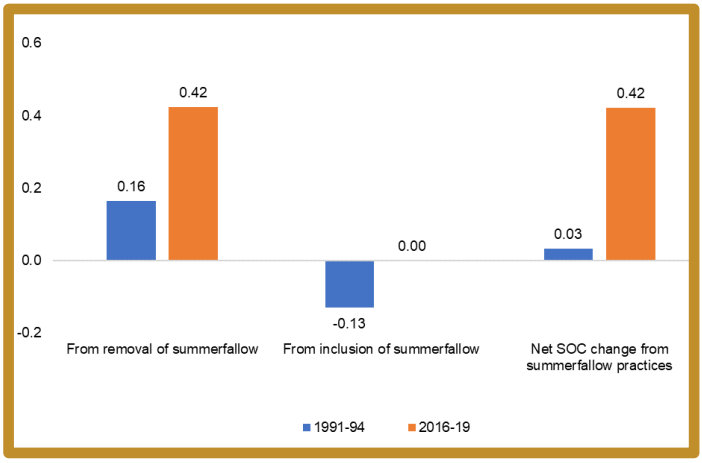
Social: On a scale from 1-10, with 10 being the highest, to what extent various technologies contributed to farmer reductions in tillage and summerfallow practices, glyphosate and HT canola received average contribution factors of 9 and 7.3, respectively. Participants commonly reported that without HT crops, changes would occur in their chemical use (30% of participants), yield and profitability (27%), tillage (20%), and summerfallow (11%). In the absence of glyphosate, 54% and 14% of participants would increase their tillage and summer fallow practices, respectively, while 4% indicated they would no longer be farming. The combined effect of reduced yields and increased inputs (chemical use and fuel) would negatively impact farmer livelihoods.

Environmental: In 1991-94, Saskatchewan soils were releasing 0.02 Mg carbon per ha, per year (C/ha/yr) from tillage. By 2016-19, adoptions of NT and MT resulted in SOC levels increasing by 0.12 Mg/ha/yr. Changes in SOC levels from reductions in summerfallow were negligible (0.03 Mg/ha/yr) in 1991-94, as summerfallow was still practiced on roughly 50% of hectares. By 2016-19, the virtual elimination of summerfallow resulted in SOC levels increasing by 0.42 Mg/ha/yr. The impact of reduced tillage and summerfallow has significantly reduced net greenhouse gas emissions. While not the focus of this paper, the additional reduction in fuel use, as a result of reduced tillage, further contributes to overall farm benefit.

Economic: The increase in annual carbon sequestration between 1991-94 and 2016-19 resulting from reductions in farmer tillage practices is valued between $9.99-$23.07/ha. From the virtual elimination of summerfallow in Saskatchewan between 1991-94 and 2016-19, the increase in annual carbon sequestration is valued between $28.24-$65.24/ha. Based on the average Saskatchewan farmer's annual carbon tax expense of $4.30/ha, the value of annual carbon sequestration in 2016-19 ($30.67-$70.87/ha) represents 201-465% of a farmer's annual carbon tax costs.

SUCCESS AND LESSONS LEARNED

Saskatchewan farmers' changes in soil and land management since 1995 were facilitated by adoptions of GMHT crops and their complementary chemicals. The opportunity for improved weed control helped farmers minimize tillage and summerfallow practices, reducing net GHG emissions through improved carbon sequestration. The economic value of the carbon sequestration is significant, representing at least double farmers' average annual carbon tax expense.



Change in SOC from changes in summerfallow practices (Mg/ha/yr)

Total emissions were not examined in this analysis, and therefore the results cannot comment on changes in net crop production emissions. However, they highlight the importance of including net carbon sinks as well as sources in emission calculations. Through the adoption of sustainable management practices, Saskatchewan crop farmers are reducing the carbon footprint of their operations by up to 8.2 million Mg/yr, contributing to Canada's climate objectives.

This research confirms the contributions to improving agricultural sustainability made by GM crops and glyphosate. It also provides insights into the challenges of reducing emissions facing jurisdictions with restrictions on the use of these technologies.

Website:

https://doi.org/10.3390/su132111679

Improving Crop Yields in Organic Farming

At-a-glance

Objective: To contribute to a sustainable yield increase of organic cropping systems in the EU.
Lead countries/organization(s): FIBL Europe – Forschungsinstitut für Biologische Landbau in Europa
Place: Belgium, Portugal, Italy, Estonia, Luxemburg, Danmark, Sweden, France, Poland, Hungary, Germany, Switzerland, Spain

BACKGROUND AND OBJECTIVES

With the Farm to Fork strategy and the Organic Action Plan, the EU aims to achieve the target of at least 25% of the EU's agricultural land under organic farming by 2030. This means tripling the current organic farm area. One of the obstacles hindering conversion to organic farming is the lower yields per hectare grown under organic conditions as compared with those produced under conventional farming. Therefore, improving organic yields is a key challenge of the organic sector, which however needs to be achieved on the basis of the principles of organic farming

Against this background, the overall aim of the project is to contribute to a sustainable increase of yields in organic cropping systems through a comprehensive and structured compilation and evaluation of existing knowledge, devising sustainable impact strategies relevant to stakeholders and policy. The project will set up a European-wide network of testing, experimentation and demonstration sites from 11 regions / countries, representing a wide range of pedo-climatic and structural conditions. It will connect actors from science and practice to jointly reflect on organic yield increase strategies. It will draw recommendations for the future research agenda and development of EU policies relevant for organic production. The outcomes of the project will be widely available and disseminated to actors within and beyond the organic community.

ACTIONS

Compile existing data and knowledge related to crop yield enhancing strategies within organic farming across Europe. Elaboration of a common database template, which will be sourced by a review of on-site and off-site scientific studies and relevant datasets from Europe and countries with similar climate zones.

Analyse and define the suitability and potential of relevant strategies and approaches taking into account (a) the standard deviation range and stability of the yield achievable for each major crop, (b) the relevance of the pedoclimatic conditions and (c) the management practices and technical constraints limiting the yield. Moreover, economic and environmental impacts will be assessed. These results will be validated and contextualized to identify similarities and differences across crops and environments. In addition, exchanges on knowledge and best practices will be stimulated through workshops with practitioners and field visits.

Codesign strategies for the improvement of yields in organic cropping systems, complemented with crop-model estimates of future yield potential for organic agriculture in the EU under various climate scenarios. This includes the assessment of the environmental and economic performance of organic farming systems at EU level.

Recommend a research and innovation roadmap, and provide reasoned advice to improve EU organic farming and related CAP policy measures.

Share the project results by using different communication tools and advisory activities, the development of practical guidelines and the provision of an updated decision-support tool for farmers.

RESULTS

Project impacts on sustainable development include:

Social: Organizing workshops with practitioners, visits to ‘lighthouse farms’, and cross-visits of the groups across regions will allow for rapid knowledge exchange, networking and co-design of strategies for yield improvements and resilience. These moments are key to raise awareness and acceptance of the strategies and approaches developed in this project. Within these strategies, special attention will be devoted to aspects of labour requirements and workers risks.

Environmental: Defining the impact of the yield-increasing strategies and approaches in terms of greenhouse gas emissions and mitigation potential, fossil energy dependance, nutrient use, soil health and circularity.

Economic: Providing strategies and pathways to close the gap between organic and conventional farming in terms of yield and economic performance, at farm level, while giving recommendations to the broader EU policy framework.

SUCCESS AND LESSONS LEARNED

As data on organic farming is scattered around Europe, a comprehensive database on research and innovation activities that deal with crop yields in organic farming would be a great achievement.

Practical guidelines on the strategies, complemented by a science-based assessment of the social, environmental and economic impact to increase the uptake and lower the barriers to changing farm practices would be a step forward.

After the life-time of the project, a concept note and action plan should be co-developed for consolidating and sustaining the cooperation as a “network of Living Labs for increasing yields in organic farming” in order to preserve and continue building on current experience.

Website:

https://cordis.europa.eu/project/id/101137068

Master Farmers Program to Enhance Uptake of Dual-Purpose Millet and Cowpea Seeds in Senegal

At-a-glance

Objective: To use the Master Farmers program to showcase the benefits and expand uptake of newly released innovative dual-purpose millet and cowpea seed varieties that are more productive and nutritious than traditional varieties.
Lead countries/organization(s): U.S. Feed the Future Sustainable Intensification Lab (SIIL), ISRA, Cornell University
Place: Senegal

BACKGROUND AND OBJECTIVES

Scientists have bred millet and cowpea seeds to be dual-purpose, i.e., they simultaneously produce more quality grain for human consumption and stay green at maturity providing more quality fodder for livestock. In addition, these dual-purpose crops are more drought-resistant and nutrient-dense; and most crucially, farmers can grow them on the same plot of land, at the same time. Scientists have also improved the agronomy of crop production of the improved varieties, increasing planting densities to nearly double with appropriate fertilizer use thereby supporting even greater productivity and profitability with reduced labor requirements due to crowding out weeds.

With dual-purpose seeds, paired with improved field crop production and soil management, there is no need to cultivate multiple plots for each use, which saves farmers time, labor and land, which is key at a time when the Senegalese population is growing, land degradation is worsening due to climate change, and farmland is being lost to the construction of buildings and roads. Using dual-purpose seed varieties is crucial to maintaining and increasing agricultural production, feeding people and animals, and spending less money on food imports.

ACTIONS

Despite their many benefits, dual-purpose seeds face the same huddles as other innovations when it comes to successful dissemination and uptake by farmers. Farmers are often reluctant to experiment with new technologies and approaches when their families' food security and livelihoods are at stake. The Senegal Master Farmers program is an example of how innovations in seed technology can be disseminated to local communities. The program's objectives include:

- Demonstrating and adapting the best technologies for gardening, field crops, agroforestry, nutrition, and agribusiness;
- Establishing decentralized training centers for farmers;
- Creating decentralized sources of plant materials and seeds.

The Senegal Master Farmers program worked with local farmers creating demonstration plots ranging from 0.5 to 1 hectare of land. Farmers were provided with dual-purpose millet and cowpea seed in addition to farming equipment and other inputs. The Master Farmer program included 20 women and 60 men, with one Master Farmer under 25 years old and nine under 30.

The Master Farmers focus on organic production and mainly use manure or compost to amend their soil. If they needed to use chemical fertilizers, they were provided with best practices such as conservation farming or deep placement of urea techniques. Farmers in the program were informed about other techniques to include proper spacing, timely weeding and thinning, and timely harvesting, etc.

To amplify and disperse the information and knowledge gained from the Master Farmer's program, agricultural demonstrations called Open Field Days (OFD) were organized for farmers in the village and neighboring villages. During the OFDs, farmers saw and learned about the improved farming and agroforestry practices implemented by the Master Farmers, and some farmers were provided with planting material such as seeds, orange-fleshed sweet potato cuttings, scions or fruit tree seedlings, etc. Other farmers adopted the improved farming practices implemented by the Master Farmers, and some farmers have replicated parts, or all, of the program.

RESULTS

Project impacts on sustainable development include:

Social: In addition to benefitting their own farms and households, farmers trained under the program shared their knowledge and training with neighbors during Open Field Days which amplified the distribution of knowledge and techniques to multiple villages. The program was inclusive with women and youth farmers included in the projects. The higher grain yields helped farmers to better feed their families and sell their extra bounty to local buyers, generating additional revenue for investments such as building sturdier homes.

Economic: The dual-purpose millet and cowpea seeds produced more quality grain and more quality livestock feed, allowing the farmers to make more profit and better provide for their families on the same area of land. The dual-purpose seeds can produce up to three tons per 2.5 acres per year, while typical seed varieties produce less than one ton on the same acreage. This can generate hundreds more dollars for farmers. In addition, the dual-purpose cowpea seeds yielded ripe plants in less than 45 days, compared to approximately 60 days for maturation. Such reduction of crop life cycle is critical in the current climate change environment. In addition to enhancing geographical land cultivation of the crop, cowpea varieties are recognized as a strategic crop that mature in the heart of the rainy season when millet and peanut are not mature. This allows women to harvest every day 2- 3 kg of cowpea to sell in the local market and buy rice or other commodities to cook for the family and then prevent against hunger.

Environmental: Cowpea is a short-cycle crop that's well-adapted to erratic rainfall, extreme heat and nutrient-deficient soils. The leaves and stems of the plant are also used as animal feed, and when farmers plant both dual-purpose seed varieties on the same plot, or "intercropping," their increased plant density shade the soil faster, reducing evaporation of precious water from the soil and reducing weed growth. More importantly, cowpea is also a nitrogen fixing crop able to fix up to 150kg of N per ha. Its cultivation is important on reducing mineral fertilizer use which negatively impact the environment.

SUCCESS AND LESSONS LEARNED

In addition to the dual-purpose see varieties, another success of the program can be attributed to the farmers who agreed to try the demonstrations on the good land they were using for their other crops. Sometimes, when introducing an innovation, farmers try it out on their poorest land and don't pay much attention to it. Another success came from the farmers who agreed to follow the advice in terms of improved farming practices (planting on time, spacing, weeding on time, organic pest management, harvesting on time, etc.). Field visits during the rainy season and calls to ensure that the farming practices were implemented on time were also part of the success.

A modification to future demonstrations could be to select a Master Farmer and another farmer from the same village who is not taking part in the program and carry out demonstrations to compare what each of them will harvest.

Photo Credit: Doudou Diouf/Feed the Future Innovation Lab for Collaborative Research on Sustainable Intensification

Pakistan Agricultural Development: Improving Sustainable Agricultural Production and Expanding Access to Horticultural Markets

At-a-glance

Objective: To improve sustainable productivity growth and expand market access in four horticulture value chains: red chili, tomato, dates, and banana.
Lead countries/organization(s): U.S. Department of Agriculture and Winrock International
Place: Punjab and Sindh provinces of Pakistan

BACKGROUND AND OBJECTIVES

Agriculture is the largest sector of Pakistan's economy, accounting for 24% of GDP, and together with agro-based products, accounts for 80% of the country's total export earnings. Half of the country's labor force is engaged in this sector. Horticulture is a vital sub-sector of agriculture. Pakistan is the fourth largest producer of dates and red chili in the world. Despite their economic potential, both crops face challenges due to climate change and other stressors.

Climate change is a persistent threat to horticultural production in Pakistan – flooding and drought affect crop yields and quality, which in turn impacts the incomes of farmers and businesses. In 2022, extreme temperatures followed by unprecedented monsoon rains inflicted major damage to crops and agricultural infrastructure across Sindh, a southeastern region of Pakistan. Climate change impacts are further compounded by challenges related to standards compliance, farm management, storage, and marketing. As a result, 25% to 40% of horticultural crops grown in Pakistan are lost due to mishandling, spoilage, or pest infestation. Smallholder farmers, particularly women, are most severely affected by post-harvest losses due to lack of resources, lack of access to credit, and poor extension services. Women farmers often do not have control of resources and farm-level decision-making. Additionally, losses due to weather, market inefficiencies, or infrastructure failure directly impact smallholder incomes.

ACTIONS

The Pakistan Agriculture Development (PAD) project is an ongoing multi-year program (September 2016 to March 2024) implemented by Winrock International and funded by the Food for Progress Program of the United States Department of Agriculture (USDA). PAD focuses on the strategic value chain development of four horticulture crops, including dates, banana, tomato, and red chili in 12 priority districts of the Sindh and Punjab provinces of Pakistan.

To improve agricultural productivity and product quality, the project partners with the private sector to provide farmers with training and services that encourage the adoption of improved agricultural production and post-harvest technologies and practices. Trainings take place on demonstration sites where farmers are invited during critical stages of the production cycle to observe firsthand the outcomes of improved practices on yields and quality. Technologies include chili drying on raised platforms, soil nutrition management based on soil analysis for tomato, and solar drying for dates, to name a few.

PAD also works to expand farmer access to financial services, grants, and improved market information, as well as activities that facilitate access to new markets for farmers and firms. PAD actively tests and promotes the adoption of Good Agricultural Practices (GAP) and new technologies through market channels. The project follows a private sector-led training model, similar to farmer field school, in which partners market their products and services while imparting embedded information, training, and services to farmers. Training partners identify host farmers and establish demonstration plots via a cost-share model (i.e. 50% PAD, 25% partner, 25% host farmer). This reduces the risk for host farmers and motivates them to innovate.

Additionally, a series of training sessions for farmers focus on real-time practical demonstrations of good agricultural practices that showcase results. Visiting farmers get a first-hand account of how impactful the techniques are and learn how they can replicate these on their farms in the following season. This model also promotes market linkages between the farmers and agri-

input suppliers and buyers. As a result, private sector businesses expand while assuring farmer access to high quality inputs and services.

The project uses WhatsApp to regularly update PAD trained farmers on important news and new techniques and tools. The team also shares various refresher contents from the training in advance of the crop season so that farmers are reminded about the recommendations provided to them on the training days. Through this forum, testimonials of past farmers who had significant success can also be shared.

In 2020, to address concerns related to climate change and the environmental impacts of agricultural production on water use, the project partnered with a private firm to install 38 high efficiency drip irrigation systems on red chili farms in Sindh and 10 in Punjab.

RESULTS

As of September 2022, PAD had reached approximately 41,321 direct beneficiaries including: 37,226 producers/workers (34,444 male, 2,782 female), 79 agro-dealers and suppliers, and 115 traders. PAD has trained a total of 34,172 individuals on production techniques and post-harvest methods (with a project goal of about 49,107 trained). PAD targets small and medium-sized farmers who constitute the largest group of agricultural producers in the project areas.

Due to the adoption of GAP and new technologies, banana farmers are producing one kg extra weight per bunch and have increased prices of PKR 1.25-3.75 per kg (PKR 1,250-3,750 per MT). Chili and tomato farmers who participated in training on nursery raising reported an average cost savings of PKR 35,000 and PKR 22,000 per acre, respectively. 67% of chili farmers also reported that their yields of dry chili doubled from 2 to 4 MT per acre in some cases, while half of tomato farmers reported yield increases from 2.4 MT to 4 MT per acre.

Social: Through an inclusive approach, the project is building the capacity of smallholders and women, thereby helping to support economic development of historically marginalized groups. Smallholder farmers in Pakistan are generally overshadowed by larger and more influential growers operating in clusters. These growers capture most of the benefits from development projects implemented by NGOs. PAD, in line with its selection criteria, promotes the selection of smallholder farmers by putting a cap on landholding. This ensures inclusivity and equal distribution of benefits of the project interventions among diverse members of the farming community. By working with these farmers to scale, PAD can also motivate the private sector to develop and pilot specific technologies and services that cater to their needs. This is important for opening new market segments.

Environmental: The high efficiency irrigation systems, combined with GAP, resulted in a 51% savings in water costs, a 53% savings in nutrient costs, and a 37% savings in pest management costs. The use of drip irrigation addresses critical water scarcity issues while maintaining profitable returns for producers. The project is currently on track to meet its target of 35,480 farmers applying improved farming practices over 136,000 hectares.

Economic: So far, 37,000 beneficiaries of the project have reported more than $792.2 million in combined sales of chili, tomato, dates, and bananas, leading to improved incomes for many small and medium farmers in the target areas. The project is on track to meet its projected result of $3,165,000 of new private sector investment in the agricultural sector.

SUCCESS AND LESSONS LEARNED

The project has demonstrated that the private sector-led approach to training and service provision can accelerate the uptake of GAP and increase the resilience of farmers and firms to climate change.

One important lesson learned from PAD's mid-term review pertained to the constraints posed by input costs for GAP uptake and educational barriers. For instance, many date farmers said that despite appreciating the harvest and post-harvest methods taught in the training, they were not able to apply the techniques due to difficulty in organizing human, financial, and logistical resources during the very short harvest season. Moreover, availability and cost of inputs such as harvesting ladders and baskets as well as trained labor were also cited as a hurdle by date farmers. Many farmers expressed the need for input grants or other resources.

Programs that complement training with resources and advisory support, such as the drip irrigation systems, plug trays, and storage bags supplied through the private sector under the PAD project, will likely have larger impacts than training alone in many cases.

Website:
www.winrock.org/project/PAD

Perennial Cover Crops: Enhancing Productivity & Sustainability

At-a-glance

Objective: To develop models for sustainable supply chains that create markets for crops farmers can grow between seasons.
Lead countries/organization(s): The University of Minnesota, Foundation for Food and Agriculture Research
Place: Minnesota and regionally, with pilot supply chain projects underway in Minnesota, Kansas, Wisconsin, and Montana

BACKGROUND AND OBJECTIVES

Summer crops such as wheat, rice, and corn can be profitable for farmers, but post-harvest farmland is unproductive for several months during the off-season. This unproductive farmland can accumulate a variety of water-related challenges, including soil nutrient loss, erosion, and precipitation runoff. However, continuous living cover crops can prevent these challenges.

While popular cover crops can be used as food or as inputs in other products, there are currently no large markets for them. The Foundation for Food & Agriculture Research (FFAR) is funding research to increase the use of cover crops – and reap the environmental benefits – by creating a sustainable market with consistent buyers for these crops.

Planting continuous living cover crops, such as intermediate wheatgrass, winter camelina, pennycress, winter barley, and hybrid hazelnut, has numerous environmental benefits. These perennials, which do not require replanting, and winter-hardy annual crops, decrease fertilizer runoff to surface and groundwater and increase farmland's ability to absorb and hold rainfall. Croplands that better retain water can reduce soil erosion and prevent downstream flooding of cities and infrastructure. However, farmers are often hesitant to plant these crops because most are not widely used commercially, making farming and supply chain logistics risky or cost prohibitive.

Most importantly, sustainable supply chains link on-farm crop production to end-use markets in economically, environmentally, and socially beneficial ways.

ACTIONS

FFAR awarded a $1.9 million grant to the University of Minnesota to develop models for sustainable supply chains that create markets for crops that farmers can grow between seasons.

University of Minnesota researchers are working with cross-sector partners to develop and scale sustainable supply chains for continuous living cover crops. Researchers are conducting six regional pilot projects to determine appropriate crops for various sites and growing conditions. This research involves examining potential markets, water management needs, and other environmental and social benefits of perennials and cover crops. The multi-level strategy will lead to a larger supply-and-demand system for a wider adoption of cover crops.

The project involves interviews and focus groups between growers, end-user companies, and other stakeholders addressing water management and environmental concerns. The planning process identified how to integrate production with post-product supply chain infrastructure and how to connect farmers with private-sector firms interested in purchasing continuous living cover crops for commercial use.

The project builds upon a previously awarded FFAR grant to the University of Minnesota in 2020 aimed at accelerating the development of intermediate wheatgrass, trademarked as Kernza® by The Land Institute. A perennial plant, Kernza® is a nutritious grain commercially used in some small niche market health foods and products such as bread, cookies, and beer. However, challenges surrounding this crop, including its production cost and decreased yield over time, prevent widespread adoption. University of Minnesota researchers are developing techniques to speed breed high-yield and disease-resistant varieties of Kernza® to replace some of the annual grains, while bringing added environmental benefits to growers.

RESULTS

Robust supply chains that link supply to demand are key to farmer adoption of continuous living cover crops and to realizing the social, environmental, and economic benefits that these crops offer. These benefits include:

Social: The results of this research provide a path for Kernza® and other perennials to become resilient, inexpensive crops that meet the needs of growing populations – and still provide some of the same nutritional benefits as other annual grains. The research has focused on two aspects, one, building a sustainable supply chain development and scaling system that uses emerging "best practice" principles for collaborative groups, and, two, developing a Learning and Experimentation Network (LEN) of actors working on the ground. In each pilot project location, a cluster of growers are provided financial assistance for piloting Kernza® production. The Economic and Environmental Clusters of Opportunity system, which was originated by the project, is designed to incentivize Kernza® production by coupling model-based environmental benefit payments and outcomes-based risk management payments. This combination of payments recognizes both the value to the public in reducing negative externalities that private markets tend to overlook or under-value and the risk of bringing novel crops into farm operations, offering a safety net to growers. Other initiatives include a novel production cooperative (the Perennial Promise Growers Cooperative), a new "steward ownership" structure to hold crop intellectual property for public good through the Kernza® Stewardship Alliance, and a new public funding program in Minnesota that provides seed capital for start-up supply-chain enterprises.

Environmental: The proposed structure for the sustainable supply chain development and scaling system is replicable and designed to advance scaling of new crops that offer a market-driven pathway to enhancing water resources. The research team expects improved varieties to yield more while withstanding environmental variables, thereby improving upon its current footprint as an important perennial cover crop.

Economic: Research will provide growers the data that shows the financial benefits of cover crops. The Kernza® project, for example, seeks to improve agronomic traits of Kernza to increase the profitability of this cover crop for growers by making its yield competitive with the currently grown grain crops. This project will better define supply chain opportunities, including examining potential markets for growers of environmentally important cover crops.

SUCCESS AND LESSONS LEARNED

The greatest successes so far are an improved understanding of trait genetics followed by population development, made possible by application of breeding tools such as refined genome assembly, genomic prediction, and gene discovery. Routine application of high-throughput sequencing technology in genotyping the breeding population has allowed for discovery of abundant genomic markers, which are used in numerous applications, including the creation of future Kernza® varieties.

Additionally, this research has also developed a cross-scale network that can build and scale up new supply chains that link on-farm production and end-use markets for novel crops. Creating market incentives to produce continuous living cover crops may increase farmer incentive to produce more of these environmentally beneficial crops, and ultimately improve water resource management. This research has brought together broad cross-sector coalitions to advance climate-smart commodities. Through this investment, the agriculture sector is better positioned to mitigate and adapt to climate change.

Broader impacts have included a successful policy initiative in Minnesota by the project's sustainable supply chain development and scaling network, in which bipartisan legislative support was obtained for a pilot "CLC Value Chain Development Fund," initially funded by the State at $400,000 per year. This fund focuses on grants to organizations in Minnesota to develop enterprises, supply chains, and markets for continuous living cover crops in the early stage of commercial development.

In addition, project personnel participated in two recent proposals to the USDA's Partnerships for Climate-Smart Commodities funding program, with total budgets exceeding $70 million between the two projects. The concept for scaling supply chains for emerging crops that were advanced in this project's first year were integral to both project proposals.

Website:
https://forevergreen.umn.edu/

Protected Cropping Systems in the Pacific

At-a-glance

Objective: To strengthen production of high-value vegetables through protected cropping systems.
Lead countries/organization(s): Australian Centre for International Agricultural Research, CQUniversity Australia, Pacific Community
Place: Fiji, Samoa, Tonga, Australia

BACKGROUND AND OBJECTIVES

Vegetable crop production in the Pacific Island countries of Fiji, Samoa, and Tonga is largely conducted by smallholders who are only able to produce crops for part of the year due to high precipitation damage in the wet season and lack of water in the dry season. Off-season vegetable availability is low, and prices are high as the production shortfall is supplied by imports. This restricts population access to fresh vegetables, which are needed to maintain healthy diets, and limits farmers' capacity to engage high-value markets, such as tourist resorts, which require a year-round supply of quality produce.

Low-cost protective cropping structures (rain shelters such as walk-in tunnels and small greenhouses) can effectively and economically overcome many off-season vegetable production challenges. The Australian Centre for International Agricultural Research, CQUniversity Australia, and Pacific Community partnered together to assess a range of protected cropping technologies suitable for smallholders. Structure designs and materials as well as crop agronomic practices and business and marketing strategies for specific crops, environmental constraints, farming systems scenarios, and target markets were evaluated.

ACTIONS

A survey of existing structures found that many were not in use. The structure itself is only one part of the protected cropping system, and often the other components (e.g. agronomy and marketing strategies) are not considered in enough detail by farmers entering protected cropping. This was particularly evident where previous aid programs had donated structures to farmers.

An analogy, based on the stability of the culturally significant kava bowl used in Pacific Island countries, was used to promote a protected cropping training program. The four legs holding up the bowl represent the physical infrastructure (the greenhouse design, materials and associated equipment used in production), the crop agronomy (management of the crop, including varietal selection, pruning, training, irrigation and fertilizer use), management of pests and diseases, and the value chains linking production to market. Training in all four areas was delivered to farmers adopting protected cropping systems.

Demonstration farms were set up with low-cost, passively ventilated structures that could be disassembled in a short time, a useful design feature when a cyclone event is predicted to occur. Data on the production environment, input costs, and crop yields were collected.

The potential impact of increased availability of vegetables on the diets of smallholder farming families and village members was assessed using a household dietary diversity survey. The need for promotion of healthy diets as a component of the agricultural production system development was essential to reduce the risk of unintended dietary changes linked to increasing income from adoption of protected cropping.

RESULTS

Protected cropping has been successfully introduced as a production system suitable for high-value vegetables in Pacific Island countries. Farming communities adopting the system have benefitted through new income opportunities and improved access to fresh produce.

Social: Households that used protected cropping were able to generate increased income from produce sales and had access to a higher diversity of vegetables, both of which were shown to increase the likelihood of having improved dietary diversity. The high prevalence of diet-linked noncommunicable diseases in the Pacific Island countries underscores the importance of increasing dietary diversity, particularly through vegetable consumption.

Environmental: Inclusion of Integrated Pest Management (IPM) approaches in protected cropping has allowed increased production compared to field-grown crops, and without the need for higher use of chemicals that may adversely impact the environment.

Economic: Crops grown via protected cropping out-yielded field-grown crops by 2-3 times and generated a higher proportion of quality produce acceptable to high-value markets. Working together, farmer collectives were able to deal directly with resorts to supply them with vegetables at prices higher than they would receive in the urban markets during peak production season. When COVID-19 shut down the resort market, the growers successfully pivoted to supplying urban markets in the off season and achieved sales that encouraged further investment into their protected cropping activities.

A training program capturing project results has been developed with agricultural ministry staff in partner countries. The information has been compiled into a training manual, which is now being used by staff to develop and administer their own set of training activities for local farmers. Building the local capacity, knowledge, and ownership of the training program has developed momentum for future growth in the area of protected cropping in the Pacific.

SUCCESS AND LESSONS LEARNED

The successes in establishment of sustainable protected cropping operations with smallholder farmers was due to the participatory approach that ensured farmers, communities, government ministry staff, and researchers were all engaged in guiding project developments.

- Providing local relevance: Use of the kava bowl analogy to assist farmers in understanding the importance of all aspects of the production system was a valuable strategy, creating a point of reference for them to remember key areas of information needed to succeed in protected cropping.
- Local farming system integration: Unique social and cultural aspects of local production systems needed to be understood and respected in development and implementation of project activities, with new knowledge being integrated into existing practices in a production system that worked for the farmers.
- Unintended consequences: Analysis of dietary diversity highlighted that while protected cropping has the potential to improve the dietary situation in farming communities, education about diet was needed to ensure increasing income did not result in a transition to purchasing of processed food products with low nutritional value.

Website:
http://www.aciar.gov.au/project/hort-2014-080

Save and Grow: Climate-Resilient Cropping Systems

At-a-glance

Objective: To advance climate-smart crop production for maize and rice.
Lead countries/organization(s): FAO funding from the German Federal Ministry of Food and Agriculture
Place: Sri Lanka and Zambia

BACKGROUND AND OBJECTIVES

Small family farmers produce a third of the world's food, yet they are the most vulnerable to the effects of climate change. Given their vulnerability, smallholder crop production can often be unprofitable and environmentally unsustainable.

FAO's Plant Production and Protection Division – with funding from the German Federal Ministry of Food and Agriculture – is working to advance climate-smart crop production with a focus on maize in subtropical climates of Zambia, and rice-based crop systems in tropical climates of Sri Lanka. This project aimed to assist small-scale farmers in Sri Lanka and Zambia to overcome challenges to the adoption of sustainable crop production practices through the implementation of Save and Grow practices.

The project identified the following areas as key constraints farmers face: (i) inadequate knowledge of sustainable agronomy and of its benefits; (ii) inadequate market linkages, limiting the availability of sustainable agronomic inputs and mechanization services; and (iii) inadequate market linkages for the sale of crop yields.

The Save and Grow approach, promoted by FAO, is a means of intensifying sustainable crop production and comprises agronomic practices that leverage ecosystem services, resulting in increased crop yields while simultaneously preserving financial and natural resources.

ACTIONS

In Sri Lanka, with the adoption of the Save and Grow approach, smallholder farmers optimized their water, fertilizers, and labor use, ultimately transitioning to a more sustainable farming system. In the lowlands, by starting field operations at the beginning of the rainy season, farmers capitalized on rain water and didn't need to use irrigation water. Farmers were trained on using leaf color charts and how to assess the actual needs of crops throughout the growing season. They were also trained on the use of cover crops in the fallow season to diversify production and mitigate weeds as well as the use of parachute trays – which help transplant plantlets – enabling them to apply fertilizer more precisely. This resulted in higher yields and less waste.

In Zambia, an econometric analysis captured the interactions between crop production, the environment, and the influence of agricultural policies. The project aimed to prioritize policies such as fertilizer subsidies and varieties distribution to target field level solutions, including the diversification of crop rotation and use of green manure cover crops to increase the income and standard of living of smallholder farmers sustainably. In addition to crop rotation and cover crop use, farmers were trained on mechanization operation for reduced labor and increased yields.

RESULTS

Project impacts on sustainable development include:

Social: By improving smallholder farmers' agronomic practices and providing access to inputs, technical advice, and credit among services through agri-business hubs, these two projects helped farmers improve resilience of crop systems to specific climate stressors and reduce yield gaps. Improved resilience ultimately leads to increased yields, helping to maintain food security in communities.

Environmental: In Sri Lanka, 20% of the total irrigation requirement saved for rice cultivation in the main season allowed farmers to use conserved water in the next cropping season. This resulted in 15% more land being irrigated in the dry season thanks to the water saved in the main season. In addition, fertilizer use was reduced by 27% as a result of cover crops, leaf color charts, and parachute trays which enabled farmers to apply fertilizer more precisely. Excess fertilizers can wash off and pollute the surrounding environment.

Economic: In Zambia, there was a 25% increase in crop yields thanks to the application of climate-smart agronomic practices, such as cover crop planting. Additionally, smallholder farmers who applied mechanical planting produced up to 36% higher yields. Higher yields increased farmers' income and standard of living.

Photo Credits: Asanga Ranasinghe

SUCCESS AND LESSONS LEARNED

The Save and Grow approach simultaneously addresses environmental and economic sustainability, while remaining replicable and scalable. The outcomes of these projects contributed to the guide co-developed with The World Bank, "Decarbonization of Air, Recarbonization of Landscapes – Climate-smart Rice."

An important lesson learned is that a climate-smart crop system requires quality seeds, diverse crops, sustainable no-till mechanization for soil and water conservation, and renewed capacities. Additionally, linking farmers to markets creates traction for sustainable agriculture. Sustainably intensifying agriculture on existing land and protecting natural areas preserves biodiversity and cuts emissions from land-use change.

Websites:

https://www.fao.org/in-action/save-grow-climate-smart/en/

https://openknowledge.fao.org/server/api/core/bitstreams/de93a3e8-3b29-4e8a-85e6-0033179723b0/content

Sustainable Control of Fall Armyworm: Native Genetic Resistance in Maize

At-a-glance

Objective: To develop and deploy elite, climate-resilient maize hybrids with native genetic resistance to Fall Armyworm (FAW) in sub-Saharan Africa as a part of an integrated pest management strategy.
Lead countries/organization(s): CIMMYT and NARES Partner Institutions in Eastern and Southern Africa
Place: Sub-Saharan Africa

BACKGROUND AND OBJECTIVES

The emergence of the fall armyworm (FAW; *Spodoptera frugiperda*) pest in sub-Saharan Africa (SSA) in 2016 has caused devastating effects on maize crops and put at risk the food security and livelihoods of millions of African smallholders. FAW has since become an endemic pest in nearly all of SSA. Together with challenges such as drought, floods, conflicts, and economic crises, the negative effects of FAW on smallholder farmers' livelihoods have exacerbated the region's food insecurity.

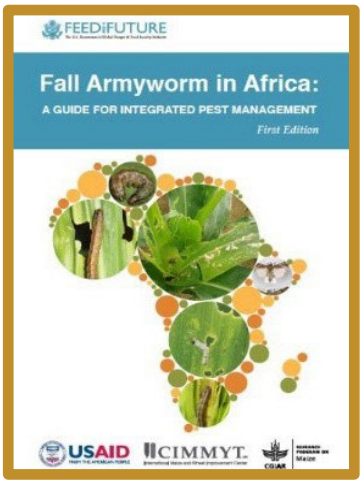
Host plant resistance to FAW is an important component of the integrated pest management (IPM) framework for FAW management. However, elite maize varieties with native genetic resistance to FAW are unavailable to farmers in SSA. Synthetic pesticides, especially when used without proper personal protective equipment, pose a serious threat to human health and to the environment, and in the long-term, can adversely affect the natural parasites and predators of the pest. Elite maize varieties with climate resilience and native genetic resistance to FAW will not only reduce farmers' dependence on synthetic pesticides, but will also contribute to positive health and economic outcomes for smallholder farmers and their families. When used in conjunction with other IPM tactics, host plant resistance results in a sustainable and long-term control of the pest.

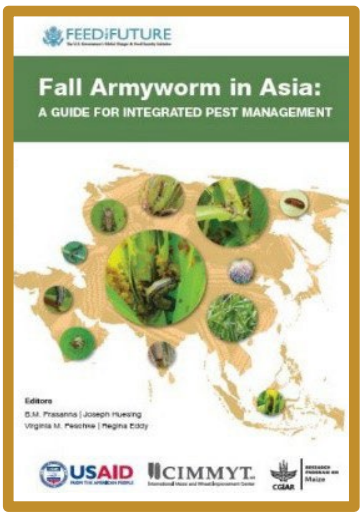
The primary objective of the project is to develop and deploy FAW-tolerant and climate-resilient elite maize hybrids (based on CIMMYT maize germplasm) in partnership with NARES and seed companies in SSA for effective and sustainable control of FAW.

ACTIONS

CIMMYT has:

- Established a FAW Screening Facility (with 16 net-houses) in partnership with Kenya Agriculture and Livestock Research Organization (KALRO) at Kiboko, Kenya.
- Optimized FAW larvae mass-rearing and germplasm screening protocols for intensive evaluation of maize germplasm under artificial infestation in the net-houses.
- Screened over 10,000 maize germplasm entries from CIMMYT's maize breeding hubs, especially Mexico and Kenya.
- Developed extensive on-station and on-farm evaluation
- of promising hybrids for identification of a subset of hybrids with native genetic resistance to FAW and other farmer-preferred traits.
- Published comprehensive IPM-based manuals for FAW
- control in Africa (in 2018) and Asia (in 2021).





RESULTS

- Identification of inbred lines and hybrids with native genetic resistance to FAW after intensive screening under artificial infestation at the FAW Screening Facility in Kiboko, Kenya.
- Dissemination of a set of 10 elite CIMMYT Maize Lines (CMLs) with native genetic resistance to 92 institutions in 34 countries globally (Prasanna et al., 2022).
- Announcement by CIMMYT (in December 2020) of a set of three FAW-tolerant elite maize hybrids for uptake by partners in SSA.
- Licensing of the FAW-tolerant maize hybrids to NARES institutions in 13 countries across SSA.
- National Performance Trials (NPTs) initiated in 12 target countries in SSA in 2021.
- Thus far, South Sudan, Zambia, Kenya, and Malawi have released the three FAW-tolerant maize hybrids. Eight other countries in SSA (including Angola, Cameroon, Ethiopia, Ghana, Rwanda, Somalia, Uganda, and Zimbabwe) are in pipeline to release the FAW-tolerant hybrids in 2023.

Additional project impacts on sustainable development include:

Social: Climate-resilient maize varieties, with native genetic resistance to FAW, have the potential to improve food and nutritional security of resource-constrained farm households globally.

Environmental: FAW-tolerant maize hybrids can significantly contribute to environmental health by reducing the application of synthetic pesticides in Africa by at least 20%. Studies showed that some farmers were applying, on average, as many as 6.4 pesticide applications per crop season for FAW control. Intensive use of pesticides, especially highly toxic pesticides, can have undesired environmental impacts, including loss of biodiversity of natural enemies of pests.

Economic: According to a recent study, a Kenyan farmer spends on average $70.68/ha for pesticides and $28.69/ha for labor to control FAW up to harvest, excluding personal protective equipment. Such costs are beyond the reach of many resource-constrained smallholders in Africa. Climate-resilient maize varieties, with genetic resistance to FAW, could significantly reduce farmer input and labor costs, in addition to increasing income from improved yields.

FAW-tolerant CIMMYT hybrid maize

FAW-susceptible maize

Photo Credits: B.M. Prasanna (CIMMYT)

SUCCESS AND LESSONS LEARNED

Establishment and operationalization of a state-of-the-art FAW screening facility in Africa, which enables breeding and deploying elite maize varieties with native genetic resistance to FAW, was a major success of this program. Development, evaluation, and identification of first-generation FAW-tolerant maize hybrids (along with farmer-preferred traits) within a short timeframe was also an important success. The NPTs ongoing in 13 countries across Africa for release of FAW-tolerant maize hybrids will continue to have implications on the sensitization of partners on the need to adopt host plant resistance as a part of the IPM strategy for sustainable control of FAW.

In addition to these successes, there is a need for greater sensitization of policymakers for accelerating the NPT process for release of FAW-tolerant maize varieties that are in strong demand in several countries across Africa.

Anticipating delays in the NPT process, we should have mobilized resources for early generation seed scale-up (especially breeder's and basic seed) for rapid production and deployment of commercial/certified seed to the farming communities.

Websites:

https://repository.cimmyt.org/entities/publication/25383a55-5602-40b4-a917-e7ed0ac261af

Prasanna BM et al. (2022) Host plant resistance for Fall Armyworm management in maize: relevance, status and prospects in Africa and Asia. Theoretical and Applied Genetics: https://doi.org/10.1007/s00122-022-04073-4

https://www.cimmyt.org/tag/fall-armyworm/

Transfer Efficient Agricultural Technologies Through Market Systems (TEAMS) Program

At-a-glance

Objective: To increase food availability and access for 15,500 smallholder farmers (60% women) in Mozambique.
Lead countries/organization(s): IFDC, United Purpose, AKSM, and the African Fertilizer and Agribusiness Partnership (AFAP)
Place: Manica and Sofala Provinces, Mozambique

BACKGROUND AND OBJECTIVES

The Transfer Efficient Agricultural Technologies through Market Systems (TEAMS) program (2021-2022) is a continuation of the Food Security Through Climate Adaptation and Resilience (FAR-Sofala) program. In partnership with the Mozambican government, the program is implemented by a consortium of four organizations: IFDC (lead organization), African Fertilizer and Agribusiness Partnership (AFAP), United Purpose, and Associação Kwaedza Simukai Manica (AKSM).

TEAMS aims to increase availability and access to food for 15,500 smallholder farmers (60% women) in three districts of Sofala Province (Nhamatanda, Buzi, and Chibabava) and four districts of Manica Province (Macate, Vanduzi, Sussundenga, and Manica).

The program is organized under three results areas for strategic interventions: (1) Scaling Improved Smallholder Productivity, (2) Scaling Agro-Dealer Networks for Input/ Output Market Development, and (3) Scaling Proven Technologies.

ACTIONS

TEAMS uses an inclusive market systems approach to engage in facilitative partnerships with market actors that enhance smallholder linkages with input and output markets, improve access to services and information that can improve farm productivity, and increase access to diversified sources of income and nutritious foods. The TEAMS program addresses resilience to shocks brought on by climate change, conflict, as well as the COVID-19 pandemic, as these factors will have potentially long-lasting and adverse effects on the agriculture sector and household food security, particularly for women farmers.

As factors like the COVID-19 pandemic evolved, TEAMS adapted its interventions to their context. Using a series of risk analysis assessments, TEAMS was able to address challenges by introducing practices that safeguard produce's quality post-harvest, allow more farmers to receive training on climate-smart agriculture, and prepare for future shocks by introducing Information and Communications Technologies for Agriculture (ICT4Ag) solutions to local agribusinesses and extension services.

TEAMS expands program-supported linkages by connecting market actors (farmers, agro-dealers, input suppliers, agricultural service providers, and local buyers) to develop a continuous agribusiness supply network for essential cost-effective inputs and extension services, ultimately scaling farmer adoption of productivity-enhancing technologies—practices through on-farm technology transfer units organized under public and private sector partnerships—local incomes, and food security.

TEAMS also conducts activities for integrating ICT4Ag in agribusiness and extension services that will make interventions more adaptive within the context of the ongoing COVID-19 pandemic and adverse climate events. These activities include radio messaging, SMS messaging to give program farmers awareness of key agronomic aspects according to cropping stage, and soil moisture sensors to analyze the need for irrigation in vegetable production.

Mozambique has faced several calamities in the recent past, including drought. The TEAMS program

implements interventions to create and improve access to climate-smart agricultural inputs and increase resilience to shocks by intensifying vegetable production through the promotion of crop diversification and cost-effective and environmentally friendly irrigation systems. The program strengthens local market systems and helps farmers improve their productivity and production using climate-smart agriculture (CSA). Farmers are also trained on spraying, post-harvest handling, storage, aggregation, collective marketing, and other skills to minimize post-harvest losses and adequately bulk and store their produce. These actions, in turn, address the food security gap experienced by much of the population due to unpredictable climatic changes.

RESULTS

Project impacts on sustainable development include:

Social: The TEAMS program is implemented in districts where former RENAMO combatants have become farmers, as part of the Disarmament Demobilization and Reintegration process. TEAMS collaborated with the Peace Process Secretariat (PPS) to train demobilized guerrillas in CSA and business skills as part of social reintegration. A total of 623 (74 women) ex-combatants were integrated into program-assisted farmer groups.

Environmental: 17,321 farmers (61% women) benefitted from improved access to climate-smart agricultural inputs, and cost-effective, environmentally friendly irrigation systems, which increase resilience to climate shocks by intensifying vegetable production. Farmers using flood-tolerant varieties of rice managed successful harvests despite Cyclone Eloise, which made landfall in January 2020.

Economic: 10,112 producers (57% women) doubled crop productivity through the adoption of climate-smart agricultural practices and inputs, increasing their income from USD $0.38 to $1.10 per day. In addition, 10,827 farmers (59% women) from associations were trained in post-harvest handling, storage, aggregation, collective marketing, and other skills to minimize post-harvest losses and adequately bulk and store their produce. As a result, farmers were able to command higher market prices for their produce.

SUCCESS AND LESSONS LEARNED

The CSA practices and technologies promoted by TEAMS effectively increased farmers' resilience and their ability to respond to climate changes. Improved access to climate-smart agricultural inputs and practices for food production and conservation has helped 58% (10,112) of the assisted farmers to improve income and food security and become more resilient to climate threats. In addition, crop diversification, achieved by intensifying horticulture production through water harvesting, conservation, and environmentally friendly irrigation solutions, allowed farmers to produce outside the rainy season.

Farmers reduced losses by 50% through the combined use of crop varieties tolerant to extreme weather conditions, pests, and diseases, improved spraying services, and improved post-harvest technologies. These reduced losses improved the availability of products for household consumption and sale for 75% (11,558) of program-assisted farmers.

5,318 women with access to post-harvest technologies promoted by the program reduced time and effort by 85% for threshing cereals and beans.

Sustainable, productive, food-secure communities require a functioning, inclusive market system that provides farmers with the appropriate knowledge, skills, inputs, market access, and financial services to make informed decisions and successfully manage production in the face of climate and other shocks.

Photo Credits: IFDC

U.S. Cotton Trust Protocol

At-a-glance

Objective: To provide quantifiable, verifiable goals and measurement in six key sustainability metrics as well as article-level supply chain transparency. Set a new standard in more sustainable cotton production.
Lead countries/organization(s): National Cotton Council, U.S. Cotton Trust Protocol
Place: United States

BACKGROUND AND OBJECTIVES

The U.S. Cotton Trust Protocol is a voluntary, farm-level science-based program that is setting a new standard in more sustainably grown cotton, ensuring it contributes to the protection and preservation of the planet by using the most sustainable and responsible techniques.

With increased scrutiny on sustainability, the program provides access to more sustainably grown cotton for brands and retailers, and science based, data-led assurances that consumers can have confidence in — something that has been lacking in the industry to date.

The U.S. Cotton Trust Protocol sets out to, first, highlight and document the hard work and commitment of many U.S. cotton growers to the highest environmental and labor standards, and second, to provide brands and retailers with a sustainably sourced and traceable cotton fiber. Brands and retailers are under increasing pressure from consumers and legal regulations to source only sustainable products and the U.S. Cotton Trust Protocol is able to fulfill that requirement with measurable, quantifiable, and verifiable data.

Combining verified cotton growing data with blockchain-enabled supply chain transparency delivers the assurance that brands and retailers need to evidence their responsible sourcing practices and demonstrate progress toward environmental targets.

The U.S. cotton industry is determined to deliver sustainability progress currently laid out in the 2025 National Goals for Continuous Improvement, and the Trust Protocol aims to be a vital driving force in this journey.

ACTIONS

The program was built on a foundation of science-based data capture, aggregation, and reporting that drives continuous improvement across six key sustainability metrics: GHG Emissions, Irrigated Water Use, Soil Conservation, Energy Use, Soil Carbon, and Land Use Efficiency. The U.S. Cotton Trust Protocol integrates these sustainability metrics from Field to Market's Fieldprint® Platform, enabling enrolled growers to measure the environmental impacts of their operation and identify opportunities for continuous improvement, while empowering brands and retailers to report on aggregate sustainability data, which is verified by Control Union Certification.

Participating U.S. cotton farmers complete a self-assessment questionnaire that captures practices they have adopted on their farms, submit field level agronomic production data into Field to Market's Fieldprint® Calculator, and commit to continuous improvement on their farms. After enrollment is complete, each grower receives a scorecard of their performance (based on the information provided in the Fieldprint® Calculator) and can compare their farm to regional and national benchmarks. The grower is also provided a report that highlights practices that they could adopt to improve sustainability outcomes on their farm.

After harvest, bales from participating U.S. cotton farmers are uploaded into the Protocol Consumption Management Solution (PCMS), where blockchain and other digital technologies within all stages of manufacturing create a digital chain of custody that provides brands and retailers visibility across their supply chain. Brands and retailers request Protocol Cotton Consumption Units (PCCUs) based on the total volume of eligible cotton tracked through the system and are able to make claims based on data-backed, verified PCCUs linked to their consumption of eligible cotton.

RESULTS

Project impacts on sustainable development include:

Social: In 2021-22, all U.S. Cotton Trust Protocol growers complied with the required practices in farm safety and worker well-being. These practices include the safe handling of pesticides and other farm products, regular employee training, fair wages, and no forced labor. Any grower who does not comply with these requirements is denied membership.

Environmental: In 2021-22, the U.S. Cotton Trust Protocol data set included farming practices for 624 grower members on more than 1.1 million cotton acres, producing over 1.6 million bales. The data set shows improvement in each of the six-sustainability metrics measured by the program.

2021-22 Trust Protocol growers increased land and water use efficiency on their farms by 13% and 14%, respectively, compared to the established 2015 baseline. Greenhouse gas emissions and energy use was reduced by 2021-22 Trust Protocol growers by 21% and 25%, respectively, compared to the 2015 baseline. 2021-22 Trust Protocol growers also observed a 78% reduction in soil loss compared to the 2015 baseline. 70% of Trust Protocol growers saw a positive soil conditioning index, which is a direct representation of practices that improve soil organic matter.

A cohort group of growers that participated in the U.S. Cotton Trust Protocol in both 2020-21 and 2021-22 was identified and used to track continuous improvement. In 2021-22, this group produced more fiber with the same land and water usage, used less energy, decreased GHG emissions and soil loss, and increased soil carbon compared to the 2020-21 production year.

Economic: Completed grower enrollment in the Trust Protocol paves the way for a redistribution of program revenue. Membership fees paid by supply chain members will cover administrative costs with the goal of providing financial support back to Trust Protocol growers.

U.S. COTTON TRUST PROTOCOL®
Trust in a smarter cotton future

The 2021-22 year was focused on foundational growth and making innovative decisions. To continue the learning process, we held regular industry meetings and events, learning sessions, and farm tours. These conversations reaffirmed our commitment to more sustainable cotton production and increased supply chain transparency. We also continue to lay the groundwork to be further recognized as a sustainable cotton sourcing option that brands and retailers can use to fulfill their sustainability commitments. As a result, the Trust Protocol was accepted as an ISEAL Community Member, approved as a standard for sustainable cotton by German Federal Government Initiative Siegelklarheit, and recognized and published in the standard mapping process by the International Trade Centre. These announcements are important for the U.S. cotton industry because they provide brands and retailers guidance on the standards and programs they can rely on to source sustainable cotton.

There is a growing expectation of brands and retailers to not only provide goods that have highly transparent supply chains and a robust sustainability profile, but to provide the evidence of this, too. We saw the supply chain positively respond as we doubled the number of acres enrolled in the program, increased mill and manufacturer membership by more than 50%, and successfully completed pilots in our PCMS with nine brands and retailers and nearly 150 mills tracking purchase orders as well as individual units.

Finally, our commitment to innovation, transparency, and providing measurable, verifiable data will remain at the forefront of our efforts. The Trust Protocol's collaborative journey will continue as we work to increase grower participation in the program by providing resources to assist with enrollment and become better educated on sustainability practices. This includes helping the grower with questionnaires on their processes and a team of scientists who can examine their individual farm-level data and answer inquiries. We are also creating custom crop rotation templates and streamlining the identification of field borders through software enhancements. Additionally, we will provide better access to the ecosystem of people that growers rely upon, including crop consultants and extension experts, who can provide further guidance and resources on sustainability practices.

Websites:
www.TrustUSCotton.org

SUCCESS AND LESSONS LEARNED

LIVESTOCK, DAIRY, AND AQUACULTURE

Alfalfa as an Alternative to Nitrogen Fertilizer in Irrigated Pastures

At-a-glance

Objective: To provide an environmentally beneficial alternative to applying nitrogen-rich fertilizers for improving grass pastures for cattle grazing while maintaining or enhancing steer productivity.
Lead countries/organization(s): U.S. Department of Agriculture, Utah State University
Place: Utah and Idaho, United States

BACKGROUND AND OBJECTIVES

Beef cattle production is one of the dominant agriculture sectors in the United States, and most of the 30 million beef cows spend at least part of each year grazing pastureland. For decades, ranchers have enhanced the forage value of pastures by applying nitrogen-rich fertilizers to increase pasture productivity and cattle weight gain. However, the environmental consequences of applying high levels of nitrogen, which can runoff pastures into waterways, is now a major environmental concern.

Reduced public grazing, increasing feed costs, and new grazing-associated environmental regulation all threaten the future sustainability of the beef cattle industry in its current configuration. Improving grazing systems so that the level of productivity is at least maintained, while maintaining environmentally sustainable systems, is critical for the survival of the beef cattle industry.

The rising costs of nitrogen fertilizer coupled with the potentially negative environmental effects of applying fertilizer to pastures is especially problematic given that nitrogen is often the limiting factor to increased forage, especially in the highly productive, irrigated pastures of the western U.S. To support beef producers in facing this challenge, the objective of this project is to develop alternatives to applying nitrogen-rich fertilizers while also placing an increased emphasis on environmental stewardship. One possible answer to both concerns is to integrate alfalfa and other legumes into highly productive, irrigated pastures. These legumes fix nitrogen into the soil, working as replacement for applying chemical nitrogen.

The overall objective of this project was to evaluate the economic and environmental benefits of grass-legume pasture mixtures as compared to using commercial nitrogen fertilizer.

ACTIONS

Scientists from the U.S. Department of Agriculture's (USDA) Agricultural Research Service (ARS) in Logan, UT, and Utah State University, compared pasture productivity, beef steer growth, economic return, and environmental impact (e.g., nitrogen leaching potential and greenhouse gas production) of tall fescue pastures mixed with alfalfa or birdsfoot trefoil compared to fescue-only pastures with nitrogen fertilizer. Tall fescue is a popular pasture grass widely grown in the United States. It produces substantial forage and is typically very responsive to supplemental irrigation and fertilizer. Alfalfa and birdsfoot trefoil are both nutritious perennial forage legumes that, with the aid of rhizobium (root-colonizing bacteria), produce and deposit nitrogen in the soil. When grown in mixtures with grass, these legumes can potentially supply some of the large nitrogen requirement needed for productive pastures. Birdsfoot trefoil plants also contain low levels of condensed tannins. Tannins have been shown to improve protein digestion and utilization by livestock, including cattle, so that there is less nitrogen and ammonia excreted and lower levels of methane (greenhouse gas) emissions.

To compare the two systems, Angus beef steers were allowed to graze through two summers (May to September) on either tall fescue pastures mixed with alfalfa or birdsfoot trefoil or fescue-only pastures that had received nitrogen fertilizer. Scientists measured forage mass, nutritive value, steer growth performance, and production economics. In addition, cooperating producers planted these same mixtures on their farms and observed cattle grazing behavior and growth.

RESULTS

The grass-legume mixed pastures produced slightly less forage, but nutrition and steer growth were higher compared to fertilized grass pastures. Researchers determined that the amount of dietary energy, fiber, and digestibility, and proportion percentage of legume in the forage, were the primary influencers of the differences in steer growth.

Social: Grazing on pastures has been shown to benefit society at large as it reduces concentrated manure storage (odor, flies, and nutrients), reduces use of fossil fuels to harvest forages, can improve livestock health, and has high public acceptance. Nearly 50% of western U.S. beef cattle are from small- to medium-sized farms, often relying heavily on grazing, and owned and operated by families that form the backbone of rural communities. This research documented cost-saving, quality of life, and good environmental practices that will help farms remain multi-generational and public-friendly, thus supporting stable rural communities.

Environmental: The grass-trefoil mixtures enhanced digestion for grazing cattle, resulting in less production of greenhouse gases, ammonia, and methane. In addition, both grass-legume mixtures produced less excess nitrogen in the water that leached through the soils compared to nitrogen fertilizer; this reduced nitrogen leached could help mitigate groundwater contamination.

Economic: Without the added cost of fertilizer, economic returns for grass-legume pastures were 2.4 (trefoil) and 1.7 (alfalfa) times greater than fertilized grass pastures. Importantly, economic returns for both grass-legume pastures were equal to or better than growing irrigated wheat or corn (common crops in the area), demonstrating an alternative to public land grazing when high-quality irrigated pastures are available. Also, grass-legume mixtures can reduce dependence on petroleum-based commercial fertilizer.

SUCCESS AND LESSONS LEARNED

By nature, grazing research on a landscape scale is highly variable, resource intensive, and requires expertise in livestock, forages, and environment.

Success of the initiative was in part due to a multi-disciplinary team, external grant funding, excellent grazing research facilities (Utah State University), and farmer input on research questions and 'proof of concept' on-farm evaluations. The results not only showed the economic and environmental benefit of grazing grass-legume mixtures but indicated that such mixtures with a greater proportion of legume (up to 50%) or added dietary energy may provide even further benefits. This led to two subsequent grass-legume grazing research projects. An important lessonwas the discovery that that there were major differences between the cows themselves. Some cows were more efficient grazers than others. In this study, data was based on the average of a group of three steers grazing together but collecting data on each steer would have shown that some steers are better for grazing grass-legume mixtures.

Photo Credits: B. Waldron (USDA)

Website:
https://scientificdiscoveries.ars.usda.gov/explore-our-discoveries/pacific-west/ut-take-your-alfalfa-out-to-pasture/

Australian Beef Sustainability Framework

At-a-glance

Objective: To reduce risks and leverage opportunities by managing what stakeholders value inside and outside the Australian beef industry.
Lead countries/organization(s): Red Meat Advisory Council, Meat & Livestock Australia
Place: The Australian Beef Industry

BACKGROUND AND OBJECTIVES

The Australian beef industry is committed to using transparent, sustainable pathways to achieve best practices. The Australian Beef Sustainability Framework (ABSF) tracks performance of the industry against a series of indicators under four themes: Best Animal Care, Economic Resilience, Environmental Stewardship, and People and the Community. Within those themes the industry has identified 24 priority issues, including biosecurity, climate change resilience, biodiversity, antimicrobial stewardship, food safety and quality, and beyond. The ABSF reduces risks within the Australian beef industry and leverages opportunities by managing what is most important to stakeholders inside and outside the industry. The Sustainability Steering Group (SSG) is appointed by the Red Meat Advisory Council (RMAC) to ensure the ABSF progresses toward these goals on behalf of the beef industry.

The ABSF aims to:

- Promote industry transparency and progress to customers and the community
- Inform industry investment for continuous improvement in areas important to the beef industry and its stakeholders
- Help protect and grow access to financial capital
- Foster constructive relationships with external stakeholders to work collaboratively with the industry

The ABSF does not:

- Establish or endorse measurement systems at an individual business level
- Provide an accreditation or certification system
- Endorse prescriptive management practices
- Create additional work for individual businesses

The ABSF supports the strategy outlined in Red Meat 2030, a red meat-focused strategic plan, to deliver for the longevity and prosperity of our people, our livestock, and the communities we serve.

ACTIONS

In January 2021, the SSG completed a project to review and update the current list of priorities in which the ABSF reports on for a materiality review. The 2020 materiality review identifies and prioritizes the industry's material topics – topics that reflect the industry's significant economic, environmental, and social impacts or that substantively influence the assessments and decisions of stakeholders. Impacts can be positive or negative. The assessment identified 24 priorities which the ABSF reports on currently. The final prioritization was informed by global standards and practices, including the Global Reporting Initiative (GRI) Standards 2016.

Throughout 2021, the SSG assessed all available industry data relevant to the 24 priorities as a result of the materiality assessment. While minimal new data points were discovered, the work continued to confirm Australia is a leader in data. The ABSF delivers specific research projects to provide data where gaps exist. For example, the ABSF continues its balance of tree and grass cover spatial monitoring on grazing properties and collaborates with Meat & Livestock Australia to deliver net greenhouse gas emission annual calculations. In 2022, an on-farm survey of animal husbandry practices was completed to provide key insights into pain relief usage for livestock.

The SSG is currently assisting the beef industry to set further goals against all priorities. For instance, there has been success in progressing toward the Carbon Neutral 2030 goal, the 100% pain relief use goal, and the 100% access to shade goal, which the industry is eager to expand upon. This process will further enhance alignment with both the Global Roundtable for Sustainable Beef (GRSB) Goals and the UN Sustainable Development Goals (SDG).

RESULTS

Project impacts on sustainable development include:

Social: The ABSF has made important strides toward upholding vital safety practices within the beef industry, ensuring improved health for both humans and livestock. The number of producers using pain relief for invasive animal husbandry procedures, for example, has increased to 35%, as the industry strives to 100% usage by 2030. Australian cattle producers continue to implement good agricultural practices, with the National Residue Survey recording a 99.6% compliance. Australia's robust traceability systems have ensured Australia remains free from exotic diseases and has increased responsiveness to biosecurity threats, with 83% of properties covered by a documented biosecurity plan. Additionally, 58.9% of cattle in feedlot have access to shade, as the industry plans to have 100% access by 2026.

Environmental: The Australian beef industry has continued to reduce its net CO2e emissions since 2005, recording a reduction of 58.21% in 2019. Native vegetation regrowth has also immensely improved, as the area of forest on Australian grazing properties increased from 12.94% in 2004 to 15.32% in 2020. Additionally, 7.6 million hectares of land typically used for cattle – an area larger in size than Ireland – has been set aside for conservation or protection purposes. 79.6% of Natural Resource Management regions achieved healthy groundcover thresholds, further protecting soils and ecosystem services. 2.39 million tons of food waste was recovered along the supply chain in 2021, diverting this from landfill. Finally, the amount of water used per kilogram of liveweight gain when raising cattle has decreased significantly.

Economic: Climate-adjusted farm productivity has increased, demonstrating that producers are adapting to climate change impacts. This adjustment will ultimately bring major cost savings to farms as they grow more resilient to erratic weather patterns and other climate change impacts. The simply reduction of CO2e emissions, for example, shrinks operating expenses in the long-run.

SUCCESS AND LESSONS LEARNED

The ABSF's legacy will be the fulfillment of its vision of a thriving Australian beef industry that strives to continuously improve the wellbeing of its people, animals, and the environment. This legacy will support the prioritization of the Australian beef industry in global market access arrangements and as a strategic sustainable supply source for our international and national customers, enabling access to competitive financial capital from our investors.

As the impacts of global warming and greenhouse gas emissions become more apparent, and social and environmental governance, disclosures, and reporting become required by governments, investors, and customers, it is important to acknowledge the Australian beef industry's commitment to and leadership of the ABSF.

Most importantly, the success of the ABSF will lead to continuous improvement in environmental outcomes, animal health and welfare standards, community prosperity, and the health of the world achieved through ensuring a secure supply of nutrient dense food to an increasing population.

As the ABSF continues this work, increased access to data – understanding the current status of the 24 SSG priorities and beyond – will be vital for reaching social, environmental, and economic goals.

Photo Credits: Amy Holcombe

Website:
https://www.sustainableaustralianbeef.com.au/

BIUe belt cLimatE acTIoN - BULLETIN

At-a-glance

Objective: To involved and train small-scale fishermen and fishermen groups in the process of monitoring and collecting primary data in the Black Sea coastal waters.
Lead countries/organization(s): RCNE, BBSBI, BBSFFMI
Place: Bulgaria

BACKGROUND AND OBJECTIVES

Common interests and potential conflicts are present in the Black Sea region in nature protection and restoration; fisheries; and regional industrial activities, including oil development and production, and the development of transport infrastructure. Minor pressures exist from the tourism, sand mining and fisheries industries. It is important to balance the different economic, social and ecological interests in the area. However, cooperation efforts are often hindered by factors such as uneven economic and political development – which are greatly influenced by activities in and beyond the coastal zone – within Black Sea countries.

Therefore, the resolution of conflicts using coastal and marine resources required a broad perspective on the environmental process and interaction among different activities.

Observing and studying seas and oceans provides predictions of trends and changes. Stakeholders taking part in systematic observations include various members of the Blue Belt Network whose work and life are related to the ocean. The inclusion of new entrants in the network for monitoring and collecting primary data can significantly improve the ocean modeling and prediction process. The participation of people involved in various maritime professions can contribute to expanding the possibilities for protecting oceans.

ACTIONS

For the last 10 years, the Balkan and Black Sea Business Institute (BBSBI) within Regional Cluster “North-East”, has been actively working to involve small-scale fishermen in the process of monitoring and collecting primary data in the Black Sea coastal waters. Given the frequency of boats going to sea – 2-3 times a day – the collection of samples of sea water and marine flora and fauna, plus data on air and water temperatures, water quality, and wind, the Institute can improve the monitoring and modeling of the processes of adaptation to climate change in the respective region.

Our first project in Byala, Varna District has been operating successfully since 2016. In 2014-2015, a project proposal was developed for the construction of a market facility for fish storage and first point of sale in Byala, which received funding under Bulgaria’s Operational Program for Development of the Fisheries Sector (European Fisheries Fund).

The second phase – which took place between 2015 and 2016 – included training and equipping small-scale fishermen for the process of monitoring and collecting primary data in coastal waters.

In 2019, our second project started, which is being implemented at the Fisheries Port "Quarantine" in Varna, Bulgaria. Unfortunately, due to the COVID-19 pandemic, the project has been delayed, but the final phase of training fishermen as **“**Seanfluencers**”** started again in 2021 and is under way now. This year, a new project is expected to be launched on the Danube River.

In 2022 a training center was created where children, youth and community representatives are involved and trained to fully participate in the Blue Belt Climate Action as seanfluencers.

Our team is currently developing an open access online platform where the data will be uploaded and updated. In 2025 we plan to launch an app that will enable fishermen to update and use the data in real time.

RESULTS

Our field research documents the process of over-development of coastal areas, entry into fishing areas and pressure on small-scale fishermen by various means, including administrative burdens. The process leads to a drastic reduction in the territories of fishing villages and to a reduction in the overall number of fishermen.

Social: The main elements identified were the positive socioeconomic effects for coastal zones such rising production, employment and food security. There are however potential conflicts from the use of shared coastal and maritime space, and environmental impacts such as alterations in coastal dynamics, increasing marine pollution, changes in the seabed and alterations to habitats and biodiversity. The increasing multiple pressures affect coastal ecosystems and, consequently, small-scale fishermen activity.

Environmental: The potential for positive synergies are expected to be most important in the interactions between small-scale fisheries and coastal tourism – including ecotourism – and marine protected areas, where small-scale fisheries can take on functions related to tourism and monitoring/management of protected areas. Additionally, there are other positive synergies with maritime transport and aquaculture through shared facilities and suppliers.

Economic: The current economic model in Bulgaria does not sufficiently balance and regulate the even distribution of resources in coastal areas. The interests of the sectors related to tourism, recreation and transport are dominant against small-scale fishing, which still provides a basic livelihood for a high percentage of its employees.

SUCCESS AND LESSONS LEARNED

The ongoing development process of the Blue Belt Climate Action (BULLETIN) initiative and the changing conditions required our team to move from the Quadruple Innovation Helix Framework applied until now to the Quintuple Helix Innovation Model. In this context, the Quintuple Innovation Helix Framework represents the most comprehensive, meaningful and valuable construct and modality as it encompasses the five core dimensions of modern, sustainable and democratic knowledge economies and societies.

For 15 years, representatives of BBSBI and Balkan and Black Sea Fresh Foods Marketing Initiative (BBSFFMI) within Regional Cluster “North-East” have been participating onsite in the life and activities of fishing groups in Northeastern Bulgaria. Our researchers live and work in fishing villages and actively participate in fishing associations.

Accelerated breeding complements and supports the work of crop and livestock breeders to enhance genetic gain, shorten breeding timelines, and improve agricultural productivity. Accelerated breeding is not *one* tool but a *suite* of technologies and should be positioned as such. Users may then be selective about which of the technologies they need to utilize to achieve their goals.

Website:
https://sites.google.com/view/regionalcluster/%D0%BF%D1%80%D0%BE%D0%B5%D0%BA%D1%82%D0%B8/blue-belt-climateaction-bulletin

Capacity Building of Actors in the Fish Farming Sector in the Republic of Congo

At-a-glance

Objective: To improve fish production in a sustainable and cost-effective way and strengthen fish value chains.
Lead countries/organization(s): European Commission, European Union
Place: Republic of Congo

BACKGROUND AND OBJECTIVES

The EU-funded Projet de renforcement des capacités des acteurs de la filière piscicole en République du Congo (RECAFIP), implemented by APDRA Pisciculture Paysanne and the Congolese NGO Forum for the Promotion of Rural Groups (FPGR), aims to strengthen civil society actors and local authorities in the fish farming sector. The project ventures to improve fish production in a sustainable and cost-effective way and strengthen local value chains in the Congo.

Due to largely insufficient production, demand is partially satisfied by frozen fish imports in the Congo. The first phase of the project aims to promote short supply chains by strengthening the organization of the fresh fish value chain.

The integration of producers into networks will contribute to their enhanced role in the local economic fabric. The second phase of this project aims to increase supply and improve the quality of fish on the market in the Congo.

ACTIONS

The project strengthens the capacities of fish farmers by helping them make investments through the mobilization of their own resources (funding and labor) and the development of their own economic activities that are or can be made environmentally sustainable.

Technical support is provided to help farmers build their own ponds. The training method is based on a collective approach that integrates exchange of experience and promotes the empowerment of producers in the sector. Fish farmers are organized into groups to facilitate the sharing of knowledge and networking among the groups. In addition, local and international exchange trips (for example, with farmers in Côte d'Ivoire) are organized to share experiences on fish farming as well as tutoring of beginner fish farmers by experienced fish farmers living in the same area.

Trials on an array of skills, including how to raise fry fish, feed fish, manage the temperature of water, and grow rice in ponds, are carried out by fish farmers with the support of experts who help identify suitable solutions to problems that arise. The organization of the value chain is improved with the collective transportation of fish in the surrounding cities.

RESULTS

In the first phase of the project, 200 fish farmers were supported and fish production increased by 20% in 40 hectares of functional ponds. Thirty women were trained in marketing of fish and 20 local entrepreneurs worked with producers providing services such advisory services and cold chain support during transport. Results include:

Social: The project strengthens capacities of 1,000 farmers, 20 farmer organizations, and numerous value chain actors. It also works to increase economic opportunities for women by designing fish marketing trainings targeted toward women. Additionally, with improved yields, local food security among fish farmers is improved.

Environmental: The principle of the project is to use only resources available locally. Agricultural by-products (cassava, taro, sweet potato leaves) or compost made from plant waste or animal waste are recycled to fertilize ponds. The integration of rice farming with fish farming contributes to environmental performance. The pond water can be used for other uses within the family farm, such as gardening or extensive pig or poultry farming. In addition to providing fertilization and free feeding of fish, this recycling practice does not yield greenhouse gas (GHG) emissions in its production.

Economic: The project facilitates diversification of livelihoods of small family farms. Fish farming activity provides additional income while contributing to the food diversification of households (600 kg of fish per ha every 6 months). Food diversification is reinforced by the possibility of associating rice and vegetable production with fish production. The simultaneous breeding of several species (tilapia, catfish, heterotis, hemichromis) enhances the natural productivity of the pond.

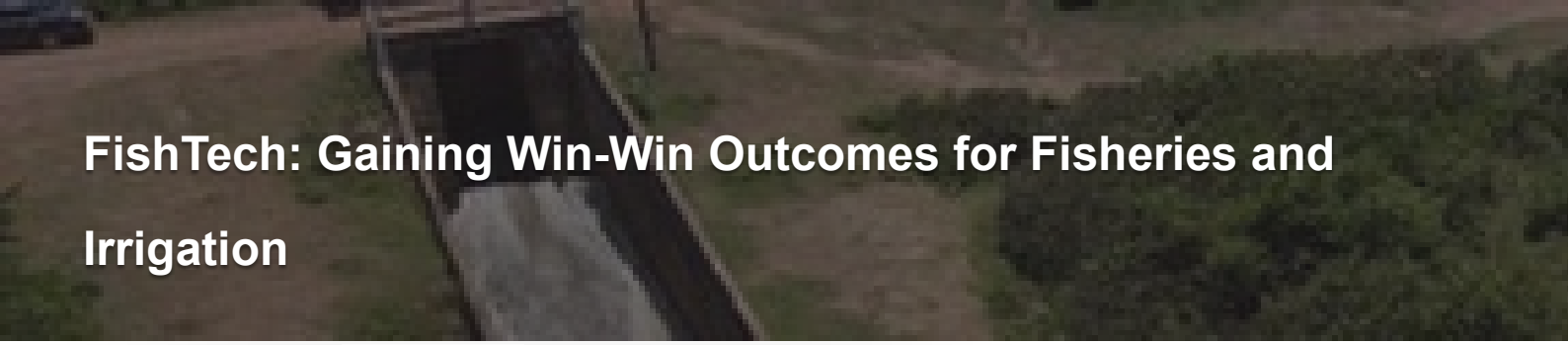
The project intervention takes place throughout the fish farming sector. Farmed fish, which represent only 0.5% of Congolese freshwater fish production, is usually sold directly near the pond. The development of farmed fish production contributes to the diversification of the local economy as it generates the emergence of different types of actors (service providers, traders) around this activity.

SUCCESS AND LESSONS LEARNED

This project's fish farming approach focuses on fish farmers investing in themselves with their own resources, tools, and skills, and only intervenes with advisory support and on the supply of the first fingerlings to start production. This approach requires important preliminary discussions with communities. Such an approach leads to sustainability of the fish production as farmers are able to maintain their activities without additional external support. Additionally, the partnership between APDRA (international NGO) with a Congolese NGO ensures continuity until the end of the project.

In terms of lessons learned, this approach is limited in that it requires fish farmers to mobilize their own resources early on in order to carry out their work. These constraints disproportionately impact women, young people, and people who do not have secure access to land. In order for the project to be as inclusive as possible, it emphasizes self-help groups to build pounds and the sharing of experiences and know-how.

Website:
https://www.apdra.org/index.php/en/our-projects/congo-en



FishTech: Gaining Win-Win Outcomes for Fisheries and Irrigation

At-a-glance

Objective: To facilitate greater adoption of fish passage technologies in the Mekong subregion and Indonesia.
Lead countries/organization(s): Led by Charles Sturt University with the Australian Department of Foreign Affairs & Trade and the Australian Center for International Agricultural Research
Place: Lao PDR, Cambodia, Thailand, and Indonesia

BACKGROUND AND OBJECTIVES

The world's most productive inland fishery – the Lower Mekong Basin (LMB) fishery – is at risk of being destroyed by the widespread development of river infrastructure to meet the region's growing demand for irrigation and hydropower generation. Irrigation structures and hydropower damns prevent many fish from being able to complete their life-cycles, by blocking access to key river and floodplain habitats. ACIAR and DFAT, in partnership with Charles Sturt University (CSU), have been facilitating the development of fish passage technologies (known as 'fish passes') throughout the LMB countries to mitigate the barrier impacts of river developments and conserve the basin's fishery for future generations.

Fish pass technologies restore habitat connectivity for fish, by providing 'ladders' for fish to swim around dams and other barriers. The FishTech project builds upon a program of work that progressed from a proof of concept into a more comprehensive research and implementation phase, which has shown that fish passes can ameliorate the effects of river development and additionally have lasting social and economic benefits. Specifically, it seeks to facilitate greater adoption of fish pass technologies in Southeast Asian countries (in particular, the Mekong subregion and Indonesia) by upscaling and scaling out fish pass implementation efforts.

ACTIONS

FishTech is enhancing fisheries productivity and biodiversity by integrating irrigation development with appropriate fish pass technologies, proven through applied research in Southeast Asian countries. It is doing this via a three-pillared approach:

Pillar 1: Fish pass design research and on-ground implementation
Targeted research is being undertaken to inform fish pass design for species and conditions in Lao PDR, Thaliand, Cambodia, and Indonesia, and to demonstrate proof of concept in each country. Also, on-ground fish pass implementation activities are being upscaled and scaled out using co-design processes with in-country partners and by integrating into development bank investments. These fish pass demonstration sites are being used to show that social, environmental, and economic benefits can accrue from appropriately executed fish pass solutions.

Pillar 2: Capacity-building research and development
A motivations and abilities analysis (MOTA) study is being undertaken to understand the needs of government stakeholders and investors to incorporate fish passage technologies in river developments. Also, focused masterclasses are being run to fill any gaps in institutional capacity, and to prioritize and co-design fish passes in each country. Furthermore, a Graduate Certificate in fisheries management has been developed and run at CSU to provide both skills and international qualifications. FishTech is evaluating the effectiveness of the project capacity building activities – both in the short term through Menti surveys, and over the long term by undertaking Tracer surveys of previously trained staff.

Pillar 3: Governance and policy research and development
A systematic review of fish passage policy and legislation has been undertaken for Lao PDR and Cambodia, and governance process maps have been developed describing the governance considerations involved in adopting fish pass technologies in those countries. Regional guidelines have also been developed by the team to advise on how to best implement fish passage initiatives in Southeast Asia.

RESULTS

The project is expected to generate many socio-economic and environmental benefits in Southeast Asia.

Social: FishTech and its broader fish passage program have so far led to the planning and/or construction of 48 fish passes throughout Southeast Asia, the increased adoption of these fish pass technologies will maintain food security and support livelihoods for villagers upstream of the fish pass implementation sites, by restoring fisheries productivity at those sites. In Cambodia, there is a particularly strong need to generate a vision on fish passage development to sustain Tonle Sap and the broader fisheries economy. Preliminary results suggest that a recently constructed fish pass in central Lao PDR could support passage rates of up to 5.5 tonnes of fish per annum. This would be enough to meet the daily protein requirements of 184 children annually. FishTech will also facilitate better integration of Gender Equality, Disability and Social Inclusion (GEDSI) considerations into all aspects of project design and implementation, with a GEDSI strategy recently being developed for fish pass adoption.

Environmental: The increased adoption of fish pass technologies into river developments will also enhance the diversity of fish communities. Preliminary analysis suggests that the same Central Lao PDR fish pass mentioned above passed over 61 species into an adjacent wetland. In addition, the fish passes constructed because of FishTech have so far restored connectivity to 8,900 km of river for other aquatic animals.

Economic: The LMB fishery is currently estimated to have an annual first-sale value of around $US17 billion, so any reductions in fishery productivity caused by disruptions to fish passage are likely to have profound economic consequences. The restoration of fish passage at the recently constructed central Lao PDR fish pass, alone, would potentially generate $US5500 of fishery-based income per annum, assuming a conservative fish price of $US1/kg.

Photo Credit: Jim Holmes

SUCCESS AND LESSONS LEARNED

Having team members based in-country

River development activities often require team members to rapidly mobilise to site and make time-bound decisions which are critical to project success. Having a network of staff based in the region, who can mobilise to site rapidly, is critical for navigating decision-making points.

Importance of existing relationships

It takes time to develop trust and working relationships. FishTech was already advantaged, and able to quickly mobilise, through existing long-term partnerships, which had matured over the past 15 years. Leveraging these contacts has been critical.

Masterclasses by 'default'

Significant effort has been put into developing masterclasses as the default mechanism for increasing working relationships between community and implementing agencies. The curriculum has been specially designed as a hands-on learning approach where real world examples are used to implement solutions to river development challenges. Through masterclass approaches, many fish passes have now been built across the LMB.

High-level dissemination

The best way to facilitate the policy/legislation space is when there is high-level support for a concept. Such support is gained through demonstration. FishTech is facilitating this through excursions and visits to implementation sites in-country, and by exhibiting a mobile demonstration fish pass 'model' at stakeholder events.

Website:

https://www.csu.edu.au/research/inland-fisheries-research-group

Greener Cattle Initiative: Enteric Methane Research

At-a-glance

Objective: To align resources and fund projects to identify and develop practices and technologies, or validate existing practices and technologies, which enable the sustainable decrease in enteric methane emissions.
Lead countries/organization(s): The Foundation for Food and Agriculture Research (FFAR) and Dairy Research Institute (DRI)
Place: Global

BACKGROUND AND OBJECTIVES

Enteric methane is the largest source of direct greenhouse gas emissions in the beef and dairy sectors. It is emitted primarily through manure degradation and enteric fermentation. Enteric fermentation is part of the normal digestive process in ruminants, with methane emissions primarily resulting from animals belching or exhaling. While several ongoing efforts to advance the sustainability of livestock production, few specifically address enteric methane emissions.

Mitigating enteric methane is a key focus of voluntary, farmer-led efforts in the U.S. dairy sector to achieve the environmental stewardship goals outlined in the Innovation Center for U.S. Dairy's "U.S. Dairy Stewardship Commitment." The "Pathways to Dairy Net Zero" initiative was created by the Global Dairy Platform to accelerate climate change action throughout the global dairy sector.

The FFAR and the DRI jointly developed the Greener Cattle Initiative (GCI) as a pre-competitive consortium to support collaborative research on enteric methane mitigation from ruminants. Its members include ADM, Council for Dairy Cattle Breeding (CDCB), Elanco, Genus PLC, Innovation Center for U.S. Dairy, National Dairy Herd Information Association, Nestlé, New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC), JBS USA, and Global Methane Hub.

The objective of this initiative is to strategically align resources and support projects that advance innovative solutions, validate existing practices, and develop sustainable technologies for reducing enteric methane emissions from cattle. These efforts emphasize practical adoption by producers and measurable benefits for agriculture and climate. Through collaboration and alignment with industry sustainability goals, GCI strives to achieve a more sustainable livestock sector.

ACTIONS

The GCI steering committee was developed by FFAR and DRI to align on research priorities and determine an approach to requesting grant applications. Raising awareness about the initiative's existence and goals through presentations at conferences and printed materials was necessary to increase the number of interested applicants leading up to the request for applications announcement in May 2022.

The GCI was able to grant three awards in 2023, totaling nearly $7 million, to advance the science of enteric methane mitigation in livestock.

- Dr. Alexander N. Hristov, Penn State's Distinguished Professor of Dairy Nutrition, will develop new enteric methane inhibitors and delivery methods for them. Hristov is focusing on inhibitors that have already been shown to reduce methane by at least 30% in laboratory tests. The project aims to develop feed additive options that will deliver the greatest mitigation potential that is practical for producers.
- Dr. Roderick Mackie, Professor in the Department of Animal Sciences at the University of Illinois Urbana-Champaign, will lead an international research study on how diets and different additives affect hydrogen production and utilization in the rumen of both beef and dairy cattle and how these changes in hydrogen dynamics affect the amount of enteric methane produced.
- Dr. Francisco Peñagaricano, Assistant Professor in the Animal and Dairy Sciences Department at the University of Wisconsin–Madison, will conduct research combining interventions that address selective breeding, data on milk composition, and rumen microbes to reduce enteric methane emissions. His research focuses on evaluating cattle genome for methane traits, including those for methane production and residual methane production.

By reducing methane emissions, beef producers and dairy farmers can help mitigate climate change and its associated negative impacts, such as extreme weather events, droughts, and floods. These changes can undermine agricultural productivity, so reducing

methane helps stabilize growing conditions. Improving livestock diets through better-quality feed or additives can reduce enteric methane emissions. These dietary improvements often lead to better feed conversion efficiency, which also enhances the productivity of the livestock sector. Reducing methane emissions in livestock production is not just about mitigating climate change; it is a key strategy for increasing the long-term productivity, efficiency, and sustainability of livestock systems.

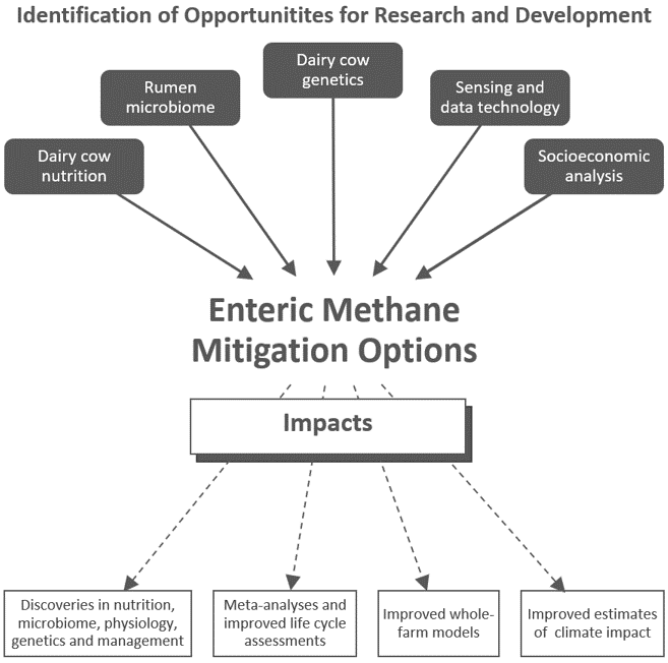
RESULTS

Although GCI just recently awarded its first three grants, the results are expected to lead to innovative solutions to mitigate enteric methane emissions from cattle. By embracing methane-reducing practices, farmers can improve their environmental footprint, reduce input costs, increase productivity, and contribute to global efforts to combat climate change — all of which foster sustainable productivity growth in the agricultural sector. Other impacts include:

Social: The reduction of enteric methane emissions can lead to multiple social benefits including improved health outcomes due to improved air quality, such as a reduction in respiratory issues and other health problems associated with air pollution. It can also contribute to increased food security by creating more sustainable and efficient livestock production systems.

Environmental: As mentioned above, the social benefits of reducing enteric methane are directly related to the environmental impacts. Reducing enteric methane can slow global warming, mitigate climate change, and improve air quality. Limiting or lowering warming can reduce extreme weather events and improve ecosystems.

Economic: Sustainable agricultural practices that reduce methane emissions often lead to overall improvements in farm efficiency and productivity. This can include better resource management, reduced waste, and enhanced animal health and welfare, all of which contribute to higher yields and profitability. Implementing practices that reduce enteric methane emissions often involves improving feed efficiency, which may lead to cost savings for livestock producers.



SUCCESS AND LESSONS LEARNED

The Greener Cattle Initiative brings together stakeholders from across the dairy and beef value chains to maximize and leverage investments in the research and development of practices and technologies that reduce enteric methane emissions and lead to continued sustainable productivity growth. This type of consortium can be replicated across research areas aimed at increasing sustainable productivity growth and lower environmental impact of agriculture. Ensuring that the initiative is informed by producers and animal health, genetic, feed, and nutrition research organizations and companies provides unique opportunities for cross disciplinary learning and research. The GCI is in its second round of funding.

Website:
https://foundationfar.org/consortia/greener-cattle-initiative/

Integrated Approach for Improving Pig Livability

At-a-glance

Objective: Reduce overall mortality in the U.S. commercial swine industry through joint research, education, extension efforts.
Lead countries/organization(s): Iowa Pork Industry Center, Foundation for Food & Agriculture Research, National Pork Board
Place: United States

BACKGROUND AND OBJECTIVES

Across the pork industry, an estimated 30-35% of commercial pigs die before reaching the market. Research shows that mortality rates are increasing across all phases of production, which severely impacts producers' profits and presents significant challenges to productivity, animal welfare and sustainability in the pork industry.

Addressing high mortality rates has been difficult due to limited information on the causes of deaths and a lack of evidence-based prevention strategies. Producers struggle to estimate the financial impact of these deaths and the economic implications of potential interventions. Providing producers with accurate economic tools could motivate them to implement strategies that reduce pig mortality.

An interdisciplinary team of researchers from Iowa State University, Kansas State University and Purdue University, in close collaboration with producers and industry partners, created the Improving Pig Livability (IPL) project with the goal of reducing pig mortality. The team aims to evaluate the attitudes and economics of improving survivability on U.S. sow farms, identify the causes of swine mortality in commercial production, develop strategies that increase wean-to-finish survivability and implement outreach and education activities to encourage producers to adopt these strategies.

ACTIONS

The National Pork Board and the Foundation for Food & Agricultural Research jointly awarded a $2 million grant to the IPL team to increase sustainable production of U.S. sow farms by decreasing pig mortality. The team's interdisciplinary membership and connections to producers has allowed them to comprehensively examine the drivers and economic impacts of swine mortality in commercial farms and develop strategies to decrease mortality rates.

The team has assessed causes of sow mortality in U.S. swine production systems and identified critical factors such as lameness, prolapse and health management practices. They created targeted strategies to increase sow survivability, such as improving early disease detection and health management. The team also investigated strategies that enhance piglet survival, which demonstrated the importance of colostrum consumption and enrichment. Additionally, they identified health and environmental factors that affect wean-to-finish mortality and provided actionable guidance to reduce these rates. They are currently pursuing research that will allow them to continue to refine management recommendations and utilize new technology to make these management strategies more cost-efficient for producers.

Through this project, researchers developed two decision tools for swine producers to estimate the cost of swine mortality for both wean-to-finish and breed-to-wean operations. These tools allow producers to input information that is unique to their operations, thereby providing tailored insights into the cost of pig mortality on their farms and the potential economic benefits of adopting mortality-reducing strategies.

The team recognized that ongoing knowledge sharing is critical to supporting the adoption of improved practices. Therefore, throughout the project the team communicated their findings through industry reports, informational videos, fact sheets available in English and Spanish, a podcast series *Pig X* and the project website. They also hosted the *International Conference on Pig Survivability*, attracting 451 participants from five countries, fostering global knowledge exchange and best practices.

RESULTS

The Improving Pig Livability project identified key strategies to decrease sow, pre-weaning and wean-to-finish mortality. Additionally, the team identified frequently used strategies that were ineffective at reducing pig mortality. The project produced 37 peer-reviewed publications, 117 invited presentations, 26 informational videos, 26 facts sheets and 45 podcasts, reaching thousands of stakeholders in the swine industry. Moreover, the team developed the first publicly available economic tool for swine producers to input their specific production information and costs, creating a farm-level specific cost of mortality for both wean to finish operations and the breed to wean operations. These economic modeling decision tool spreadsheets are available at no cost on the ISU Ag Decision Maker website. Other impacts include:

Social: A significant component of IPL was developing a nationally effective extension program to disseminate results. Strategies for decreasing pig mortality were distributed through diverse channels, and the project's economic tools are open-access and available for all producers. These tools lower barriers to the adoption of new strategies, leading to more widespread use and improved overall animal welfare.

Environmental: The adoption of the strategies outlined by IPL allows producers to more efficiently produce pork by reducing pig mortality. Improved resource efficiency reduces the emissions per pig, decreases environmental waste and creates healthier and more disease-resilient farms.

Economic: By improving pig survival rates with these strategies, the number of pigs that reach market weight increases, thereby increasing farm revenue. The new economic tools allow producers for the first time to analyze the cost of mortality on their own farm and weigh that against the projected economic benefits of mortality-reducing strategies. This knowledge empowers producers to make informed decisions about adopting new strategies to reduce pig mortality, and the researchers expect, will help lower barriers of adoption of new pig survivability management strategies.

SUCCESS AND LESSONS LEARNED

The IPL project's workforce development and extension is a key factor of its success. Over 80 students have taken part in research and training, which not only prepare students for careers in the swine industry but also increased the project's scholarly and extension outputs. These hands-on experiences contribute to the overall knowledge base through publications, presentations and outreach activities.

Collaborations with industry partners are also critical to the success of IPL, as these partnerships facilitate affordable data collection and dissemination of results. Partner farms frequently allow researchers to utilize their facilities at no cost, contributing an estimated $1.5 million in-kind support. This generosity makes the ambitious scope of IPL research possible. Training these producers to implement mortality-reducing protocols on farms leads to a 4-5% decrease in mortality and encourages broader adoption of these protocols.

This project highlights the importance of prioritizing industry collaborations, workforce development and outreach. Future work should continue to emphasize practical application and feasibility, to ensure that research is not only communicated but also adopted across the industry. Continuous feedback from producers and iterative refinement of recommendations based on farm data will be crucial to continue driving change in the swine industry.

Website:
https://piglivability.org/

Low-Cost Systems to Double Levels of Animal-Sourced Protein for Bangladesh

At-a-glance

Objective: To improve Bangladesh food security through low-cost animal-sourced protein production.
Lead countries/organization(s): Charles Sturt University, The University of Sydney, Bangladesh Livestock Research Institute (BLRI)
Place: Bangladesh

BACKGROUND AND OBJECTIVES

The supply of animal-sourced protein to those most in need is limited in Bangladesh primarily due to supply and cost. Whilst species such as Napier grass exist as a primary feed source for ruminants, current management limits the nutritive value of this feed and with this the scope of production. In addition, farmers are cross-breeding dairy and beef cattle, and in doing so, widening the gap between nutrient requirement and supply due to the genetic potential of such animals with consequence on reproductive performance and body condition. Our objective was to improve feed quality through simple changes in defoliation management, and by doing this, improve food security in Bangladesh whilst reducing the cost of production.

ACTIONS

A five-year research project was implemented based on co-design with Bangladesh Livestock Research Institute (BLRI) staff and smallholder farmers. Phase One of the project determined the impact of increasing the nutritive value and yield of Napier grass under varying defoliation heights, cutting severities and plant densities. Phase 2 determined the impact of improved Napier grass management on liveweight gain for the indigenous Red Chittagong cattle. Conventional management was contrasted with new best practice management which increased defoliation frequency through a reduction in cutting height.

Photo Credits: Charles Sturt University

RESULTS

Our work markedly improved the quality of this grass (crude protein from 8% to 18% and metabolisable energy (ME) from 7.5 to 9.ME/kg dry matter) by increasing the frequency of defoliation (cutting) such to limit the accumulation of fibre which typically occurs as plants mature. However, growth was reduced. We overcame this by increasing the plant density such that we now have a Napier Grass system that both has high levels of growth (35 t dry matter/ha/year) alongside markedly improved quality.

Our next stage of this research was to determine the impact of Napier grass management on animal production. For this work, we used Red Chittagong cattle, offering Napier grass either managed according to current protocol, or our new best practice. Red Chittagong yearling growth doubled from 0.3 to 0.6kg/animal/day, noting that the mature liveweight of this breed is around 200-300kg. So, our new levels of growth when converted to a mature liveweight basis of heavier animals, such as those in Australia, are very good. Further work is needed to determine the impact of this new system on milk production, and more broadly across social, environmental and economic domains.

Social: 10% of the Bangladesh population are undernourished and 28% of the population stunted[1]. Increased supply of animal-sourced protein by smallholder farmers will flow directly into the communities that surround them, helping to decrease levels of undernourishment and stunting.

Environmental: Whilst not directly measured, the outcomes of this work will flow into a reduction of methane output per unit of product given the improved feed quality.

Economic: Through our discoveries, farmers can have access to high-quality forage throughout the year, improving milk and meat production at approximately half of the current cost. From this, increased income for farmers may be observed through improved livestock productivity and the potential for surplus forage sales.

SUCCESS AND LESSONS LEARNED

Here we applied simple changes to management practices for an existing resource base to double levels of animal-sourced protein production. This is important as such changes are low cost which are critical to the success and competitiveness of such farming systems given the increasing price of inputs. This achievement is now impacting the health of rural communities through the supply of highly nutrition animal protein but needs additional investment to scale and explore the use of such principles across differing species for the differing regions of Bangladesh. We have learned to focus on improving existing systems before attempting significant change in both feed type and animal as these indigenous resources are often well adapted to the environment. Further increases in productivity can then be explored once such ‘base systems’ are working optimally.

Websites:

https://www.csu.edu.au/research/gulbali/find-experts/profiles/deputy-director/cameron-clark
https://www.csu.edu.au/research/gulbali/home
https://www.mdpi.com/2076-2615/14/3/467#:~:text=Conclusions,of%20milk%20and%20meat%20production.
https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2021.688641/full
[1]https://openknowledge.fao.org/server/api/core/bitstreams/90afce5b-9e70-46db-b720-f77c9fa2279e/content

New Research Shows Cows Fed Canola Meal Produce Less Methane

At-a-glance

Objective: To reduce methane emissions while increasing milk production by applying canola meal to dairy rations.
Lead countries/organization(s): Canada, Agriculture and Agri-Food Canada, Canola Council of Canada
Place: Canada, United States, and other countries using canola meal in dairy rations

BACKGROUND AND OBJECTIVES

Canola is one of Canada's most important cash crops. Every summer, about 20 million acres (8 million hectares) of prime Western Canadian farmland turn brilliant yellow as canola crops bloom. These vast fields yield millions of tons of tiny round seeds, containing 40-45% oil, which is extracted for use as one of the world's healthiest culinary oils. After the oil is extracted, the seed solids are processed into a protein-packed meal co-product that is a valuable addition to livestock feed.

Canola is an offspring of rapeseed (*Brassica napus* and *Brassica campestris/rapa*) that was bred through traditional plant-breeding techniques to contain low levels of erucic acid (<2%) in the oil portion and low levels of glucosinolates (< 30 µmol/g) in the meal portion. The glucosinolates were reduced due to their negative impact on certain livestock species.

The term "canola" (Canadian oil) was coined in order to differentiate the product from rapeseed. Some countries, especially in Europe, use the term "double-zero rapeseed" (low erucic acid, low glucosinolate) to identify "canola quality" seed, oil, and meal.

Canola meal is approximately 36% crude protein on an as-fed basis. The superior amino acid profile, along with a high percentage of rumen bypass protein, has repeatedly been shown to support increased milk production and to lower levels of milk urea nitrogen (MUN) in dairy cows, resulting in less waste. Canola meal is a well-researched feed ingredient for dairy cows that consistently provides value for producers, as shown in academic studies.

While the benefits of increased production were well known, little was known about the effects that feeding canola meal to dairy cows had on greenhouse gas emissions, particularly enteric methane emissions. To fill these knowledge gaps, a study was designed to determine the optimal inclusion level of canola meal in dairy cow diets to mitigate enteric methane emissions, reduce nitrogen excretion, and enhance milk production and efficiency.

ACTIONS

The Canola Council of Canada, along with provincial canola grower associations, partnered with the Government of Canada to fund research projects under the Canadian Agricultural Partnership's AgriScience Program, a federal, provincial, territorial initiative.

One project examined how canola meal can improve efficiency and sustainability of dairy production. Diets involved in the study contained 52% forage and 48% concentrate (on dry matter basis). The diets were balanced to provide 16% crude protein, with all the supplemental protein in the control diet provided by soybean meal. The test diets contained (on dry matter basis) 8, 16, or 24% canola meal.

Multiparous cows were used in the study (4 cows/treatment/period) with periods of 35 days in length. Cows were housed in individual tie stalls for the duration of the feeding trial, with ad libitum access to feed and water. Greenhouse gas production was measured using closed respiratory chambers from days 14-21 of each period. Total tract digestibility was assessed from days 28 to 33.

RESULTS

Results from the study, "Diet supplementation with canola meal improves milk production, reduces enteric methane emissions, and shifts nitrogen excretion from urine to feces in dairy cows," were published in the September 2021 issue of *Journal of Dairy Science.*

Researchers found that methane, expressed on a dry matter intake basis, as a percentage of gross energy intake, or grams per kg of energy corrected milk, declined as the amount of canola meal in the diet increased. This energy was captured in greater milk production, rather than lost to the atmosphere. Dry matter intake and energy-corrected milk increased as canola meal in the diet increased, with no effect on feed efficiency (energy corrected milk/dry matter intake). Researchers also found that more of the dietary nitrogen from canola meal was converted to milk protein, and less was lost in the urine with each incremental increase in dietary canola meal. Urine nitrogen contributes to atmospheric ammonia and nitrous oxide.

Social: Cattle producers face societal pressure regarding methane emissions from their animals. Using a sustainably grown feed source like canola meal to reduce methane emissions could provide a positive message to consumers, helping to tell a different story about cattle and their environmental impact. It could help secure dairy producers' access to markets.

Environmental: Reducing methane and nitrous oxide emissions from agriculture is one of the many ways humans can reduce climate change impacts. The global warming potential of methane and nitrous oxide are 28 and 285 times, respectively, more potent than carbon dioxide. Canola meal reduces methane emissions, shifts nitrogen excretion from urine to feces (i.e. less potential N emissions), and improves performance at the same time.

Economic: When valued on protein content alone, canola meal appears to be a good choice for enhancing dairy diets, however, when one views the added milk production benefits and reduced methane emissions, canola meal becomes a preferred source for dairy. Methane offset incentive programs may be available in some regions and provide additional economic benefits to dairy producers.

The research showed an increase in milk production on the all-canola meal diet. The leading market for canola meal is in dairy rations, and results from this study could increase the use of canola meal in dairy rations in the U.S., Canada, and other countries. Improving protein efficiency could lower feed costs for dairies and improve milk production. If canola meal is reassessed based on its complete package of benefits, it could lead to more value to canola growers and the industry.

SUCCESS AND LESSONS LEARNED

This research provided support for previous Life Cycle Analysis (LCA) model work. A complete "Cradle to Gate" assessment was conducted that simulated farms typifying conditions in Quebec and Alberta, Canada. The LCA models revealed that, relative to diets where other meal was used as the primary supplemental protein source, greenhouse gas/unit of fat and protein-corrected milk was reduced by 6.6% for the Quebec and 3.0% for the Alberta LCA, respectively.

The researchers noted that, while this study focused on milk production in Canada, the concepts and methodology used are transferrable and can be used elsewhere to evaluate greenhouse gas-mitigating strategies. The Canola Council of Canada hopes the results from this study help support canola's differentiated value in the marketplace and encourage more dairy nutritionists to include canola meal in their ration recommendations.

Website:
www.canolamazing.com

Pathways to Dairy Net Zero for a More Sustainable Future

At-a-glance

Objective: To reduce methane emissions while increasing milk production by applying canola meal to dairy rations.
Lead countries/organization(s): Global Dairy Platform, IDF, SAI Platform, ILRI, DSF, IFCN
Place: Global / East Africa

BACKGROUND AND OBJECTIVES

In September 2021, Pathways to Dairy Net Zero (P2DNZ) was launched, led by partners Global Dairy Platform, International Dairy Federation, Sustainable Agriculture Initiative Platform, International Livestock Research Institute, Dairy Sustainability Framework and IFCN Dairy Research Network, and with support from the Food and Agriculture Organization of the United Nations (FAO).

P2DNZ is a global movement that brings together the dairy sector to demonstrate its commitment to optimizing productivity and reducing greenhouse gas (GHG) emissions while continuing to provide nutritious foods for six billion people and livelihoods for one billion.

A program that demonstrates the theory of change for P2DNZ is Dairy Nourishes Africa (DNA). With DNA, P2DNZ helps coordinate investment in East Africa's dairy sector to help transform food systems delivering enhanced nutrition, environmental sustainability, improved livelihoods, economic growth and more inclusive societies. DNA is led by Global Dairy Platform, Bain & Company, Land O'Lakes Venture37, and regional and local partners.

DNA, which was launched in 2019, is designed as a 15-to-20-year public-private partnership. There are examples of DNA's success in Tanzania, where it has helped develop the country's processed dairy sector. At one time, less than 3% of the total milk produced entered formal processing. Through its programs, DNA has also worked to build inclusivity in Tanzania's dairy sector.

ACTIONS

Climate-smart farming is at the heart of P2DNZ and is a vital aspect of the work conducted by Dairy Nourishes Africa. The DNA theory of change focuses on farmer-allied dairy processors as the anchors for sector growth. These enterprises can provide predictable and transparent prices and volume offtake, technical assistance, and high-quality products while also lessening farming's environmental impact. This market-driven approach can provide farmers with higher and more stable incomes and improve consumer access to safe, nutritious, and affordable dairy products.

P2DNZ, Bain & Company, and Venture37 have also promoted inclusivity in Tanzania's dairy sector. Women comprise 70% of the dairy sector labor force in East Africa, but women's participation in other parts of the value chain is limited at best, with most benefits directed toward men. For example, it is difficult for women to access finance and business services to grow their small businesses and are often neglected by extension and input service providers.

Additional issues include high unemployment rates among youth and limited educational and financial infrastructure to support social entrepreneurship. Small businesses, in particular, struggle to access low-income customers and smallholder farmers with efficient marketing, collection, and distribution mechanisms.

Those issues underscore the importance of the Dairy Nourishes Africa – Building Inclusive Livelihoods through Dairy (DNA-BILD) initiative, a two-year project funded by the Swedish International Development Cooperation Agency (SIDA) that started in 2022.

In Tanzania, DNA-BILD is transforming the country's dairy industry by creating vibrant ecosystems of farmer-allied and environmentally sustainable enterprises that improve nutrition, enhance livelihoods, and stimulate inclusive economic growth.

DNA-BILD has expanded on the early successes of a pilot program and is designed to complement and leverage DNA's participation in the newly launched Tanzania Inclusive Processor-Producer Partnerships in Dairy (TI3P) project. This extends DNA's impact to reach resource-poor, opportunity- constrained

stakeholders across the dairy value chain that would otherwise not be engaged - particularly women and youth - to enable inclusive, climate-smart economic development in the dairy sector.

RESULTS

DNA-BILD significantly enhances farmer livelihoods and inclusivity through training, capacity building, and targeted support for women and youth in the dairy Social: The project has led to 11,860 farmers adopting climate-smart technologies, such as improved feeding and manure management, including 5,403 women who received targeted training. The project also supports women- and youth-owned enterprises, fostering gender equality and youth involvement in the dairy sector. Promotional campaigns are reaching underserved communities, boosting demand for dairy products and expanding market access.

Social: Cattle producers face societal pressure regarding methane emissions from their animals. Using a sustainably grown feed source like canola meal to reduce methane emissions could provide a positive message to consumers, helping to tell a different story about cattle and their environmental impact. It could help secure dairy producers' access to markets.

Environmental: Enhanced productivity has led to lower methane emissions per cow and per liter of milk, reducing overall dairy farming emissions. The project has also planted 38,400 multi-purpose trees, involving 2,867 farmers in tree planting. Activities such as improved soil health and irrigation, as well as using multi- purpose trees, support better land and plant management, while the use of herbaceous vegetation decreases soil erosion and run-off.

Economic: 35% increase in farmers income from baseline ($943 to $1,270) which has resulted from the increase in milk production per cow (0.9 litres per cow per day), contributing to increase in milk sales.

Photo: Millet forage demonstration plot ready for harvesting under DNA Tanzania pilot project. © Land O'Lakes Venture37

SUCCESS AND LESSONS LEARNED

A major driver of success with DNA and in Tanzania specifically is the focus on the entire value chain.

As noted by Jay Waldvogel, a former dairy company executive who helped lead DNA projects in Tanzania and other African countries, "Dairy development in LMICs is not a new solution. The challenge has always been execution, which requires a focus on the full dairy chain from farm inputs all the way through to consumer education. And these changes require a long-term commitment."

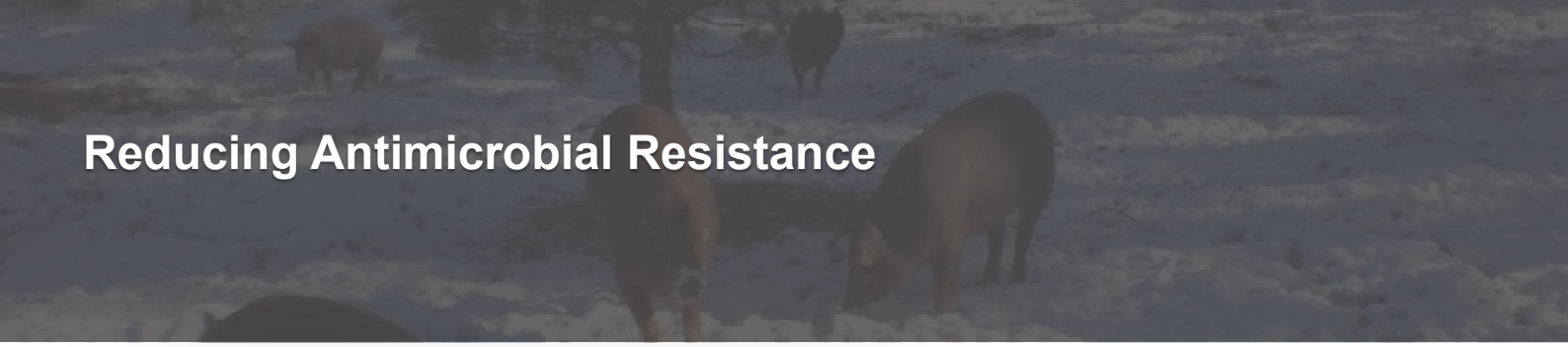
The broader P2DNZ initiative has benefited from the lessons learned in the DNA program and has evolved its theory of change based upon successes from DNA. The P2DNZ initiative is now expanding into Latin America and parts of Asia with the approach informed by the successes in East Africa.

"Dairy should not be overlooked in global efforts to sustain the health of our planet — the sector will play a critical role in sustainable development efforts," said Joachim Balakana, the National Coordinator for the Dairy Nourishes Africa program. "That means that old school dairy projects can't keep focusing on simply increasing the quantity and quality of milk; programs need to consider the environmental impact of their outputs.

"Likewise, global industry players have the resources and technical background to support supply chain improvements and share lessons learned with their smaller peers. It's really going to take a collaborative, all-hands-on-deck approach to invest in our planet's future."

Websites:

https://globaldairyplatform.com/dna/
https://www.landolakesventure37.org/



Reducing Antimicrobial Resistance

At-a-glance

Objective: To address antimicrobial resistance while maintaining productivity by reducing the use of antimicrobials in livestock production.
Lead countries/organization(s): European Commission, all 27 EU Member States
Place: All 27 EU Member States

BACKGROUND AND OBJECTIVES

Antimicrobial resistance (AMR) – the ability of microorganisms to resist antimicrobial treatments, especially antibiotics – has a direct impact on human and animal health and carries a heavy economic burden due to higher costs of treatments and reduced productivity caused by sickness. AMR is responsible for an estimated 33,000 deaths per year in the European Union (EU). It is also estimated that AMR costs the EU €1.5 billion per year in healthcare costs and productivity losses.

ACTIONS

Farm to Fork Strategy: The Farm to Fork Strategy aims to reduce the overall EU sales of antimicrobials for farmed animals and in aquaculture by 50% by 2030. To achieve this, efficient implementation of the new EU regulation on veterinary medicines is instrumental, as it catalyzes a wide range of concrete measures to fight antimicrobial resistance and promotes a more prudent and responsible use of antimicrobials in animals. More generally, curbing antimicrobial resistance is a priority for the European Commission, which is reflected in the EU's overall legal framework.

One Health: In June 2017, the European Commission adopted the EU One Health Action Plan against AMR. The key objectives of this plan were built on three main pillars:

- Make the EU a best practice region
- Boost research, development, and innovation
- Shape the global agenda

The Commission has complemented EU guidelines on the prudent use of antimicrobials in animal health with guidelines on their use in human health. The European Commission issues a progress report twice a year regarding the 2017 "EU AMR Action Plan."

Research: Health is an important topic in the EU research and innovation program Horizon Europe, with an allocation of €8,25 billion over the 2021-2027 period. This includes international research partnerships and cooperation projects. A roadmap towards the creation of the European partnership on One Health antimicrobial resistance has been created. The European Partnership for Animal Health and Welfare aims to deliver key knowledge, services, and products to significantly improve the control of animal infectious diseases and animal welfare in a coordinated way, which will sustain animal production and protect public health.

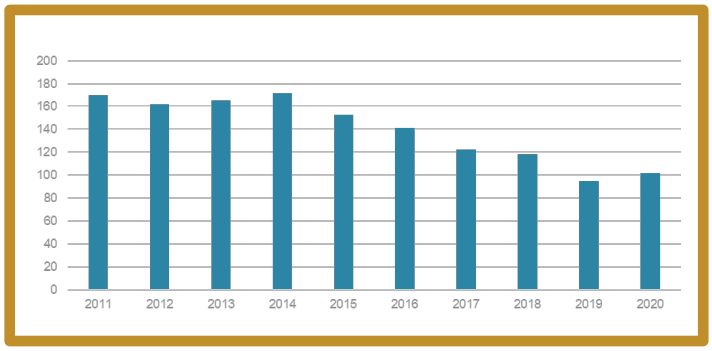
Animal Welfare: Better animal welfare improves animal health and food quality, reduces the need for medication, and can help preserve biodiversity. The Commission has and will further revise the animal welfare legislation, including on animal transport and the slaughter of animals, to align it with the latest scientific evidence, broaden its scope, make it easier to enforce, and ultimately ensure a higher level of animal welfare.

Common Agricultural Policy (CAP): The CAP supports animal welfare and thereby contributes to AMR reduction.

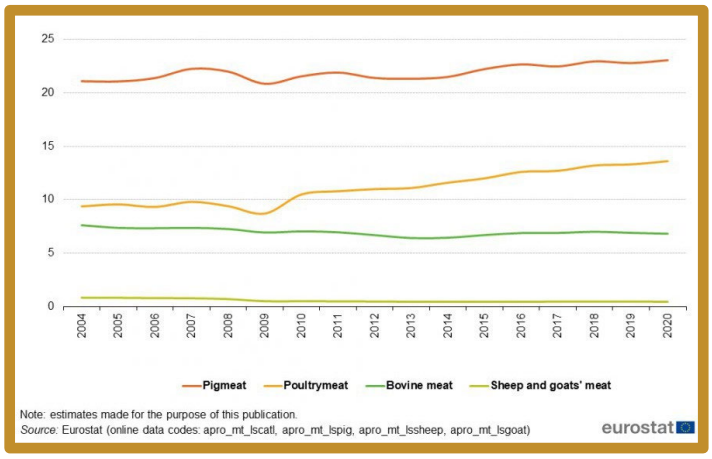
For the 2023-2027 period of CAP, improving animal welfare and combatting antimicrobial resistance is included in the specific objectives of the policy under "responding to societal demands on food & health." The CAP also funds a number of projects with and by farmers under its European Innovation Partnership program, for example, in Spain and Italy, where farmers are supported to reduce antibiotics in pig production.

RESULTS

Overall, EU sales of veterinary antimicrobials for animal production decreased by 40% between 2011 and 2020, while production increased (see ESVAC report).



Sales of veterinary antimicrobial agents marketed mainly for food-producing animals in the EU-27 (Mg/PCU of active ingredients)



Meat production (million tonnes of carcass weight, EU, 2004-2020)

Additional project impacts on sustainable development include:

Social: The reduction of antimicrobial use decreases the risk of antimicrobial resistance in animals and humans, which costs human and animal lives.

Environmental: Antimicrobial resistance in animals has a number of implications on their surrounding environments. Surrounding soil and nearby water sources, for example, could potentially be put in danger by the waste of food-producing animals treated with antibiotics.

Economic: The reduction of antimicrobial use leads to decreased spending on antimicrobials and can thereby have positive income effects, including increased meat production.

SUCCESS AND LESSONS LEARNED

The One Health approach and the combination of actions have resulted in a successful decrease in the use of antimicrobials in livestock production in the EU. With the new EU regulation on veterinary medicines, the concrete measures to fight antimicrobial resistance continue.

Improvements in animal welfare contribute to animal health and thereby to a reduction in the use of antimicrobials. The CAP has helped improve animal welfare. Additional funding possibilities and specific indicators for actions that benefit animal welfare, such as investments in stables, are foreseen in new CAP Strategic Plans that will start in 2023.

Advisory services should be encouraged as they have proven to be effective in raising farmers' technical knowledge in reducing use of antimicrobials on farms and ensuring best animal welfare practices.

To enable consumer choice for livestock products produced under higher animal welfare conditions, and to better transmit value through the food chain, the Commission is considering options for animal welfare labelling.

Website:
ESVAC Report

U.S. Dairy Net Zero Initiative

At-a-glance

Objective: To accelerate voluntary action on-farm to reduce environmental impacts, making sustainable practices and technologies more accessible and affordable to all U.S. dairy farms.
Lead countries/organization(s): Innovation Center for U.S. Dairy, U.S. Dairy Export Council, Dairy Management Inc., National Milk Producers Federation, International Dairy Food Association, NEWTRIENT
Place: United States

BACKGROUND AND OBJECTIVES

In 2020, the Innovation Center for U.S. Dairy set industry-wide environmental stewardship goals to achieve greenhouse gas (GHG) neutrality, optimize water usage, and improve water quality by 2050. U.S. dairy is accelerating efforts to reach these goals through the U.S. Dairy Net Zero Initiative's (NZI) foundational research, on-farm pilots, and development of new product and ecosystem market opportunities that remove barriers and make cutting-edge feed production, enteric methane reduction, energy production, and manure management practices accessible and economically viable for U.S. farms of all sizes, everywhere. Many technologies and practices identified through NZI can benefit dairy producers around the world. NZI strategies include:

- Attracting investments and partners to advance technology and innovation. Over the last two years, NZI has partnered with more than 50 organizations ranging from those targeted toward consumer-packaged goods to retailers, research institutions, and NGOs to develop and fund projects across the dairy supply chain.
- Evaluating new technologies and revenue sources such as manure-based fertilizer product development and ecosystem services markets. NZI focuses on development of ecosystem services markets that benefit dairy farming as a top priority.
- Expanding science-based research and data collection that close knowledge gaps, improve analyses, and advance practices and technologies that reduce the environmental impact of dairy production. Rooted in science, NZI has identified research gaps and developed plans to fund research in feed production, methane reduction, and other topics.
- Strengthening the use of best practices, resources, and tools for farmers, cooperatives, and processors, for example, through prioritizing scientific developments in the evolution of the FARM Environmental Stewardship module.

Producing the food necessary to feed a growing population amid the backdrop of climate change is challenging, and U.S. dairy farmers recognize they have a responsibility to support healthy people, healthy communities, and a healthy planet by providing nutrient-rich, responsibly made products. NZI addresses the urgent need to reduce GHG emissions and improve environmental protection to support dairy's position as an essential part of the global sustainable food system.

ACTIONS

NZI's environmental stewardship work is currently driving action in the four areas that comprise farms' environmental footprint: feed production, enteric methane emissions, energy, and manure management. Activity is organized in three workstreams:

Research, analysis, and modeling: Provides foundational science to increase knowledge, fill data gaps, improve estimation models, and identify key areas for potential impact. This leads to a comprehensive understanding of technologies and practices that are applied in dairy cropping systems and dairy farms, as well as improvements to on-farm tools to help make decisions and measure progress. Current research initiatives include the nationwide Dairy Soil and Water Regeneration project focusing on improving feed production research gaps to improve soil health and water, and the Greener Cattle Initiative, a global research consortium aiming to reduce enteric methane from dairy cows.

On-farm pilots: Focused on implementing a full suite of best practices and technologies on pilot farms across the country to prove the economic viability of reaching net zero GHG emissions on-farm. These pilots are intended to provide the scale needed to create benefits for all farms by driving down technology costs, establishing new markets and revenue opportunities, improving their environmental footprint, and discovering

untapped revenue potential on-farm. Through Dairy Scale for Good (DS4G), on-farm pilots are taking place across the country, partnering corporate entities like Nestlé and Starbucks with commercially operating dairies to demonstrate the ability to reduce emissions in an economically viable way. Simultaneously, small farm case studies are demonstrating how sustainability practices can be implemented on small- and mid-sized dairy farms.

Scale adoption: To support broad, voluntary adoption of best practices and technologies, an industry-wide network will share positive impacts and increase awareness of technical assistance and financial support opportunities. This will be further informed by supply chain demonstration projects that provide proof of concept.

Projects such as the Dairy Feed in Focus project are underway to pilot, replicate, and scale the adoption of sustainable practices. Farmers participating in the project will receive educational services, technical support, and financial incentives to support improved feed/forage production and feed efficiency on farms.

RESULTS

One key result of NZI's efforts is the 2021 launch of Starbucks' first DS4G on-farm pilot with Alliance Dairies in Florida. This woman-operated farm has a strong record of sustainable practices and is piloting additional technologies to help grow its renewable energy efforts and improve water reuse, while significantly reducing GHG emissions. Other results include:

Social: The Greener Cattle Initiative (GCI) is an industry-oriented research consortium that brings together the dairy industry, the Foundation for Food and Agriculture Research, the Council on Dairy Cattle Breeding, the National Dairy Herd Information Association, Nestlé, and other industry leaders and non-profits to accelerate progress to mitigate enteric methane emissions. GCI is currently on track to award more than $5 million in grants to fund collaborative research focusing on key areas that will help dairy farmers reduce methane through improvements in nutrition, genetics, the rumen microbiome, and sensing data and technology. The program is a vehicle for collaboration and exposure to new ideas from a variety of stakeholders within the value chain while leveraging resources and de-risking research and development, particularly for smaller organizations.

Environmental: The Dairy Soil and Water Regeneration initiative is a six-year program that involves eight research institutions and farms across the United States' four major dairy regions. The initiative focuses on research to fill three key dairy feed production gaps: soil carbon sequestration for regional dairy feed rotations; environmental, agronomic and delivery outcomes of new manure-based fertilizer products; and soil health and water benefits. Work is currently underway on this project, including developing baseline data on soil health indicators, such as reduced tillage, adding cover crops, and more, to see the effects on soil health and environmental outcomes like water quality and emissions.

Economic: The multi-year DS4G on-farm pilots set up partnerships with commercially operating dairies to demonstrate the economic viability of reaching net zero GHG while increasing and diversifying revenue. The initiative is pursuing new technology and practice change due diligence; profit and loss modeling; de-risking through demonstration; and ecosystem services market building. Nestlé and Starbucks have both launched on-farm pilots in partnership with the DS4G initiative.

SUCCESS AND LESSONS LEARNED

NZI builds on U.S. dairy's proven track record as a global leader in producing high-quality, nutrient-dense food, while using few natural resources. A study published in the Journal of Animal Science in 2020 found that producing a gallon of milk in 2017 required 30% less water, 21% less land, and had a 19% smaller carbon footprint than in 2007.

Dairy's global efficiency gains (reducing emissions per kilogram of milk produced by 11% from 2005 to 2015 while increasing global milk production by 30%) have been largely driven by innovation in U.S. dairy as the largest producer in North America. North America was the only region in the world to increase production while also reducing absolute emissions, making its emissions per kilogram of milk produced the lowest in the world.

Through NZI, U.S. dairy farmers are continuing to optimize feed and genetics, further decrease emissions (including methane), reduce food waste, and support healthier, sustainable communities. The initiative has already generated opportunities to establish nationwide research initiatives, create essential partnerships, and evaluate the feasibility of technologies to better serve a diverse industry. Even more importantly, NZI is building effective pathways for all farmers to take action by sharing learnings broadly.

Website:
https://www.usdairy.com/sustainability/environmental-sustainability/net-zero-initiative

Water Quality Management in In-Pond Raceway Systems (IPRS)

At-a-glance

Objective: To demonstrate and evaluate the technical and economic feasibilities of In-Pond Raceway Systems (IPRS) technology and soy-based feed to increase fish production with minimal pressure on water recourses through zero water exchange.
Lead countries/organization(s): U.S. Soybean Export Council
Place: The Arab Republic of Egypt

BACKGROUND AND OBJECTIVES

In-Pond Raceway Systems (IPRS) are an advanced approach to pond aquaculture that combines the management benefits of confining fish in a small portion of the pond with the production capacity of a flowing water system.

This is achieved using highly efficient aeration and water mixing equipment, which creates a robust continual flow, brings a constant supply of clean, well oxygenated water to the fish, and allows the removal of a large portion of the solid waste produced by the cultured fish. This system lowers per unit production costs, reduces environmental risks related to water quality and waste management, and significantly improves yields.

IPRS is designed to maintain water flow and is a waste removal system that keeps water quality parameters within the desired range for fish.

IPRS systems solve a number of economic and environmental problems for fish producers. Water is a scarce resource in Egypt, so improving the efficiency of the valuable resource is critical for improved water, economic, and food security. Continuous aeration keeps the fish healthier and their confinement to the cell allows for more targeted feed management. The waste removal system allows waste to be removed while the fish are growing, an improvement over other systems that require ponds to be drained and waste to be manually removed by hand or with heavy equipment. Waste removal also improves the water quality for the fish, improving their health.

ACTIONS

Egyptian fish producers face a number of challenges, including poor water quality, limited feed management options, and low survival rates for fish populations. These challenges threaten the economic sustainability of aquaculture in Egypt and can have sub-optimal environmental impacts. To provide efficient solutions, the U.S. Soybean Export Council (SEC) introduced the IPRS technology to the Egyptian aquaculture sector through collaboration with the Egyptian Government's General Authority for Fish Resources Development (GAFRD), the research and development institute WorldFish, and private sector farms. The IPRS system was implemented in the regions of Behera, Dakahlia, Kafr El-Sheikh, Fayoum, Sharkia in Egypt.

The team assessed important indicators of the IPRS system, for example, water quality parameters (Oxygen, Ammonia, pH) and water exchange rates were tested at the WorldFish farm in Sharkia and a private farm in Behera. In addition, fish growth rates at all demonstration sites were tested.

RESULTS

USSEC IPRS systems have a number of economic, social, and environmental impacts, including:

Social: USSEC training programs for IPRS systems have produced positive social benefits for Egyptian fish producers by raising the level of awareness around sustainable production practices. These trainings increase producer knowledge and allow for information sharing between producers.

Environmental: IPRS systems have positive environmental impacts, particularly around water use and efficiency in water-scarce Egypt. The production system maximizes water use efficiency in fish farming to meet the increasing pressure on water availability in the country (Nasr-Allah et al., 2018). In addition, water quality was managed properly in IPRS compared with the common pond system; no harmful ammonia levels or oxygen decline were recorded during the study period.

Waste removed from IPRS was collected and used as fertilizer for crops and vegetables planted on the dykes of fishponds or used to fertilize agriculture lands. This is considered a positive benefit of IPRS aquaculture that minimizes the nutrient and organic waste loads in discharged water from aquaculture facilities.

Economic: The IPRS system helps increase productivity and yields for Egyptian fish producers. A study concluded that tilapia demonstrate high growth performance when cultured in IPRS. Producers attained improved productivity, including a three-time increase in tilapia production in the same area pond with zero water exchange and better survival rate. Moreover, fish stocked in the open pond areas (the service species – water filter species) also produced an extra 1-2 tons/acre.

Photo Credits: USSEC

SUCCESS AND LESSONS LEARNED

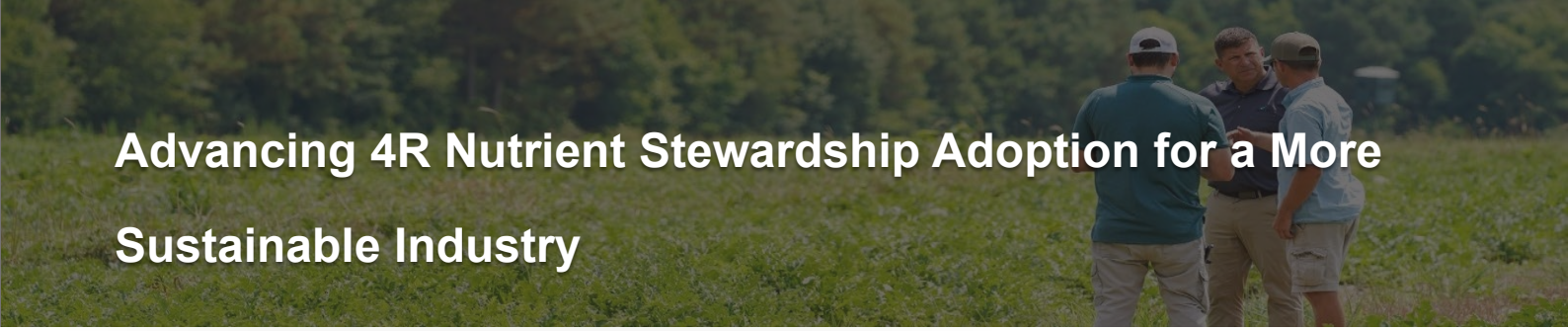
A major success of this program was the improved water quality and increased yields, ultimately leading to improved food security in Egypt. Performance of fish was not impacted by water quality issues throughout the study period and production was three times the productivity of same pond area when compared to fish produced from the open pond outside the IPRS (the service species).

Going forward, USSEC is working to introduce IPRS in other markets with different production practices in order to educate producers on the system and adapt it to local needs. In particular, USSEC is working through regional Soy Excellence Centers (SEC) to train producers in the Middle East and North Africa, South Asia and Southeast Asia, sub-Saharan Africa, and the Americas on IPRS with the hope that it can be adapted widely in different production environments and improve economic, social, and environmental outcomes in diverse markets.

Websites:

www.ussec.org
In-Pond Raceway Systems Manual
A Visual Guide to Understanding and Using IPRS

GENERAL SPG RESEARCH AND TECHNOLOGY DEVELOPMENT



Advancing 4R Nutrient Stewardship Adoption for a More Sustainable Industry

At-a-glance

Objective: To improve environmental outcomes through increased farmer adoption of 4R nutrient stewardship practices with a goal of 70 million 4R acres by 2030.
Lead countries/organization(s): The Fertilizer Institute (TFI)
Place: United States

BACKGROUND AND OBJECTIVES

Photo credits: Teresa Michael, The Fertilizer Institute

TFI looks to the future with an industry-wide commitment to 70 million acres under 4R Nutrient Stewardship management by 2030. Land managed using the 4R concept incorporates practices that use the right fertilizer source, the right rate, the right time, and apply fertilizer to the right place. When the 4Rs are put into practice, growers can achieve higher yields, lower input costs, less nutrient losses to the environment, and reduced greenhouse gas emissions.

A 4R acre is defined as an acre of U.S. cropland under management using 4R practices. This includes crediting organic sources and removal rates, variable rate technology, split applications, the use of cover crops, and accounting for weather during application.

Fertilizer is a key component of sustainable crop production systems, and the fertilizer industry recognizes the need to use these nutrients efficiently. 4R Nutrient Stewardship is an innovative and science-based approach that offers enhanced environmental protection, increased production, increased farmer profitability, and improved sustainability. Case studies have demonstrated that 4R Nutrient Stewardship practices can improve nutrient use efficiency as well as yield, resulting in improved agricultural productivity.

Objectives:

1. Increase farmer adoption of 4R Nutrient Stewardship practices to protect the environment while ensuring profitability.
2. Demonstrate unified industry commitment to nutrient management and environmental stewardship.

The world's growing population depends on responsible agricultural practices to provide a steady supply of food. Modern fertilizer techniques, such as 4R Nutrient Stewardship, precision agriculture, and best practices to help farmers improve their productivity and food nutrition.

ACTIONS

TFI values the contributions of the scientific community to the fertilizer industry and seeks to leverage those contributions to promote a strong industry, a healthy environment, and productive policy. This is accomplished through the association's strategy around research, development and science communication in the industry, which has six core elements. 1. 4R field-based applied research using University of Kentucky model; 2. Identify and solve industry research needs in partnership with research institutions; 3. Disseminate $8 million for existing research projects; 4. Establish a scientific advisory network; 5. Enhance and promote 4R industry resources and tools including the Soil Test Summary and NuGIS platforms; 6. Mobilize private industry research.

The 4R Advocate program has recognized 120 farmers and agricultural retailers who manage over 290,000 acres in twenty-five states. These forward-thinking individuals champion sound nutrient stewardship to their fellow growers, policymakers, and the media.

Aligned with TFI's research strategy, each 4R Advocate collaborates with TFI's Director of Agronomy to develop case studies for nutrient stewardship practices and their impact on environmental sustainability metrics on-farm, including nitrogen use efficiency and nitrogen balance. Case studies are an effective research communication tool to increase farmer adoption of the 4R Nutrient Stewardship framework by demonstrating improved yield and economic profitability metrics as well as environmental metrics as a result of 4R practices.

TFI also partners with member companies to financially support 4R Field Days in six different states each year with a total of $40,000 in 2024. These field days feature hands-on educational programming for farmers and trusted agricultural advisors and focus on effective adoption of 4R Nutrient Stewardship practices. In many cases, these events focus on education around intermediate or advanced 4R practices that could enhance the growers' continued investment in sustainable agricultural development.

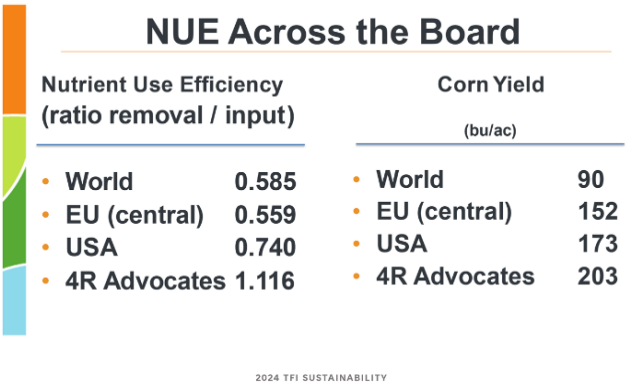
RESULTS

As of 2023, TFI, in partnership with its members, can confidently report that 46 million acres of U.S. farmland are under 4R Nutrient Stewardship practices. The combination of 4R research, the 4R Advocate program and case studies, and support for 4R Field Days have expanded acreage under 4R practices and helped to unify the fertilizer supply chain in a commitment to nutrient management and environmental stewardship.

Social: 4R Advocates serve as innovators and leaders in their communities. Farmers follow farmers and adoption is increased with a credible spokesperson. 4R practice adoption can also lead to increased land preservation.

Environmental: 4R research and the Advocate case studies demonstrate nutrient use efficiency and other metrics that show positive impacts on water quality. Broadly speaking, 4R practices can lead to reduced GHG emissions and prevent land degradation through erosion.

Economic: When farmers utilize advanced 4R nutrient stewardship, fewer inputs are required, and they can increase profitability, as demonstrated in TFI's 4R case studies.



SUCCESS AND LESSONS LEARNED

The industry is still progressing toward committing 70 million acres of farmland to 4R Nutrient Stewardship. TFI and its retail members can confidently report that there are 46 million farmed acres in the U.S. under 4R Nutrient Stewardship as of 2023. Reporting for the 2024 growing season is currently underway.

The Fertilizer Institute relies on members within the retail agronomy sector to accurately report on the acreages of growers they work with, while abiding by data privacy standards. TFI is leading the way in ensuring acres are accurately accounted for.

Stakeholder engagement has been another lesson learned. A goal like this requires strong relationships with key stakeholders in the supply chain to ensure commitment to farmer adoption and the acre goal, as well as timely reporting. As a result, TFI has provided additional resources to retailers and agronomists who advise growers on both products and on-farm practices through research communications as well as the Agronomy Conference and Expo.

Website:
https://www.tfi.org/insights/nutrient-stewardship/

Antimicrobial Resistance (AMR)

At-a-glance

Objective: To promote the resilience of agriculture to antimicrobial resistance for the health and safety of animals, plants, and the public.
Lead countries/organization(s): USDA's Agricultural Research Service (ARS)
Place: Global

BACKGROUND AND OBJECTIVES

Concerns are growing about the increase in the amount and diversity of multi-drug resistance in bacteria, which reduces the usefulness of current antibiotics and may increase the risk of more severe infections and hospitalizations, particularly from *Salmonella*, *Escherichia coli*, and *Campylobacter* infections in humans. The increase of pathogens with antimicrobial resistance (AMR) is a serious threat to animal, plant, and public health and can lead to economic loss for agricultural industries. In September 2024, a United Nations General Assembly high-level meeting on AMR resulted in a political declaration that recognized AMR as one of the most urgent global health threats and called nations to action to protect the ability to treat human, animal, and plant disease, and to enhance food safety, food security, and nutrition. Work is needed to develop innovative AMR control strategies and tools to protect animal, plant, and public health, and to understand the fate and transport of resistant bacteria through agricultural ecosystems.

National and international strategies have been developed and continue to be regularly updated to address AMR. With the increased scrutiny and pressure to reduce antibiotic use, particularly in agriculture, there is an immediate need to develop and evaluate effective alternatives to antibiotics. These alternatives include vaccines; microbial-derived products; phytochemicals; immune-related products; plant resistance to pathogens; and innovative drugs, chemicals, and enzymes that could reduce the use of medically important antibiotics.

ACTIONS

ARS scientists conduct broad, cross-cutting research on AMR to address stakeholder priorities to protect food safety, food security, animal and crop health and productivity, and agricultural sustainability. Research foci include (but is not limited to) applied genomics, epidemiological analysis, virulence analysis, bioinformatics, data analysis, and machine learning. Work includes assessing drivers and developing mitigation technologies such as precision agriculture tools, management strategies, vaccines, diagnostics, and alternatives to antibiotics. ARS scientists use breeding to improve plant and animal resistance to pathogens to reduce the need for antibiotics.

ARS is a key collaborator as part of national and international interagency working groups, including Genomics for Food Safety, National Antimicrobial Resistance Monitoring System, Transatlantic Taskforce on Antimicrobial Resistance, and Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria. ARS research priorities related to AMR are:

- Risk: Developing risk tools and models to assess drivers of infections and resistance genes across agricultural settings, and developing predictive analysis abilities to optimize processes to address AMR
- Systems biology and detection strategies: Developing rapid and innovative end-user-based technologies for AMR detection and diagnosis, facilitating data exchange, and advancing strategies for using risk models and decision support systems to reduce and prevent critically important AMR
- Mitigation: Developing novel infection prevention and intervention strategies, including alternatives to antibiotics (ATA), to optimize antibiotic use and reduce AMR transmission.
- Science outreach: Fostering collaboration and communication around AMR and ATA research to enhance solution-based research.

RESULTS

Reducing AMR throughout the food chain is a priority for ARS and USDA. Research findings protect the health and welfare of people and animals, enhance agricultural productivity, food safety, and food security. ARS prioritizes research on mechanisms that confer antimicrobial activity, antibiotic alternatives, gene editing for disease resistance, and models to assess drivers of AMR movement across agricultural settings.

Social: ARS AMR research provides innovative, equitable, and sustainable AMR solutions that will protect consumer health, support stakeholders (e.g., producers), and improve agricultural production systems.

Environmental: Research priorities ensure the productivity of agriculture while understanding drivers, and vectors that reduce transmission of genes or pathogens associated with AMR.

Economic: Research includes reducing the economic burden associated with treating plants, animals, and people who are infected with antibiotic-resistant pathogens to ensure a sustainable and secure food supply. ARS research prioritizes solutions that are economical and practical so as not to contribute to rising food costs and food insecurity.

SUCCESS AND LESSONS LEARNED

Recent ARS results include the following:

- Developing novel lytic bacteriophages as antibiotic alternatives to control foodborne pathogens, such as Shiga toxin-producing *E. coli* and *Salmonella enterica*, to minimize antibiotic resistance.
- Demonstrating that vaccinating turkeys with an available *Salmonella* vaccine limited intestinal colonization and systemic dissemination by serovars Infantis and Hadar containing the pESI megaplasmid, a known carrier of antimicrobial resistance genes.
- Developing a bacteriophage endolysin treatment for combating *Streptococcus iniae* infections in aquaculture; the treatment is a green alternative to antibiotics and is the first successful use of endolysins in aquaculture.
- Working on using artificial intelligence (AI) to detect emerging infectious bovine keratoconjunctivitis (IBK), the most common ocular disease of cattle worldwide. The AI detected early, emerging cases before clinical signs were visible, making it useful for preventing large outbreaks and thereby reducing antibiotic treatments.
- Developing rapid assessment techniques for grape powdery mildew resistance to fungicide resistance, providing producers with tools to make more efficient fungicide selections and avoid crop losses associated with fungicide resistance.

Website:
https://www.usda.gov/antimicrobial-resistance-overview-amr

Building a Global Toolkit for Disease- and Climate-Resilient Crops

At-a-glance

Objective: To combat the most intractable, destructive crop diseases plaguing agriculture by scaling the first-of-its-kind global resistance toolkit.
Lead countries/organization(s): 2Blades, The Sainsbury Laboratory, IBM, Kaneka
Place: Global

BACKGROUND AND OBJECTIVES

Crop disease and pests are among the most significant threats to our food supply, accounting for up to 40% of all global yield loss among major crops. Losses are compounded by the escalating climate crisis, leading to more pathogens in new places.

A highly effective way to protect our crops is through a plant's native immune system. Plants contain immune receptors that detect pathogens both outside and inside the cell and alert the immune system. The largest class of intracellular plant disease receptors are "NLR" proteins. Just as people are not innately immune to all diseases, individual plants may not be resistant to specific crop diseases. Often, this occurs because they do not have an NLR to recognize a particular pathogen, resulting in a failure to activate their defense mechanisms. It is possible for plants to gain recognition by breeding in new NLRs through conventional and molecular breeding, a major goal of crop improvement. Yet identifying and validating functional resistance genes has historically been difficult, time-consuming, and expensive.

To meet this challenge, 2Blades developed the gene discovery platform, NLRseek™. It rapidly enriches, identifies, and validates effective disease resistance genes for any crop. Objectives are to expand a successful first-generation platform for cereals into a next-generation platform for legumes and solanaceous crops, such as potato, and implement Artificial Intelligence (AI) tools to make the platform smarter and faster, improving efficiencies and reducing costs. The resulting faster, cheaper access to new resistance accelerates breeding and yield protection, enabling productivity growth.

ACTIONS

The NLRseek™ program was initiated seven years ago to explore an observation that effective resistance genes appeared to be expressed at higher levels than ineffective ones. 2Blades and collaborators undertook a process of identifying promising NLR genes from a diverse panel of grasses, and, in collaboration with Kaneka Corp, it transformed an unprecedented scale of 1000 genes into individual wheat plants. The outcome was a living array of genetically similar wheat plants, differing by a single NLR. This whole plant assay system provides a unique system for detecting the contribution of individual resistance genes in intact plants.

The wheat-based cereals array was subsequently screened with a series of the most damaging diseases of wheat: wheat stripe rust, stem rust, leaf rust, wheat blast, and Fusarium head blight. The platform both confirmed the handful of known resistance genes and identified new, *functional* resistance genes against each pathogen on an unmatched scale.

NLRseek™ also overcame bottlenecks found in conventional approaches for identifying and validating genes by reducing discovery time and staffing by 2-3x while increasing output up to 30x. This breakthrough approach enhances our capability to source scores of immune receptors for agriculture. Moreover, NLRseek™ does not depend on the availability of a reference genome, which is available for only 0.1% of land plants, so it can be used for mining genes from virtually any plant for virtually any disease.

2Blades has been investigating machine learning and AI to extract deeper information about the NLR gene family. AI tools can improve efficiency and even make the platform predictive, speeding options for new and emerging diseases. With a functioning prototype, 2Blades is now replicating the array for other types of crop plants and drawing on deeper sources of plant materials held in broad germplasm collections.

RESULTS

The initial 1000 gene NLRseek™ wheat array identified and validated hundreds of genes in screens with the five distinct pathogens mentioned above. For example, it validated nineteen new gene candidates to protect wheat from deadly stem rust - the cause of epidemics since Roman times - and 82 new gene candidates for wheat stripe rust - a 1,640% increase from the five genes identified over the past 50 years. Resistance to Fusarium in wheat is an important target, and functional genes in wheat may also protect corn from Fusarium – in both cases reducing levels of dangerous mycotoxins, which are severe and even deadly contaminants in food and feed.

Social: NLRseek™ is vastly scaling the availability of sustainable genetic solutions to protect the global food supply from pathogens. This growing global gene collection is a digital compendium that can benefit any crop. Because 2Blades will implement this innovation by capturing fair market value in commercial markets and providing low-cost access to benefit smallholder farmers in developing countries, NLRseek™ can ensure productivity growth equitably.

Environmental: NLRseek™ captures biodiversity from a wide swath of natural species, and it produces solutions to protect large acreage, as well as regional and "orphan" crops important for agrobiodiversity and climate resilience. The platform can extract resistance genes from global genetic diversity collections and realize additional value from these deep resources for crop resilience to pests and diseases. Even genes from threatened species can be preserved. Implementation of NLRseek™ genes will reduce chemical use to manage disease.

Economic: Losses from crop diseases have existential consequences, including severe undernourishment, political instability, and economic losses approaching $300 billion every year. By streamlining access to disease resistance, NLRseek™ supports economic benefits and productivity growth by ensuring growers reap what they sow.

SUCCESS AND LESSONS LEARNED

While NLRs have been used successfully in resistance breeding in a range of crops, pathogens are constantly evolving, and they overcome and evade NLRs, especially when resistance is based on individual NLRs deployed over a broad area as a monoculture. Generating gene stacks by introducing multiple NLRs into a single region of the genome can provide a strong defense and increase the durability of these resistance genes, as 2Blades and others have successfully demonstrated in wheat, potato and other crops.

Yet for this strategy to be effective, sufficient numbers of new NLRs—and especially NLRs not previously deployed in agriculture—are needed. Modern crop cultivars have a limited number of inherent NLRs; therefore, it has proved important to expand the gene pool by looking into related plant species.

The first-generation NLRseek™ platform has provided tools to help protect wheat from deadly diseases. The next generation of the platform allows for expansion – in the number of genes in the cereals dataset, into new crop families, into deep germplasm resources, and into computational tools that can improve efficiencies and produce solutions faster in the face of existing and emerging threats.

Website:
www.2blades.org/our-activities/nlrseek

Climate Services Australia: Combining Historical, Seasonal Forecast, and Projected Climate Data

At-a-glance

Objective: To enable farmers, businesses, and communities to better understand the climate risks they face and their resilience to those risks.
Lead countries/organization(s): Funded by the Australian Government's Future Drought Fund and delivered by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Bureau of Meteorology
Place: Australia

BACKGROUND AND OBJECTIVES

Australia's climate is highly variable, with lower average rainfall and higher rainfall variability than most other nations. As a result, Australian agriculture is subject to more climate related risk than almost any other country in the world. While Australian farmers are accustomed to climate variability, the emergence of climate change is presenting new challenges. Climate models predict changes in future rainfall patterns and more severe droughts and floods. Over the last 20 years, large changes in Australian climate have already been observed including reductions in average winter rainfall in southern Australia and general increases in temperature. Climate Services for Agriculture (CSA) is a foundational program of the Future Drought Fund and is an online platform that supports users to make decisions based on the risks and opportunities of future climate scenarios. Farmers, businesses, and communities that better understand their climate risks, resilience, and adaptation pathways are more likely to take action to manage drought risk.

What is the CSA Platform?

- A free online platform designed to make climate information more accessible and useful for farmers, industry, and rural and regional communities.
- Aims to build resilience by enabling users to:
- Anticipate future climate conditions
- Draw comparisons with recent weather
- Consider what it could mean for the commodities they produce
- Developed through co-design processes

ACTIONS

- Initially tested within 8 pilot regions, covering 2 commodities. As of February 2023, this has expanded to 17 commodities
- By December 2023, the program is expected to have extended, delivering nation-wide coverage, and covering approx. 27 commodities
- 5km2 data resolution

Users can access the CSA platform using a digital device by first identifying their location on a continent wide map and stepping through various options – from accessing commodity specific seasonal indicators (such as heat risk for productivity for sheep or spring heat risk for barley crops), through to historical records and forecasts. As a large continent with considerable climate variability, CSA provides for site specific and commodity specific climate information.

User engagement and feedback continues to support the development of the platform with ready feedback options available. Initial improvements are focused on enabling faster data loading and responsiveness, and enhancements to web design for improved access via mobile devices.

RESULTS

Project impacts on sustainable development include:

Social: Communities can make informed decisions, adopt risk management practices, and implement activities that improve their resilience to drought.

Environmental: Farmers are making informed climate decisions to better manage their natural resources through drought.

Economic: Farmers are using integrated climate information to make business decisions to improve business resilience, reduce financial exposure to drought, and manage income streams.

Further developments to enhance the tool include:

- An 'Extreme Years' feature has been added, which allows users to compare past extremes with potential future extremes in climate
- Tailored climate impact information for a greater number of commodities
- User customisation of temperature and rainfall thresholds and date ranges
- A new Temperature Humidity Index for beef, dairy, and sheep
- A News and Events section
- Updated FAQ and About pages
- Updates to user interface focused on ease of use of the data and interpretation based on user testing
- Further enhancements to web design for improved access via mobile devices

SUCCESS AND LESSONS LEARNED

A major success of this program was the improved water quality and increased yields, ultimately leading to improved food security in Egypt. Performance of fish was not impacted by water quality issues throughout the study period and production was three times the productivity of same pond area when compared to fish As of January 2023, the CSA platform has more than 1,800 returning users. Feedback on the prototype has been largely positive. Constructive feedback and advice from users continue to guide further developments to the platform.

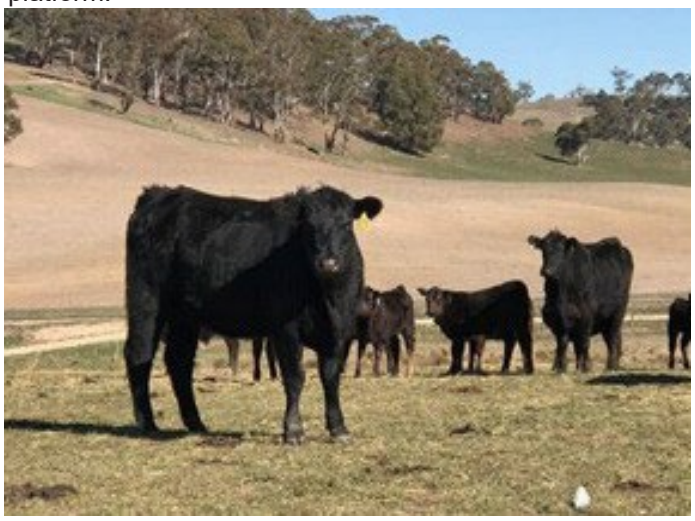


Photo Credits: Bureau of Meteorology

Conservation Resource Guides: Building Grower Awareness of Conservation Funding Opportunities

At-a-glance

Objective: Provide easy-to-use conservation resource guides that allow farmers to understanding funding opportunities for their operation.
Lead countries/organization(s): United States/Syngenta
Place: USA

BACKGROUND AND OBJECTIVES

For growers, acquiring knowledge and access to funding for continuous improvement and conservation practice adoption can be challenging. Recognizing an opportunity to simplify sustainability for growers, the Sustainable and Responsible Business (SRB) team at Syngenta developed easy-to-understand guides for growers to identify conservation funding opportunities in their area. These Conservation Resource Guides have been developed for multiple states, allowing growers to view conservation programs and direct contacts available in their area. Currently, Syngenta offers these guides for Idaho, Illinois, Iowa, Maine, Minnesota, Nebraska North Dakota, Oregon, Washington, and Wisconsin with more to come as demand for the material grows.

Our purpose behind developing these guides was to provide a simple reference point for growers looking to boost their conservation practice adoption through access to funding opportunities. Ultimately, the guides will help growers implement practices for positive environmental outcomes and greater business operational efficiency.

ACTIONS

Syngenta's Sustainable Outcomes in Ag Standard encourages growers to adopt opportunities for continuous improvement based on the results of their performance assessment. After countless conversations with producers across the United States, the SRB team at Syngenta identified an opportunity to support them in accessing public funding for these efforts, such as NRCS's Environmental Quality Improvement Program (EQIP) or Conservation Stewardship Program (CSP) – opportunities designed to supplement the costs of implementing continuous improvement in agriculture. We decided to invest in developing Conservation Resource Guides – an at-a-glance view of some of the more popular or readily available funding sources for farmers seeking to adopt new practices or continue existing ones.

The resources are customized by region (as determined by the participating producers in Cropwise™ Sustainability (CWST) projects) that provide background information on available programs, with links to access more information and specific contact information where it is available. For easy access, we have made these guides available on the Syngenta Sustainability Champions website and update them annually. Depending on demand, the team can work to develop new guides throughout the year.

The Conservation Resource Guides contribute to sustainable agriculture productivity growth by steering growers towards continuous improvement. They offer tailored information and access to public opportunities that can help offset the costs for growers looking to adopt or maintain sustainable practices. They effectively empower farmers with the knowledge and resources to make decisions that can reduce costs and boost productivity.

RESULTS

In its over two-decade deployment in dairy, accelerated breeding has successfully led to the introduction of low-methane dairy cattle, improved animal health, and lowered the environmental footprint of the cattle industry.

In 2024, Syngenta's SRB team published its Conservation Resource Guides for potatoes, corn, and soybeans in states where these crops rank among the most produced and align with partnerships on CWST.

The guides are proving to be a helpful resource for partners who are using CWST and the Sustainable Outcomes in Ag Standard for measuring sustainability performance in their supply sheds. If interested, the documents can be co-branded with partners.

Since launching our first round of resource guides, the SRB team is awaiting feedback from growers who have used them to find funding sources. We expect their uptake to grow over the coming years as more programs become available and CWST adoption expands.

Overall, this initiative empowers farmers to make informed decisions that benefit their communities, economies, and the environment.

Social: The guides support the agricultural community's knowledge sharing by providing growers with resources to access funding and improve sustainability practices. Access to funding can lower implementation costs and improve the grower's bottom line.

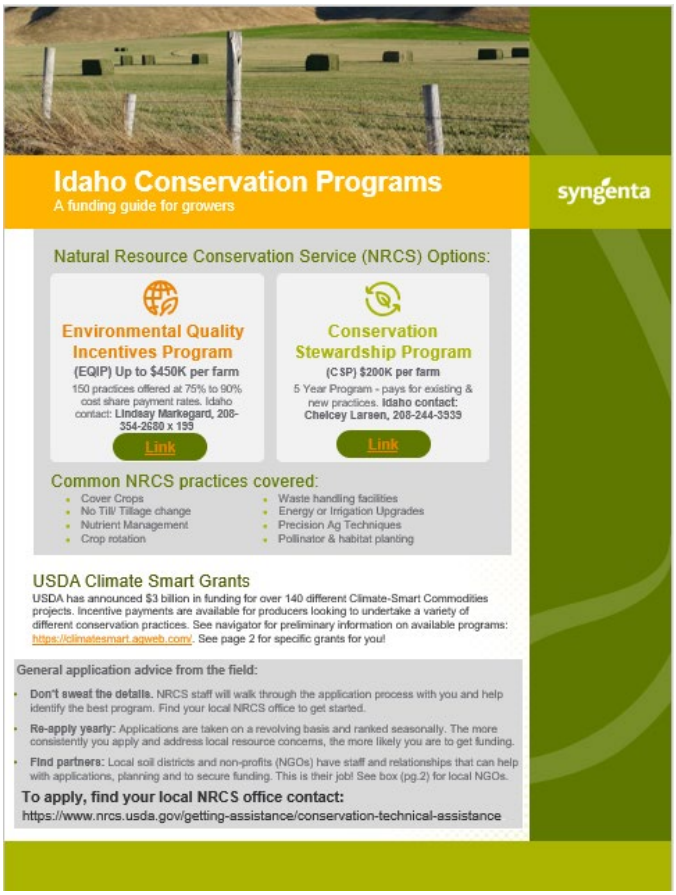
Economic: The funding support provided by the highlighted programs can foster long-term agricultural productivity and profitability.

Environmental: The guides help farmers reduce their environmental impact by promoting sustainable farming practices. Promoting continuous improvement encourages better resource management and conservation efforts on farms.

SUCCESS AND LESSONS LEARNED

Leveraging decades of experience of collaborating with growers, Syngenta recognizes the importance of creating simple and easy-to-use sustainability tools that enable them to run their businesses more efficiently. Through several iterations of the guides, we landed on a single-page front and back format. While there are numerous conservation programs throughout the United States, we selected focused opportunities we believed could bring the biggest impact to their operations.

We recognize that some conservation program contacts may change throughout the year, which can be frustrating. Hence, we are exploring ways to keep the information up to date on our Sustainability Champions website with minimal burden and cost.



Dalan's Honeybee Vaccine Advances Food Security, Safety, and Sustainability

At-a-glance

Objective: To advance science-based and sustainable solutions for honeybee health through innovations in vaccine development.
Lead countries/organization(s): Dalan Animal Health
Place: US and Canada

BACKGROUND AND OBJECTIVES

Although pollination is valued at $1 trillion and critical to around 40% of the world's food supply, honeybee pollinator populations remain threatened by infectious diseases and colony collapse. Every year, honeybees are the most abundant pollinators used to secure high crop yields in large-scale agricultural projects globally, but 20-40% of colonies die in the process.

Multiple threats, including biodiversity loss, excess agrochemical exposure, climate change, and parasite vector spread make them more susceptible to infectious diseases. These range from bacterial diseases such as American Foulbrood (AFB) and European Foulbrood (EFB) to varroa mites, which are major carriers of viral diseases like the Deformed Wing Virus B (DWV-B), which is significantly correlated with Colony Collapse Disorder. As honeybees compete with native pollinators, these dangerous diseases are also at risk of spreading to other populations.

To tackle this disease pressure, beekeepers worldwide resort to pesticide and antibiotic use in hives. However, these interventions have unintended consequences, including residues in honey, disturbance of the bee microbiome - leading to enhanced disease susceptibility - and development of Antimicrobial Resistance (AMR). AMR-resistant bacteria are being documented in apiaries worldwide.

ACTIONS

To directly address these concerns, Dalan has developed the world's first honeybee vaccine, which is conditionally licensed by the USDA and CFDA to protect against a leading driver of antibiotic use in hives: AFB.

In this non-GMO and first-of-its-kind science-based solution, Dalan has found a way to reduce colony losses to a major infectious disease, increase honey yields, with the goal of becoming a leading tool in sustainably improving agricultural productivity.

Dalan's vaccine works safely with the insect's immune system and leverages their natural Trans-Generational Immune Priming (TGIP) mechanism to provide generational protection. When fed to the queen via her nurse bee, the vaccine leads her to lay vaccinated eggs in the entire hive, thus maximizing immunity.

In addition to rigorous assessment by the USDA Center for Veterinary Biologics during development, the vaccine has shown significant promise in addressing infectious diseases in honeybees and promoting agricultural productivity growth by removing pollinator loss as a factor that limits growth potential. In two large-scale controlled field trials with commercial beekeepers in the US, comprising 600 hives, the vaccine has demonstrated an 83 to 90% reduction in DWV-B virus loads in vaccinated bees, with extended protection across an entire season. By reducing DWV-B loads in honeybees, we expect to see reduced virus spillovers to native pollinators as well.

To date, over 20,000 colonies have been vaccinated across the US and Canada, and there have been no reports of AFB or any adverse effects. Further trials are also underway in France, Italy, South Korea, Chile, Spain, and Switzerland to demonstrate the global utility of this vaccine to various honeybee subspecies and production systems.

RESULTS

Social: Improved bee health will contribute to better pollination, crop yields, and food security. The quality of honey for broader uses and public health is also expected to improve as vaccinations reduce the need for antibiotic use in hives. Any potential impact on potential sources of AMR will reduce the societal burden of this “silent pandemic.”

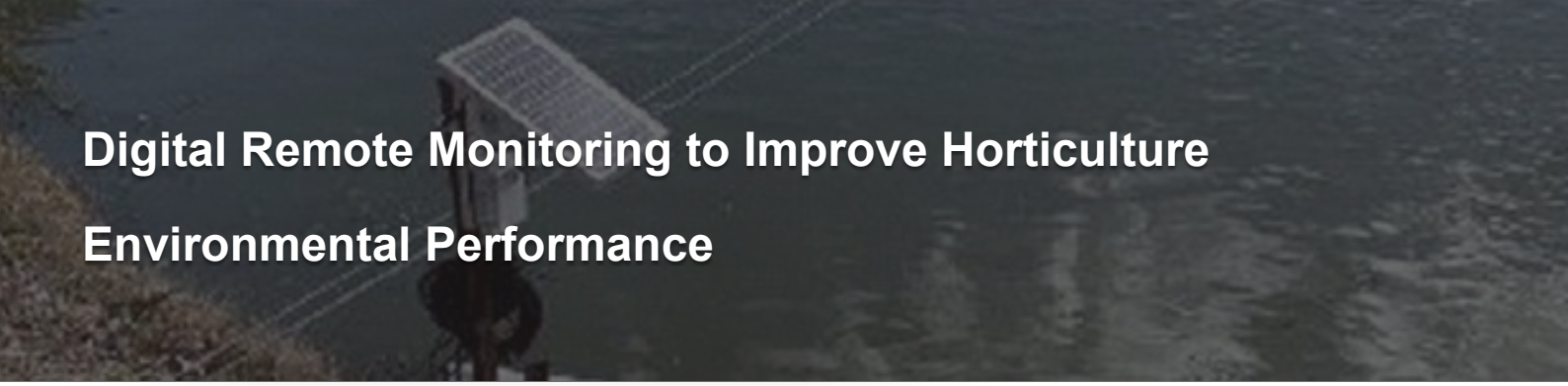
Environmental: Given the evidence of DWV-B control through the vaccine, there is the potential to reduce the risk of spillover to native pollinators. Healthy honeybees pollinate up to 200 plant species in addition to commercial crops, thus contributing to biodiversity health in agricultural areas. By preventing loss of bees, this vaccine can eliminate the “wasted emissions” in raising non-productive bees.

Economic: Reduced loss to disease means enhanced productivity for beekeepers using existing inputs. One-third of all the food we consume relies on pollination; food security depends on honeybee health. Healthier and stronger honeybee colonies increase crop yields for growers and ensure the availability of the most nutrient-rich foods to consumers.

SUCCESS AND LESSONS LEARNED

- **Success:** Dalan has developed and registered the world’s first honeybee vaccine, with efficacy against two significant diseases. This has demonstrated the value of harnessing the innate immune system of insects to develop sustainable solutions to the pollination crisis instead of toxic antibiotics.
- **Challenges:** While the societal benefits of honeybee health regarding food security and AMR are huge, the costs of interventions accrue solely to the beekeeper. We have yet to engage government, growers, and civil society in sharing the cost burden of a sustainable intervention traditionally considered “free.” This is an area we are actively working to address.

Website:
https://dalan.com/dalan-bee-vaccine-technology/



Digital Remote Monitoring to Improve Horticulture Environmental Performance

At-a-glance

Objective: To use digital remote monitoring to increase understanding of costs and benefits to businesses by monitoring and evaluating environmental performance. The project aims to reduce time spent on farm auditing to demonstrate environmental performance compliance.
Lead countries/organization(s): Australia, Hort Innovation Australia Ltd.
Place: Great Barrier Reef catchment

BACKGROUND AND OBJECTIVES

There is increasing pressure for horticultural industries in Queensland to manage phosphorus and limit inorganic nitrogen loads, which are difficult to measure and model. Runoff from farms drains into local catchments that eventually reach the ocean in coastal areas close to the Great Barrier Reef marine park.

Nutrient pollution in marine parks can impact various aspects of sensitive reef ecosystems. In combination with climate change impacts, including extreme weather events, nutrient pollution is impacting the Reef's resilience and recovery.

Hort Innovation Australia Ltd has established three pilot demonstration smart farms in the Great Barrier Reef catchment. These pilot farms incorporate four different crop management systems, including for banana, vegetable, and avocado, and nursery crops. These smart farms use a digital dashboard to integrate sensor and other data to remotely monitor environmental performance and drive adoption of best management practice codes nationally. In addition, new technologies have been used to automatically collect and provide evidence for certification audits.

Remote technology has been used in the continuous monitoring of environmental indicators, such as nutrient leaching, sediment runoff, water and energy use efficiency, and more. These insights will guide best management practices around irrigation, fertilization, and plant care, and optimize horticulture practices for sustainable, environmentally friendly food production.

ACTIONS

The project has leveraged data, artificial intelligence, advanced analytics, edge computing, and sensor technology to predict and prescribe actionable insights based on data algorithms. In the future, the project plans to incorporate machine learning, which is a type of artificial intelligence that will allow the project's software applications to become more accurate at predicting outcomes without being explicitly programmed to do so.

Using the data, models are developed, including water balance, nutrient load, and growth, which are then fed into a digital control tower (web-based dashboard). The data is collected and interpreted remotely, reducing time spent on farm auditing.

The control tower holistically interprets productivity and environmental stewardship by integrating sensor data, weather forecasts, and biophysical models. The control tower also automates collection of data required in audit reports and provides growers with decision support tools for managing nutrient runoff, leaching, irrigation, and other management practices.

Specific technologies used to collect and collate data include:

- Soil moisture testing
- Weather station
- Band Dendrometer
- Nitrate sensor
- Sap flow sensors
- Leachate monitoring
- Irrigation pressure transducers
- Full stop wetting front detectors
- Rated flumes
- Pest cameras
- Smartphone and tablet

RESULTS

Using a digital dashboard to integrate sensor and other data remotely, farmers have been able to monitor environmental performance and implement responsive management practices to improve productivity while reducing costs and minimizing environmental footprint.

Social: Automating environmental reporting is freeing up time for farmers by reducing the time needed to manually monitor farms. This is allowing more time for farmers to plan and evaluate farm activities.

Photo Credits: Hort Innovation Australia LTD

Environmental: Establishing remote monitoring and data analytics has reduced environmental runoff and leaching (including nitrate and sediment) into the neighboring environment and catchment areas by providing accurate and actionable management insights. Modelling of nitrate leaching has been tested by the delivery partners and outcomes of the model have been incorporated into the control tower. The ability to automate records regarding fertilizer application allows modelling of nitrate runoff and leaching to occur. The control tower now allows the user to understand risks of nitrate leaching and runoff so as to improve crop, fertilizer, and irrigation management to minimize any off-farm impacts. This will improve surrounding water quality and reduce impact on the Barrier Reef marine park. The combined data is also improving the accuracy of environmental audits.

Economic: The technology installed on the pilot farms was designed to improve farm productivity, reduce costs, and simplify compliance with environmental regulations. Targeted data analysis assisted with improvements in labor efficiency by directing interventions and avoiding unnecessary management. Automated data reduced the time taken to manually collect data for audits. These factors will inevitably increase the profitability of farming systems.

SUCCESS AND LESSONS LEARNED

Use of the digital control tower has led to immediate improvements in crop management across all sites, including water, fertilizer, and pesticide input. This has led to savings in water use, farm inputs, energy use, and labor time.

Future development is planned to allow mapping for nitrogen use against Reef regulations. The next phase is progressing from data insights to business solutions and final automation for selected systems such as irrigation.

Implementing this initiative in a number of pilot sites has allowed this technology to be tested under different management practices. This shows that the technology is robust and flexible and can be tailored to different production systems.

The use of the control tower to automatically complete environmental audit forms has been welcomed by farmers. This is reducing the labor input and improving the accuracy of reporting.

Website:
www.horticulture.com.au/growers/help-your-business-grow/research-reports-publications-fact-sheets-and-more/st19024/

Diversified Species in Agroforestry Systems for Home Garden Improvement: Climate-Smart Agriculture Practices and Ecosystem Restoration in Central Viet Nam

At-a-glance

Objective: To improve the adaptive capacity and livelihoods of farmers in Ha Tinh province through applying gender-sensitive CSA approaches in home gardening systems with the potential for upscaling.
Lead countries/organization(s): GIZ/ICRA/Ha Tinh Provincial Agricultural Extension Center, Farmer's Union
Place: Can Loc and Huong Son Districts, Ha Tinh, Viet Nam

BACKGROUND AND OBJECTIVES

Ha Tinh is one of the most disaster-prone areas in the country. Natural disasters, like cold and hot spells, whirlwind, tropical storms, heavy rain and floods, occur frequently throughout the year. Agriculture is most affected by recurring drought and drastic rainfall. Out-of-date seedling species and lack of technologies make it more difficult for smallholder farmers to diversify their income and increase productivity.

The project "Support to Viet Nam for the Implementation of the Paris Agreement" (VN-SIPA), implemented by GIZ and funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK) through the International Climate Initiative (IKI), supported climate-smart agriculture (CSA) so smallholder farmers benefit from the 'triple wins' of food security, adaptation, and mitigation.

The selected CSA models in Ha Tinh aimed to improve home garden farms by combining fruit trees, peanut-grass, pineapples, bee-keeping, and duck and fish farming. These integrated home gardens with multiple-crop farming reduce the dependency on mono-plantation crops, more vulnerable to climate extremes and consequently ensure more stable livelihoods and increasing productivity and income sources for smallholder farmers. For example, peanut grass and growing pineapple help manage water resources, regulate water flow and reduce soil erosion.

Trees can moderate temperature and reduce evapotranspiration through their shades and windbreak functions, maintaining more stable growing conditions for crops. Biodiversity promotion in agroforestry also enables habitats for various beneficial animals and insects, acting as natural enemies against increasing pests and diseases. The model maintains ecosystem functions and reduces the impact of floods and droughts through green corridors on sloping land.

ACTIONS

There are three main activities:

1. *Participatory identification of scalable CSA measures:* The selection of project sites was conducted through field visits and consultation meetings with key stakeholders including farmers, local authorities, technical staff, and relevant mass organisations, considering gender-sensitive issues and household income levels (e.g., poor, near-poor, and non-poor households). Key steps to identify CSA practices including 1) collection of baseline information; 2) key problems and challenges caused by climate change, 3) existing CSA interventions; 4) a shortlist of potential interventions for CSA implementation.
2. *Fruit trees-based agroforestry:* is applied in home gardens in two districts of Ha Tinh. Planting new citrus fruit species addresses poorly designed farms and monocultural farming with low production yield and quality, while planting pineapple and pinto-grass to enhance vegetation as cover crops reduces surface runoff and evaporation and prevents soil erosion. New seedlings and probiotics were distributed for composting. Beekeeping and other livestock farming were integrated in home gardening systems to enhance ecosystem services like pollination and organic fertilization. Technical training and guidance improved farmers' production knowledge and skills, helping to replace unsustainably traditional farming techniques. Participatory agro-climate information services provided farmers with weather forecast information for better production planning.
3. *Regular 'round table' or technical working/advisory groups and organise relevant CSA capacity-building activities (trainings and local study tours) for implementation partners:* Technical guidelines and instruments to integrate CSA in land-use and development planning were developed and farmers received trainings on CSA practices, farm management and specific farming techniques. Together with Ha Tinh Farmer's Unions and Agricultural Extension Center, the project provided

direct supervision and monitoring so that farmers receive advice and support on farms. Furthermore, farmers were supported in accessing new markets to promote their products.

RESULTS

The model had the following impact:

Social: The project achieved equal participation of men and women in the household interviews, trainings, field implementation and farmer's interest groups. Local women were supported significantly in enhancing their knowledge and confidence in managing their farms and household budget. According to the project endline survey, more than 85% of interviewed women confirmed that they are involved in decision making regarding farm investment and household expenditures.

Environmental: The use of chemical fertilizers and pesticides were reduced by 30–50%. Resource efficiency was increased through organic-oriented production techniques such as netting, biological traps, recycled bags and tree pruning to prevent pests and diseases. The applied bio-fertilizer, compost, soil erosion reduction methods, and leguminous cover crops improved the soil-nutrient levels. The increase of tree cover, aboveground biomass and field biota also contributed positively to the local landscapes and reduces soil erosion.

Economic: Enhancing technical knowledge, farming practices, and product diversification increased productivity, product quality and income. The integration of short and longterm crops diversified income sources. According to the project endline report, 80% of supported households had their income increase by 30-45% per year from fruit tree and other plantation products. The application of environment-friendly farming techniques, such as bio-fertilizer and compost reduced the production cost considerably. Over 75% of participating households confirmed that their apiculture production scale and yield had improved, increasing in their annual income by 28-34%. 20% of direct beneficiaries reported an increase of at least two new sources of agricultural income.

The supported households also reported that the production and economic losses from frost, storms, floods, droughts, forest fires, pests, and diseases decreased from 30-50%. The approach has been extended from 3,000 to about 17,000 farmers in 13 districts in Ha Tinh via Farmer's Unions and the Agricultural Extension Systems after 2 years of project implementation.

SUCCESS AND LESSONS LEARNED

The home garden improvement activity has successfully enhanced technical knowledge, skills, awareness, farming techniques on CSA of 2381 households and supported an area of 200 ha for the period from 2021–2022. As of now, Ha Tinh Farmer's Union has upscaled the results of the practice to more than 25,000 households in the province via its program.

Biophysical features of project site as well as socio-economic and cultural conditions of the local people need to be considered when designing CSA measures. Support to local people must be context-specific and respond directly to the needs of the pilot households based on participatory assessment and discussion with all relevant actors, ensuring the buy-in of the farmers on the technologies from its start.

Regular technical backstopping is very important when working with local farmers. Farmer-to-farmer learning is essential as smallholders and local farmers are often inspired and motivated by witnessing new practices implemented by their neighbors or peers.

Websites:

https://ikinews.climatechange.vn/from-living-in-poverty-to-becoming-a-successful-model-farmer/

https://ikinews.climatechange.vn/wp-content/uploads/2024/07/LE00286-21.pdf

Economics of Soil Health Systems to Enhance Adoption and Environmental Benefits

At-a-glance

Objective: To assess and communicate the economics of soil health promoting practices and systems to increase adoption of soil health management systems to achieve soil health, productivity, and environmental benefits.
Lead countries/organization(s): USDA NRCS Soil Health Institute, National Association of Conservation Districts
Place: United States

BACKGROUND AND OBJECTIVES

U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS) prioritizes soil health management systems (SHMS) because healthy soils are fundamental to sustainable agriculture, environmental protection, and economic resilience. SHMS include management practices that minimize soil disturbance and maximizes soil cover, biodiversity, and the presence of living roots. NRCS is committed to helping private landowners adopt SHMS because it enhances agricultural productivity, supports environmental conservation, builds resilience, encourages biodiversity, promotes economics benefits, and ensures sustainability.

Understanding the economics of soil health is important because it highlights the financial benefits and cost-effectiveness of investing in practices that improve and maintain soil health. The connection between soil health and economics is critical for promoting the adoption of SHMS among producers, stakeholders, and policymakers.

USDA NRCS partnered with the Soil Health Institute (SHI) and National Association of Conservation Districts (NACD) to demonstrate how improving soil health can help farmers build resilience and improve profitability across a diversity of soil types, geographies, and cropping systems.

The initiative was designed to enhance adoption of soil health management systems by providing quantitative evaluation of the economics associated with those systems by:

- Evaluating profitability of soil health management systems (SHMS) using both field experiments and on-farm data.
- Conducting a joint communication/education campaign to convey results to farmers, field conservationists, agricultural consultants, and others who influence adoption.

ACTIONS

A total of 30 farmers from across the U.S. with an established history of successful implementation of SHMS in crop production were selected to assess the economics of soil health management systems for a range of crops including corn, soybean, wheat, cotton, canola, dried beans, sunflower, peanut, grain sorghum, and walnut. Some of the operations also raised dairy cows, beef cattle, chickens, and hogs.

SHI and NACD conducted extensive interviews with the 30 farmers, covering 150 field sites on which the farmers had an established history of successful implementation of a wide range of SHMS, including cover crops, no-till, reduced till, strip till, planting green, rotational grazing, livestock integration, and manure incorporation across 20 states. Interviews were designed to learn about farmers' experiences with adopting these systems and to evaluate the economics by comparing the costs and benefits before and after practice adoption utilizing partial budget analysis. Data collected were used to develop case studies, fact sheets, and videos to support soil health training and outreach. Specific objectives include:

1. Collect information on management practices, experimental treatments, yield, etc. from approximately 150 field sites and develop written reports for distribution.
2. Collect data on economics before and after adoption of a soil health management system.
3. Develop case studies, fact sheets, videos and a database to support soil health training and outreach.

RESULTS

The Initiative developed partial budget analyses for participating farmers before and after adoption of a SHMS. The data collected was then used to develop case studies for each farmer, fact sheets, and videos to support soil health training and outreach to farmers, conservation planners, and stakeholders. The outcomes highlight the diversity in SHMS and that each farm is unique. While the focus was on the economic benefits of SHMS, implementation of sustainable practices also contributes to all three dimensions of sustainability:

Social: SHMS promote healthy soils which reduces the need for chemical inputs and cleaner water from reduced soil erosion. SHMS also improve resilience to environmental challenges such as droughts and floods, thereby maintaining agricultural productivity. Data collected from the Initiative was used to develop videos, case studies, and fact sheets to promote and encourage implementation of SHMS. The data is also being incorporated into training materials to support the implementation of soil health management systems among USDA NRCS conservation planners, farmers, and stakeholders.

Environmental: Farmers reported decreased erosion and soil compaction, earlier access to fields in wet years, and increased resilience to extreme weather, among other benefits.

Economic: Adopting a SHMS not only reduced expenses, but also increased net farm income. On average, after implementing a SHMS, it cost producers $14/acre less to grow corn, $7/acre less to grow soybean and $16/acre less to grow all other crops. Across 29 farms, SHMS increased net farm income by an average of $65/acre (1 organic farm was excluded due to high revenue from price premiums that would skew the average results). Yield increases due to SHMS were reported for 42% of farms growing corn, 32% of farms growing soybean, and 35% of farms growing other crops.

SUCCESS AND LESSONS LEARNED

The initiative highlights that soil health management systems are both feasible and profitable. Conservation planners and stakeholders can provide technical assistance to farmers to design and implement a system that works for them, while also enrolling farmers into programs that offer financial assistance that best aligns with their business model.

The initiative has also demonstrated the consistently positive economic benefits reported by farmers that have adopted soil health management systems. The wide range of farms, production systems and climates included in this initiative indicates that many more farmers may also benefit economically from adopting soil health management systems, thereby expanding the associated sustainable agricultural productivity and environmental benefits for society and our natural resources.

Websites:

www.nrcs.usda.gov
www.soilhealthinstitute.org
www.nacdnet.org

Enhanced Farm Dams

At-a-glance

Objective: To quantify the impact of revegetation and control of livestock grazing on the vegetation structure, biodiversity value, economic value, and water quality of farm dams.
Lead countries/organization(s): Sustainable Farms Initiative, Australian National University, Australian Department of Agriculture, Fisheries and Forestry; Deakin University
Place: The Box Gum Grassy Woodland region, across New South Wales, and Victoria, Australia

BACKGROUND AND OBJECTIVES

The Murray–Darling Basin, in southeastern Australia, is the nation's most important food-producing area and supports more than 650,000 farm dams with more than 2.1 gigalitres (GL) of water stored, primarily for domestic livestock. While high quality farm dams can be important for biodiversity conservation, degraded dams can have significant negative impacts on the environment, including acting as a major source of greenhouse gas emissions. Sustainable Farms investigated the extent to which enhancement of farm dams to improve vegetation cover around and within them could enhance the value of such areas for livestock production and biodiversity and potentially reduce greenhouse gas emissions. Prior to this research project, there was limited information on water quality, biodiversity, and greenhouse gas emission response to management interventions to improve the condition of farm dams.

This study asked the question: Can enhancing the vegetation around a farm dam improve water quality, biodiversity, and production values, while reducing greenhouse gas emissions?

The objective of this research project was to provide new insights into the ecological properties of farm dams as a regionally significant landscape feature and quantify how they might be improved by management interventions, such as fencing, to control access by domestic livestock or vegetation planting. The other area of work being undertaken to address the research question involves applied economic analysis. The findings from the ecological research provide the parameters for the economics research, which aims to evaluate adoptability of farm dam enhancements and identify related policy and natural resource management program implications.

ACTIONS

To address the research question, the water quality, vegetation, and biodiversity among three types of farm dams were compared:

- "Control" dams were those where there had been no attempts to improve environmental conditions;
- "Transition dams" were those where a range of environmental works (such as fencing to keep livestock out) had begun within the past six months;
- "Enhanced dams" were where grazing control, such as through fencing, had been practiced for at least two years.

Our study encompassed 128 dams across 35 farming properties. Four times a year, the following indicators were measured:

- Water Quality: Three water samples were collected at two meters from the edge of each dam at a depth of 200 mm. All three samples were combined to create one sample per dam, per season. Samples were tested for 11 metrics of water quality: electrical conductivity, turbidity, pH, chloride, total nitrogen (consisting of nitrate, nitrite, and Kjeldahl nitrogen), total phosphorus, *E. coli*, and thermo-tolerant coliforms.
- Vegetation: Cover in the water ('aquatic'), the area from the edge of the water to high water mark ('riparian'), and up to 10 meters beyond the high-water mark ('terrestrial'). The woody vegetation at each site within 20 meters of the high-water mark was also quantified.
- Biodiversity was measured in winter and spring, including frog and bird life and water invertebrates. Established survey methodology included point counts for birds, artificial substrates for herpetofauna detection, and frog surveys.

The economics research focused on the following areas:

- Farm-scale net private benefits associated with animal productivity gains from dam water quality improvement.
- Farm-scale net private benefits from reduced evaporation from farm dams associated with windbreaks as part of farm dam enhancement.

- Evaluation of drivers and constraints to the adoption of farm dam enhancement across diverse cohorts of farmers.

RESULTS

The study is ongoing, with initial results showing:

- Enhanced dams have lower levels of nitrogen and lower turbidity, factors which can contribute to algal outbreaks, reduced water palatability, and animal health issues.
- Enhanced dams have significantly lower *E. coli* counts and fewer thermotolerant (faecal) coliforms. 65% of unfenced dams actually had coliform counts that exceeded guidelines for water quality for stock.
- Once a dam is enhanced, some effects of improved water quality become evident within a relatively short period, in some cases, fewer than 6 months after stock exclusion.
- The economic value of increased stock weight gain in response to improved dam water quality indicates it is possible to achieve net private benefits from enhancing farm dams. The stock weight gain parameter was 11%, which was derived from a review of the international literature.
- Windbreaks around farm dams have the potential to significantly reduce evaporation and improve dam water persistence. The production value is being evaluated as a change in the destocking with and without windbreaks around dams.
- The production value of farm dam enhancement varies significantly across different farming and stock water management systems.

The impacts for sustainable development can be considered in the following dimensions:

Social: Enhanced dams support improved stock health – both through better water quality and through better water retention during drought. Higher water quality and retention, particularly during drought, supports greater financial resilience for farmers, which in turn, plays a significant role in mental health. Healthy farmers contribute to healthy rural communities, particularly through drought periods.

Environmental: Farm dams are ubiquitous in agricultural landscapes. Our findings suggest that significant environmental benefits could be gained from relatively small interventions if they are implemented across the landscape. On a landscape scale, farm dam enhancement can increase drought resilience by holding water in the catchment for longer during dry periods, reducing greenhouse gas emissions and increasing biodiversity.

Economic: The findings from our farm-scale economics research will provide support for farmers' natural asset management decisions and inform government policy and program design. While initial research suggests that the returns to farmers far outweigh the costs of enhancing farm dams, research looks into what policies and programs could support the drivers and reduce the constraints to widespread adoption of this approach.

SUCCESS AND LESSONS LEARNED

The strength of this study is in its multidisciplinary approach, integrating insights across ecological, social, and economic research. This approach has supported capacity to bring together ecological findings with questions related to adoption of natural asset management on farms.

A major surprise from our research is the relatively short period from intervention to environmental response – in some cases, just 6 months to see benefits. This short period could be used to promote changed practices to farmers; they will not have to wait years, as one does with tree plantings, for instance, to earn a financial gain, climate resilience gain, and biodiversity gain.

A concerning finding is the presence of *E. coli* above what is recommended in 'typical' farm dams in the region. This could have an impact on stock health.

This study is groundbreaking in identifying farm dams as major greenhouse gas emitters, and the significant role that enhancement can have on reducing emissions, with the best performing farm dams acting as greenhouse gas sinks.

The adoptability of enhancing dams is influenced by the interaction between the characteristics of the farming population, their farming systems, and the characteristics of the management innovation. It is how these interact and influence the relative advantage of farm dam enhancement and how farmers can learn about and trial the practice that will determine likely adoption rates. Our ongoing research hopes to understand this interaction better and explore the implications of our findings for agricultural extension and other NRM policy and program interventions to support adoption.

Website:
www.sustainablefarms.org.au/

FAO's Drought Program

At-a-glance

Objective: To support countries to build resilience by enabling the implementation of integrated drought management.
Lead countries/organization(s): Food and Agriculture Organization of the United Nations (FAO) and United Nations Convention to Combat Desertification (UNCCD)
Place: Global

BACKGROUND AND OBJECTIVES

Drought hit more than 1.5 billion people between 2000 and 2019, and over 10 million people lost their lives due to major drought events in the past century. The importance of proactive and integrated drought management (IDM) is now increasingly being recognized. A wide array of methods and tools are available to support the planning for IDM, which allows an increasing number of countries to develop their national drought plans. Nevertheless, planning for drought follows an iterative process that requires regular reviews. More importantly, plans must be operationalized to reach their ultimate goal.

FAO and UNCCD, together with other partners, including the Integrated Drought Management Programme, World Meteorological Organization, and University of Nebraska, are working in partnership to achieve this objective and support countries in operationalizing their drought plan.

Photo Credits: ©FAO/Luis Tato

ACTIONS

The 2017 International Seminar on Drought and Agriculture was a notable step to reaffirm FAO's commitment to work with its partners and support the paradigm shift to proactive drought management. FAO's support deploys seven types of actions under its mandate to improve nutrition, increase agricultural productivity, raise the standard of living in rural populations, and contribute to global economic growth:

- Awareness-raising to anchor the engagement of decision-makers;
- Development of technical guidelines to supply tested and effective methodologies and tools, including innovative and digital applications;
- Capacity-building to empower relevant stakeholders;
- Direct support to countries to respond to concrete and context-specific requests;
- Partnerships and cooperation to widen the network and integrate the required expertise into the program on drought;
- Studies and assessments to build baselines for drought management;
- International Forums to support information-sharing and common learning.

FAO, together with the Global Mechanism of UNCCD, works further to mobilize resources and translate its vision into action. With the support of the Global Environment Facility (GEF), FAO and UNCCD embarked on a new program in 2020 to enable the implementation of national drought plans (NDPs). The project has been supporting countries since 2021 with the provision of tools and methods, peer-to-peer learning, and information to empower cooperation and partnership, establish a community of practice, align policy, and better access financing. The project implements the following actions:

- Supports the Intergovernmental Working Group on Drought to fulfill countries' aspirations on "Effective Policy and Implementation Measures for addressing drought under the UNCCD";
- Enhances the Drought Toolbox hosted by the UNCCD, and the FAO-hosted Drought Portal, as versatile and accessible online digital platforms for IDM;
- Enables the implementation of national drought plans to better align with the relevant national

frameworks through capacity development programmes and global awareness raising events;
- Improves drought vulnerability assessment and preparedness for mitigation measures to strengthen the existing methodologies with leading methods.

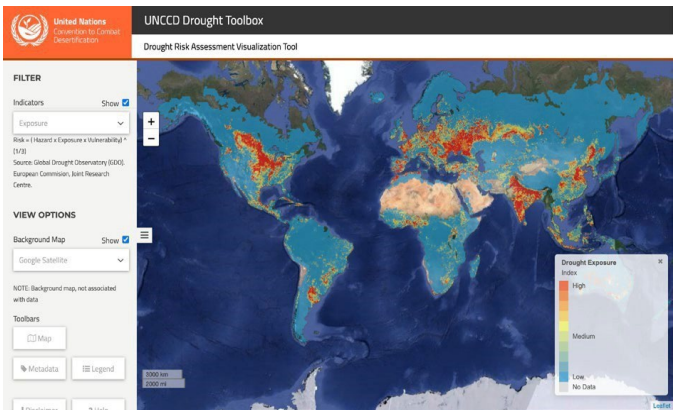
RESULTS

FAO's program on drought is expanding in terms of thematic areas and partnership, with results in line with the dimensions of sustainable development:

Social: The overall impact of the program aims to strengthen the resilience and preparedness of communities, thus improving livelihoods. Vulnerability and impact assessment is at the heart of the program, in particular, the integration of social and gender aspects in the conducted methods for enhanced resilience. Direct resources and investments can thus be directed towards the most vulnerable to make IDM accessible and inclusive.

Environmental: Inadequate natural resource management, including land and water, can impair the ability of ecosystems to withstand the impacts of drought. Therefore, building resilience of ecosystems to drought is a fundamental expectation. FAO's program advocates for sustainable practices, such as drought-smart land and water management.

Economic: Reactive approaches and emergency actions prove to be more expensive and less effective than proactive drought management. FAO promotes innovative modalities, including through public-private partnerships (PPPs), of financing for drought at all stages (pre-, during, post-drought stages). Beyond the potential for additional fundraising, such innovative modalities are based on the premises that investment in resilience and risk-financing have better financial and social returns.



SUCCESS AND LESSONS LEARNED

The lessons learned from FAO's drought program reinforces that IDM requires holistic and multidisciplinary approaches to respond to its complexity. Being considerably more intricate than planning, the future implementation of national plans will benefit from key project achievements, which include:

Strengthened global partnership: Through enhanced stakeholders' involvement, a multicriteria assessment of 31 NDPs was conducted, which led to the identification of the ready-for-implementation plans. Moreover, preparatory events in Cape Verde's WASAG Forum (February 2023) and the UN Water Conference (March 2023) were organized on drought preparedness and drought financing in view of the High-Level Meeting on Drought Resilience to be organized in November 2023, aiming to raise the profile of drought on the global agenda through multi-level dialogues. The collaboration involves national authorities, development agencies, decision-makers, research institutes, and NGOs.

Knowledge management: To develop capacities for strengthened institutional frameworks, three regional workshops were held in support of the implementation of NDPs. Based on the mapping of vulnerability assessment methodologies, six case studies were developed to illustrate approaches for drought risk profile and representation of vulnerability across the globe.

Continued development: As science and research expand, new and tested approaches are made accessible to countries to be more effective in implementation. This includes the development of the FAO Drought portal to provide open access to on-ground applications of relevant tools for drought preparedness in agriculture. A multi-criteria analysis tool, furthermore, was produced in support of national databases for drought vulnerability measurement and indication on priority areas of intervention.

Targeted finance: The increasing need for funds is addressed through the analysis and facilitation of access to innovative mechanisms and instruments to close the drought finance gap. A drought financing tracker was developed to assess the status of drought investments and inform the elaboration of statistics and analyses to support decision making based on global finance trends.

Farmers' Organisations Leading Research & Innovation on Agroecology for Sustainable Food Systems (FO-RI)

At-a-glance

Objective: To drive transition towards resilient, productive, and sustainable agroecological food systems through farmer-led innovation and research.
Lead countries/organization(s): European Commission, EU, AgriCord Alliance
Place: 16 countries: Africa (Burkina Faso, Mali, Senegal, Cameroun, Burundi, RDC, Madagascar, Tanzania), Asia (Philippines), Pacific (Fiji, Tonga, Solomon Islands and Samoa), Caribbean (Haiti) and Latin America (Brazil & Uruguay)

BACKGROUND AND OBJECTIVES

Evidence suggests that supporting small-scale farmers to build on their innovations through farmer-led joint research with scientists is important for management of natural resources and climate change adaptation. Moreover, farmer-led research strengthens the resilience of rural communities and helps farmers to maintain and improve their livelihoods in fast-changing contexts. Farmer Organisation (FO) support is crucial for transitioning to agroecological production and sustainable food systems. Agroecological sustainable practices are key to coping with climate change and meeting increasing food needs. From the FO perspective, agroecology requires adopting natural farming systems to increase soil fertility, manage pests and diseases, and build resilience to climate change, while reducing production costs and increasing incomes. FOs also view agroecology as an opportunity for peer-to-peer learning and exchange of experiences.

Resilient, productive, and sustainable agroecological agrifood systems secured through farmer-led innovation and research represent the impact of three key expected outcomes of the EU-funded Farmers Organizations Leading Research and Innovation on Agroecology for Sustainable Food Systems (FO-RI) programme: (i) Strengthened national and regional institutional support for farmer-led action research on innovative agroecological approaches, (ii) Increased local farmer know-how to apply agroecological approaches and to innovate for sustainable and resilient agroecological agri-food systems, and (iii) Enhanced organizational capacities of FO and partner entities to support farmer-led agroecological innovation.

ACTIONS

To obtain these outcomes, FO-RI developed a participatory approach structured around five components, each putting farmers and their organizations in the driver's seat of action-research and innovation. The project began with a short inception phase. Strategic partners from the continental, regional, national, and local levels, including FOs, agri-agencies, and researchers, were involved in the different aspects of the implementation. Gender and youth were mainstreamed in all programme-related activities.

At the core of FO-RI is a set of 13 action-research projects led by FOs with the technical support of agri-agencies and research organizations to design, test, and disseminate innovations based on agroecological principles. The projects focus on one or several dimensions of the food system – production, transformation, marketing. To achieve results, the capacities of researchers, farmers, and Fos to carry-out experiments and to develop agroecological approaches are strengthened.

Training and local peer-to-peer events on agroecological topics (e.g. mixed-cropping, rotation with legumes, mixed farming with livestock, agroforestry, bio-pesticides, organic fertilisers, farmers' seeds) are organized based on the farmers' demands and interests. Special attention is paid to women and youth in decision-making processes at the FO level with regards to local experiments. Specific groups are created to address topics of interest for women – such as vegetables and integrated pest management – and youth – such as organic fertilisers. Socio-political conflicts and food and health crises in some countries could affect programs; however, close monitoring and evaluation is put in place to address bottlenecks. Together with the phased planning approach, it allows for regular adjustments to activities and areas of intervention.

This knowledge-creation and sharing effort builds on farmers' own experiences, ideas, and knowledge. Capitalization of relevant experiences within and outside FO-RI is generated and disseminated by FOs, agri-agencies, and AgriCord, which is a grouping of agri-agencies and farmer organisations. Scaling of innovations related to agroecology is addressed through

the networks of these actors and similar programs worldwide. The capitalization process feeds into the advocacy component of engaging with policymakers to advance the agroecology agenda. For this purpose, partners from government, international, and regional farmer organizations and research institutes attend advocacy events and multi-stakeholder platforms and dialogues.

RESULTS

Project impacts on sustainable development include:

Social: The capacities of farmers' organizations and farmers to innovate were improved with increased training and knowledge-sharing on productive and resilient farming systems and value chains. With support of research and agri-agencies, farmers can experiment with new agricultural practices, design new farming systems based on agroecological practices, and negotiate for access to markets and services. Special attention in this project was given to increasing the skills and knowledge around agroecological practices for women and youth, two groups who, historically, have limited access to such information.

Environmental: Through this project, farmers designed and managed more diversified farming systems, increasing biodiversity at farm- and landscape-level, and nourishing soil health through better nutrient recycling and better organic matter management at farm- and value chain-level. Based on new agroecological practices farming systems became more productive and resilient to climate change. For example, diversified agroforestry systems help ensure crops are more resistant to higher temperatures.

Economic: Farmers and farmers' organizations improved the productivity of their farming systems by strengthening ecological processes, limiting the use of external inputs, and participating in value chains and markets with increased added value. New products and new markets were promoted by strengthening the participation of FOs in the governance of existing value chains or by creating new value chains.

SUCCESS AND LESSONS LEARNED

The experiments are based on action-research approaches, farmer-led innovation methodologies, and farmer-to-farmer exchanges to share results and lessons. For example, farmers learned how control pests in orchards, experimenting with different practices, such as attracting certain ants to attack insects, and shared results with other farmers during workshops. The approaches valorize local knowledge and local capacity is a key factor of success.

Strong partnerships are built at the local level with farmers, farmer organizations, agri-agencies, and research organizations to ensure the quality of the experiments, mobilize the scientific expertise, and monitor resource management. Farmers lead the process, steering planning, monitoring, and evaluation, with the support of Agricord and agri-agencies. In fact, multi-stakeholder approaches are more efficient when farmers are in the driver's seat of external supports.

As a lesson learned, advocacy is an important issue to scale the agroecological transition. The project mobilizes relevant farmer organizations at the national, regional, and continental level to support a dialogue with policymakers by disseminating policy briefs, organizing events with policy makers, participating in dialogues organized by policymakers when designing new programmes or regulations.

Website:
www.europa.eu/capacity4dev/desira/wiki/fo-ri

Farming Innovation Programme

At-a-glance

Objective: To enhance productivity, environmental sustainability, and resilience to threats in England's farming sectors.
Lead countries/organization(s): Department for Environment, Food and Rural Affairs, UKRI – Innovate UK
Place: England

BACKGROUND AND OBJECTIVES

The farming industry in England is facing changes as the industry moves away from the CAP system that relies on farming subsidies. The CAP system provides direct payments to farmers, as well as market support measures and rural support. Post EU-exit, farming businesses will need to become more resilient and efficient to thrive amid the changes. Simultaneously, England and other countries around the world face challenges related to climate change, biodiversity, carbon neutrality, and food insecurity. Agriculture plays a vital role in addressing these challenges. By funding industry and farmer-led research, development, and innovation, the Farming Innovation Programme will address the following Department for Environment, Food, and Rural Affairs (Defra) priority outcomes:

- Increase the sustainability, productivity, and resilience of the agriculture, fishing, food, and drink sectors, while enhancing biosecurity at the border and raising animal welfare standards
- Reduce greenhouse gas (GHG) emissions and increase carbon storage in the agricultural, waste, peat, and tree-planting sectors to help reach carbon neutrality
- Improve the environment through cleaner air and water, minimized waste, and thriving plant and terrestrial and marine wildlife.

Defra is operating an industry-driven Farming Innovation Programme, delivered by UKRI–Innovate UK, to support a green economic recovery by stimulating innovation and boosting sustainable productivity in agriculture during the Agricultural Transition period (to 2029). The Programme will deliver on the government's commitment to invest 2.4% of GDP in Research and Development (R&D) by 2027 and will unlock innovation to deliver farmer-led solutions to short- and long-term productivity challenges. It will address tactical and strategic challenges, such as producing nutritious food more efficiently and sustainably, whilst helping the sector to reduce GHG emissions to achieve its net zero goals. It will also mainstream new agricultural technologies, underpinned by cutting edge science, and increase farmer engagement by putting them at the center of R&D. The Farming Innovation Programme will also be relevant to the transformation of the UK's food and farming sectors and the UK's Food Strategy. It will help to drive the development of new technologies, processes, and practices that will be needed to secure a productive and sustainable farming sector into the future.

ACTIONS

The Farming Innovation Programme provides grants toward the cost of research projects and trials, awarded on a competitive basis. The programme is separated into three funds:

Fund 1: Industry-led R&D Partnerships Fund: Collaborative, industry-led research, and development projects responsive to immediate, specific, or shared industry needs with commercial relevance.

Fund 2: Farming Futures R&D Fund: Collaborative projects to address longer-term strategic and sector-wide thematic challenges impacting environmental sustainability, productivity, and resilience.

Fund 3: Projects to Accelerate Adoption Fund (under development): Smaller, agile 'on-farm' projects to test the feasibility of new technologies and demonstrate new methods to the farming community. These projects will be farmer-led and focused on finding practical solutions to immediate on-farm productivity challenges.

Underpinning these three funds will be a knowledge exchange and demonstration function. This will be aligned across the package to disseminate promising outputs and drive uptake and adoption of new technologies, processes, and practices by farmers, growers, and other end users. As of 2022, Funds 1 and 2 are live and run through the Agricultural Transition Period, while Fund 3 is still in the planning phase.

RESULTS

The Farming Innovation Programme will support innovation to improve productivity, enhance the environment, reduce GHG emissions, and improve climate-resilience. It will support the development of ideas and products to drive on-farm improvements.

Social: This programme promotes increased collaboration between farmers and researchers. It seeks to ensure that farmers, growers, and foresters remain at the heart of projects, bringing their valuable real-life experiences to the project consortia. This means that each innovation remains focused on helping to improve the day-to-day real challenges faced by those in the food sector.

Environmental: We have estimated that the Farming Innovation Programme will lead to an abatement of 4.9 mega tons of CO2-equivalent by 2050. Agriculture is responsible for 11% of total GHG emissions in the UK. As such, it has a key role to play in helping the UK meet its net zero emissions target by 2050 and these projects can help to meet these goals.

Economic: The Farming Innovation Programme is projected to contribute to increased sustainable productivity. We have estimated that the programme will raise agricultural productivity by 15% by 2050. The programme will encourage new commercial products, services, and patents by supporting R&D and new job creation in relation to the research projects. It will also promote increased private sector investment in R&D, as projects require match funding.

Our first projects started their R&D in the summer of 2022. Projects can last between one and five years. Examples include:

- Developing a herd of electric robots for horticulture. The project will aim to harvest vegetables in-field sustainably and reliably. It will overcome challenges in safety, harvest-planning, communication, and display of data.
- Developing a novel way to gain insights into the health of dairy cows. A completely hands-free solution will monitor a cow's welfare and performance without the need for wearable devices.
- Developing a crop disease surveillance network. The project utilizes several identical sensing devices located in the field of crops. The data from each sensor provides an early warning of the presence of pathogens, which is turned into a recommended management plan for the farmer or grower.

SUCCESS AND LESSONS LEARNED

As of July 2022, we have committed over £54M in funding across seven competitions. Some examples of the projects we have funded include:

- The development of sustainable, low-impact fertilizers for agriculture
- A robotic courgette harvester, which can reliably replace manual laborers
- The development of a test that can rapidly and inexpensively detect major bacterial and viral lung pathogens of pigs.

The programme has now been running for over a year, so we can use application data to gain insights on the programme. Projects are spread across sectors and we received applications from all sectors of the UK. Overall success rates show that 68.3% of applications were fundable, which shows the high quality of projects received.

From March 2023, Defra will be running a Checkpoint Review to review early outcomes and understand where the Programme can be improved further. We will look to ensure funding is reaching widespread groups across different sectors and is targeting areas that need the greatest support.

FCC Accelerated Breeding Program at GIFS

At-a-glance

Objective: Supported by a $5 million investment into GIFS' accelerated breeding by Farm Credit Canada (FCC), the FCC Accelerated Breeding Program at GIFS will drive sustainable advancements in agricultural productivity across Canada.
Lead countries/organization(s): The Global Institute for Food Security; FCC
Place: Saskatchewan, Canada and global

BACKGROUND AND OBJECTIVES

Global agricultural productivity, including Canada's, is declining. A 2023 report by FCC identifies a $30 billion opportunity over 10 years to rekindle Canada's agricultural productivity growth, and highlights innovation and technology as pathways to achieving this.

The accelerated breeding program combines technologies such as genomic selection, speed breeding, bioinformatics, and computer simulation to increase the rate of genetic gain for crop and livestock breeding programs. As a result of this innovation, new products can be delivered to producers faster with improved agronomics, quality, and disease-resistant traits. Increased genetic gain and yield derived through accelerated breeding can help stimulate economic growth and translate to increased revenue and market share for Canadian agriculture.

Deployed for over 20 years in dairy and for more than a decade in crops such as corn and soybean the FCC Accelerated Breeding Program at GIFS provides public and private breeders access to the same technologies for critical crops and livestock in Canada. By boosting Canadian agriculture's productivity, competitiveness, and sustainability, it will help to bolster the country's global position as a reliable and sustainable producer of food for the world.

This program, which is the only one of its kind in Canada that is accessible to public and private breeding organizations, specifically addresses Canada's declining productivity by:

- Increasing and improving the rate of genetic gain and the return on investment per dollar invested;
- Enabling climate–adaptive breeding for complex and desirable traits, and
- Delivering economic impact for Canada through increased sustainable productivity growth that grows farm and value-added revenue.

ACTIONS

GIFS' model of operation embraces collaboration across the entire agriculture value chain to deliver value for all. It **intentionally supports a sector-based approach** to give Canada a globally competitive edge, including through this initiative.

Moreover, GIFS has strategically positioned itself in the agri-food ecosystem to bridge the innovation gap and address the challenges of moving innovation to market for Canadian agriculture. This intentional positioning is vital as the 2024 Global Innovation Index shows Canada "performs worse in innovation outputs than innovation inputs," And the country ranks 8th in innovation inputs and 20th in innovation outputs. Canada is not deriving corresponding value from our inputs; GIFS' model is a vehicle to help Canada improve its innovation outputs.

Through the FCC Accelerated Breeding Program, GIFS has invested in much-needed expertise, scale, capacity, infrastructure, and technology platforms to shorten the breeding cycle for crops and livestock. This will help us get higher-quality and higher-yielding varieties into the hands of producers faster and improve the food on consumers' plates.

RESULTS

In its over two-decade deployment in dairy, accelerated breeding has successfully led to the introduction of low-methane dairy cattle, improved animal health, and lowered the environmental footprint of the cattle industry.

Deployment in crops has yielded more robust corn crop performance in the Americas, despite recent and dynamic weather changes. Improved stress tolerance, higher yields, resistance to pests, e.g. Bt corn with natural pest resistance, are some examples of the results of accelerated breeding.

Accelerated breeding introduction to pea development has resulted in higher yields than traditional varieties. Pulse Breeding Australia (PBA) Noosa announced the PBA Noosa Blue Pea variety, which yields 20-30% higher yields than the older Excell variety.

The following are identified as potential impacts from continued accelerated breeding efforts:

Social: Continue to improve resiliency in the face of climate change; enhance Canada's sustainable productivity growth and strengthen its global position as a reliable and sustainable food producer; and contribute to groundbreaking advancements that benefit farmers, breeders, researchers, consumers and all stakeholders.

Environmental: Enable climate-adaptive breeding for complex and desirable traits, and promote environmental stewardship through increased crop yields, heat resistance, etc.

Economic: The initiative will stimulate economic activity, help to close Canadian agriculture's productivity gap, and grow farm gate revenue.

SUCCESS AND LESSONS LEARNED

A major success is the attraction of a key federal stakeholder in Canada's agriculture sector, Farm Credit Canada. FCC's investment into GIFS and its Accelerated Breeding Program is a critical and welcome investment into Canadian agriculture.

Another success is the deployment via bilateral partnerships with GIFS, engaging all members of the value chain, including producers, public and private breeders, seed companies, grain handlers and value-added processors.

Accelerated breeding complements and supports the work of crop and livestock breeders to enhance genetic gain, shorten breeding timelines, and improve agricultural productivity. Accelerated breeding is not *one* tool but a *suite* of technologies and should be positioned as such. Users may then be selective about which of the technologies they need to utilize to achieve their goals.

Website:
www.gifs.ca

Fertilize Right

At-a-glance

Objective: Maintain or increase current levels of productivity while promoting good agricultural practices (GAP) to increase fertilizer use efficiency, enhance fertilizer effectiveness, and develop alternatives to manufactured fertilizers for building soil health and soil fertility.
Lead countries/organization(s): USDA, Embrapa, Alliance of Biodiversity International, CIAT, ICARDA, IRRI
Place: Brazil, Colombia, Pakistan, Vietnam

BACKGROUND AND OBJECTIVES

Fertilize Right is a 4-year USD 19.8 million initiative funded by the Department of State (DOS) Bureau of Oceans and International Environmental and Scientific Affairs (OES), Office of Global Change (EGC), and implemented by the USDA Foreign Agricultural Service. The initiative responds to the White House Global Fertilizer Challenge launched in June of 2022. Fertilize Right's goal is to mitigate pressure on both food and fertilizer supply through more effective and efficient application of fertilizer and the use of non-chemical alternatives which will result in lessened greenhouse gas (GHG) emissions while simultaneously maintaining, or possibly increasing, agricultural productivity growth. Fertilize Right is active in four countries: Brazil, Colombia, Pakistan, and Vietnam. Each country works with its implementing partners to promote best management practices such as precision agriculture, and tools and technologies such as educational mobile applications, mechanized composting, and technical manuals.

ACTIONS

Fertilize Right actions in all four countries are aimed at developing tools, sharing best practices, increasing soil health for sustainable agriculture, and reducing GHG emissions. The Fertilize Right Initiative is a multi-faceted program aimed at mitigating pressure on food and fertilizer supplies while reducing greenhouse gas emissions from fertilizer use.

Fertilize Right Brazil, known locally as Fertilize for Life, has pursued cutting-edge research to lessen dependence on synthetic fertilizers and lower GHG emissions. Fertilize Right Brazil's research includes synthesizing precision management technologies, conducting organo-mineral fertilizer evaluations, developing new fertilizers from livestock waste, and promoting integrated crop-livestock systems. Collaborators include public organizations like Embrapa and private sector entities such as Mosaic. Fertilize Right Colombia has conducted workshops and training events with key producer associations like Fedearroz (rice) and Augura (bananas).

Stakeholders have learned about analyzing soil health, composting, and utilizing alternative fertilizer solutions. In Pakistan, as in Colombia and Vietnam, Fertilize Right aims to address dwindling availability of agricultural inputs, such as synthetic fertilizer and irrigation, through promoting the 4Rs concept of fertilizer use efficiency and soil nutrient management. Fertilize Right Pakistan emphasizes improved agricultural practices to address overuse of synthetic fertilizers, while maintaining or improving agricultural productivity. Farmer field day events promote alternatives to manufactured fertilizers and train stakeholders how to improve soil health and soil fertility while reducing GHG emissions.

Vietnam has made strides in developing tools and technologies to improve fertilizer use efficiency and effectiveness in rice production. Initiatives include further development of the Rice Crop Manager (RCM) app, e-Extension app, and promoting practices like rice straw composting. The project's approach involves collaboration with local agriculture officials and farmers cooperatives to implement sustainable practices. Fertilize Right Vietnam is implementing precision mechanized rice seeding and site-specific nutrient management, leading to significant GHG reduction while maintaining or improving agricultural productivity. The

development of apps like RCM and e-Extension (Lua Viet), further supports farmers with tailored fertilization recommendations.

RESULTS

The Fertilize Right Initiative, incorporating results from across the four involved countries, has seen considerable impacts in the sustainable development space. Efforts in all countries are aimed at developing tools, sharing best practices, increasing soil health for sustainable and productive agriculture, and reducing greenhouse gas emissions.

Social: Appropriate fertilizer use has benefits to the health of farmers and farm workers. Inclusive educational outreach improves social capital, including for marginalized groups. In 2024, Fertilize Right oversaw trainings of 1,725 individuals across multiple countries with the intent to educate farmers on the following topics: nutrient management, soil health assessment, and use of digital tools. The Vietnam and Colombia teams are respectively developing digital applications that will aid farmers in rice crop management and fertilizer knowledge. The Pakistan team is making a concentrated effort to advocate for gender equity, including highlighting female farmer leaders in communities and holding female farmer field days to promote inclusivity.

Environmental: There was an estimated reduction of 775 metric tons CO2e from April – September 2024. This reduction was accomplished through activities such as water management, site-specific nutrient management, and nitrogen use efficiency. None of these reductions would have occurred without US Government intervention.

Economic: Projected economic benefits for the Fertilize Right project include increased crop yields from farmers following fertilizer recommendations as well as cost savings from increased fertilizer use efficiency.

In Pakistan, implementing partners conducted trials to determine the Benefit-Cost Ratio (BCR) of various fertilizer technologies or practices. They found that the recommended practice of using a dibbler, when compared to standard farmer practices such as broadcasting, significantly outweighed the cost with a BCR ranging from 2:1 to 5:1.

SUCCESS AND LESSONS LEARNED

Fertilize Right has made significant progress in launching activities in all four countries. Local partners have been identified and assessments completed. Fertilize Right is currently implementing focused training activities in each of the countries. It is still a little too early to count major successes and lessons learned from the activities. However, it is significant to note that cumulatively, among the four countries, Fertilize Right has identified 29 technologies or practices to be developed, shared or supported that increase fertilizer-use efficiency, enhance fertilizer effectiveness, and develop alternatives to traditional fertilizers for building soil health and soil fertility.

Website:
www.climatehubs.usda.gov/hubs/international/topic/fertilizing-smarter-future-introducing-fertilize-right

Fertilizer Use of Phosphorus Recovered from Sewage Sludge

At-a-glance

Objective: To facilitate the shift of the source of fertilizer from imported raw materials to the utilization of domestic phosphorus resources through enhancing the circular economy.
Lead countries/organization(s): Ministry of Agriculture, Forestry and Fisheries
Place: Japan

BACKGROUND AND OBJECTIVES

Phosphorus is a major component of fertilizer that is indispensable for agricultural production. The reserves of phosphate rock, the main raw material of phosphorus, are finite. It is important to use phosphorus sustainably to meet the global food demand that will be driven by future growth in population and income.

While the conventional source of phosphorus is excavation from mines, a new method of recovering phosphorus from sewage sludge has been attracting attention as a new phosphorus resource. Japan has also focused on this point and has been working to improve phosphorus recovery technology, progressing to the stage of using the recovered phosphorus for fertilizer.

Another concern regarding phosphorus is the geographical distribution of reserves of phosphate rock. About 80% of the world's economic reserves are concentrated in certain countries, includingof Morocco, Egypt, and China. This means that many countries need to import phosphorus, implying substantial fossil fuel consumption for transportation. In Japan, most sewage sludge is currently incinerated, landfilled, or used for building material, with only about 10% being used for fertilizer. Further utilization of sewage-origin phosphorus is possible, and its potential is significant for sustainable productivity growth in terms of saving phosphorus stocks and fossil fuels.

As global fertilizer consumption continues to increase, Japan is currently promoting the expansion of fertilizer use from domestic resources, including sewage sludge, to break away from excessive dependence on imports. Our action will contribute to improving global Sustainable Productivity Growth by reducing GHG emissions from agricultural activities caused by fossil fuel consumption for transporting fertilizer, which is indispensable for agricultural production.

ACTIONS

When using sewage sludge for fertilizer, there are two main methods: recovering phosphorus and fermenting sewage sludge to use it as compost. Regarding the method of recovering phosphorus, reducing the costs associated with phosphorus recovery and stabilizing the quality of recovered phosphorus are challenges for the expansion of the use of fertilizer. For this reason, the Ministry of Agriculture, Forestry and Fisheries (MAFF) is currently working with the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), which has jurisdiction over sewerage services, to overcome these challenges through methods such as promoting technology verification by private business operators.

MLIT has set a policy of prioritizing and maximizing fertilizer use when processing sewage sludge and has been promoting efforts by sewage system administrators. In addition, MLIT has installed full-scale facilities at local governments' sewage treatment plants and has been implementing pilot projects to further improve the efficiency of phosphorus recovery with Stravite (magnesium ammonium phosphate) and to establish phosphorus recovery technology using new methods other than Stravite, such as biochar.

Meanwhile, to promote the use of fertilizer made from sewage sludge discharged from sewage treatment plants, MAFF is promoting efforts to develop new fertilizers that use recovered phosphorus instead of imported raw materials and verify the fertilizing effects of these fertilizers. To make these efforts sustainable, it is important to promote collaboration between raw material suppliers, manufacturers, and users. MAFF is working to provide the opportunity to match these businesses. Moreover, MAFF is working to foster consumer understanding of the use of sewage sludge as a fertilizer raw material by disseminating information about advanced examples of such efforts and creating a logo mark to indicate the use of domestic fertilizer resources.

RESULTS

Project impacts on sustainable development include:

Social: Consumers' recognition of phosphorus resource circulation, that is, from sewage to food production, human consumption, and then used water, are facilitated by branding and visualization, leading to their support for the promotion of sewage recycling. As the cost of phosphorus recovery technology has been reduced and compound fertilizers made from it have been optimized, some regional administrations (Yokohama and Tokyo) responsible for sewage management launched initiatives for collaboration with farmers' organizations to utilize sewage-origin fertilizer. This is a new initiative toward realizing phosphorus circulation, recovery in urban areas, and utilization in agricultural areas. These actions will contribute to stable procurement of phosphorus resources, which are essential for agricultural production.

Environmental: Verification tests of new fertilizers in which recovered phosphorus is mixed with other fertilizer raw materials have shown comparable results to conventional chemical fertilizers. These efforts also contribute to the goal set in Japan's Strategy for Sustainable Food Systems, MIDORI, of reducing the use of chemical fertilizer made from imported raw materials and fossil fuels by 30% by 2050.

In addition, appropriately circulating phosphorus resources, such as recovering phosphorus from sewage sludge and reusing it for fertilizer, reduces fossil fuel consumed in transporting raw materials and can reduce GHG emissions caused by long distance transportation of fertilizer imports.

Economic: Technology verification of new phosphorus recovery methods in large cities has begun, and the use over a wide area and a decrease in recovery costs are expected in the future. By establishing a stable supply system for fertilizer using recovered phosphorus that satisfies the needs of actual users in terms of quality and price, we will contribute to establishing an agricultural production system that is less susceptible to fluctuations in international prices. Supply of affordable fertilizer, which is made from recovered phosphorus, can reduce costs of agricultural materials and contribute to agricultural productivity for the future.

SUCCESS AND LESSONS LEARNED

While efforts to use fertilizers made from domestic resources, including recovered phosphorus, are becoming established in some areas, pilot projects for even more advanced use are also being carried out in parallel. To further expand efforts in the future, it is essential to reduce the cost of phosphorus recovery, develop and stably supply fertilizer that meets the needs of farmers, and accumulate effectiveness verification necessary for switching from existing fertilizer. Relevant ministries and agencies will continue to promote the use of these in production sites through establishing technology and demonstrating cultivation.

In addition, to promote these efforts, it is essential not only to focus on the technical aspects, but also to foster understanding among stakeholders, including consumers, about the global situation regarding fertilizer raw materials and sewage sludge. We will continue to disseminate information on verification results and advanced examples of efforts.

Recovering phosphorus resources and using them for fertilizer in agriculture contribute not only to sustainable agricultural production, but also to global issues such as global warming and the creation of a resource-circulating society, and we will continue to work on these in cooperation with relevant parties.

Photo: Recovered phosphorus

Flooding Fields May be a Win-Win for Farmers and Birds in the Mississippi Delta

At-a-glance

Objective: To determine whether flooding corn fields after harvest in the Mississippi Delta can provide critical habitat for migrating birds while enhancing or maintaining farm productivity.
Lead countries/organization(s): U.S. Department of Agriculture, Delta Wind Birds, University of Mississippi, Mississippi State University Extension Service
Place: Mississippi Delta, USA

BACKGROUND AND OBJECTIVES

Agricultural areas in many parts of the United States fall within migratory flyways for birds. Many farmers in these areas flood their fields during winter (November to February) to provide habitat for migrating waterfowl. This practice is common in the Mississippi Delta, where farmers flood a portion of their fields to create duck habitat and make extra income by participating in conservation programs or through leasing land to duck hunters.

Other groups of birds, including migratory shorebirds, use the same Mississippi flyway to migrate from Canada and the Arctic to Central and South America. Shorebirds rely on shallow mud flats to stop and feed in between long flights while migrating but require this habitat earlier in the year (September to November). The objective of the project was to determine if earlier flooding, around September instead of November or December, could provide critical habitat and other ecological benefits for these migrating birds while enhancing farm productivity and the farmers' bottom line.

ACTIONS

Scientists from The U.S. Department of Agriculture's (USDA) Agricultural Research Service (ARS) and partners –including Delta Wind Birds, University of Mississippi, and Mississippi State University Extension Service – are working with farmers at multiple locations to reflect differences in soil type and farm management within the Delta to flood corn and soybean fields immediately following harvest. This conservation practice provides shallow water habitat for shorebirds during their fall migration. Shifting this practice to fall months not only provides shorebird habitat but also supports fall migrating ducks, such as Blue-winged Teal.

Scientists are working with partners to assess shorebird and waterfowl use as well as food resources provided by the created habitat. Partner institutions are conducting regular shorebird surveys and measuring aquatic invertebrate densities (shorebird food resource) at different field sites.

In addition to wildlife benefits, researchers are studying other ecosystem services related to soil health and water quality that could support more sustainable farming. For example, the practice of flooding fields creates temporary wetlands that may stimulate important ecosystem processes like denitrification. Monitoring of storm events is also being conducted to assess whether these processes in flooded fields decrease nitrogen and phosphorus runoff from agricultural fields. Temporary flooding may also decrease soil loss through runoff of suspended soil particles during heavy rain events. Scientists are also conducting soil assessments in flooded and control fields to determine impacts on soil health. Working with participating farmers, scientists are assessing yields on flooded and control fields.

RESULTS

Flooded corn fields were able to provide critical habitat for migrating shorebirds. Seventeen species of shorebirds were recorded using flooded fields associated with the project. Based on a 10-day residence time per individual bird, 36 hectares of flooded fields supported at least 2,100 shorebirds during fall migration. High aquatic invertebrate densities (>1,000 individuals/m2) were established within two weeks of flooding and persisted throughout the fall flood period.

Social: Participating farmers have reported positive experiences, including higher subsequent crop yields in some cases, and no substantial issues with spring planting after the flood treatments. Although these management practices do require extra work for farmers, they have not encountered other significant barriers. Moreover, some farmers have begun to take a new interest in the wildlife attracted to their fields.

Environmental: One of the discovered benefits of this program was enhancing processes that decreased nitrogen runoff to the Gulf of Mexico, like denitrification. This process converts excess nitrogen from the field to atmospheric nitrogen, but is fairly inactive in cold weather. By flooding fields in September before colder winter temperatures occur, denitrification was enhanced. Temporary flooding removed an estimated 36 kilograms per hectare of residual nitrogen from flooded fields, which translated into significant reductions in nitrogen runoff. This practice reduces the amount of unused fertilizer running off into waterways. Early flooding had other environmental benefits such as reduced sediment and phosphorus runoff in the winter, which not only protects water quality but also preserves critical soil resources for farmers.

Economic: Preliminary results indicate the program had no negative impact on crop yields, suggesting soil health is not negatively impacted by short-term flooding. In fact, one farm reported a slight (4%), but significant, increase in soybean yields in fields previously flooded after corn compared to control fields. At current soybean prices, that translates to a $61 per acre boost in profit. There are fuel costs involved with initial flooding and some inconvenience associated with timing during harvest. Future economic analysis will focus on whether the potential wildlife, environmental, and yield benefits exceed farmer costs.

SUCCESS AND LESSONS LEARNED

The biggest success of this project has been the adaptation of NRCS EQIP 644 in Mississippi. Farmers can now receive financial incentives to create shallow water habitat in both the fall for shorebirds and the winter for waterfowl. However, one lesson learned by project staff is that farmers in the Delta have varied opinions on the impact of controlled flooding on their fields. Expanded application of the practice will require significant outreach and education efforts. Mississippi State University Extension Services, Delta Wind Birds, and participating farmers are hosting farm days and USDA's Natural Resources Conservation Service agent trainings that highlight the project.

Photo Credits: Jason Taylor, Larry Pace

Moving forward, the project organizers are planning to do larger-scale studies on farms in the Delta region to provide more data for outreach efforts. These studies are supported by a three-year U.S. Environmental Protection Agency Farmer-to-Farmer grant with university and extension partners. This research will focus more on assessing soil health benefits and understanding what management practices are needed in conjunction with temporarily flooding fields.

The project is in its second year and has expanded the research scope and incorporated additional research questions comparing the provision of ecosystem services provided by fall, winter, and fall-winter flooding periods. Additional analysis is being done to confirm whether this practice is economically acceptable for farmers.

Website:
https://tellus.ars.usda.gov/stories/articles/flooding-fields-may-be-win-win-farmers-and-birds-mississippi-delta

FORGROUND

At-a-glance

Objective: To transform the way farms of all sizes can more easily make the transition to sustainable agricultural practices with the introduction of Bayer's farmer-first digital platform – ForGround.
Lead countries/organization(s): Bayer US
Place: USA

BACKGROUND AND OBJECTIVES

The ground we stand on has potential to support a more resilient and regenerative planet, yet much of this potential remains locked. Bayer's regenerative agriculture program aims to revitalize this potential by supporting soil health, reducing erosion, and increasing soil water availability.

Thanks to our science, data, and technology, it's possible to scale regenerative practices across the value chain, but to make this happen, Bayer must work hand-in-hand with farmers and companies committed to fighting climate change. Only together can we start to unlock the land and leave it better than we found it, for the benefit of families, farms, and futures.

Based on the successful foundation of the existing Bayer Carbon Program, ForGround by Bayer – a farmer-first digital platform – expands and evolves beyond carbon offsets to explore other ways that farmers can make a positive impact in their operations through the adoption of regenerative agricultural practices and technologies. It also aims to help farmers to connect with companies to help meet their sustainability goals, whether it be through footprinting, value chain interventions, or carbon offsets.

ACTIONS

Via ForGround, Bayer will assist enrolled farmers to implement and manage agricultural practices that can help provide benefits to their land, such as improved soil health,[1] increased water availability,[2] fewer inputs,[3] increased weather resiliency,[4] and reduced soil erosion,[5] as well as provide the opportunity to generate incremental revenue by connecting farmers with programs like Bayer Carbon.

The available benefits at launch are:

- Best-in-class practice transition assistance with agronomic support, evidence-based field studies and trials, curated content and events, like-minded community, and a trusted network of leading experts.
- Connection to potential new revenue streams for adopting new practices (e.g., Bayer Carbon Program), evaluating the current market price of carbon assets on an annual basis, and increasing farmers' payment rate to reflect those increases.
- Reduced transition cost barriers (e.g., specialty equipment, seed discounts), including incentives and rewards such as a free subscription to Climate FieldView™ Plus7, Bayer's industry-leading digital farming app, which allows an even deeper understanding of the management of farmers' fields. Climate FieldView provides a variety of management tools such as tracking seed populations, yield management, customized seed scripting, and field scouting.

RESULTS

In 2021, Bayer partnered with growers and companies to further advance the Carbon Initiative. Initially launched for US and Brazilian growers in 2020, the Carbon Initiative has expanded to Europe and Argentina and has launched key partnerships with other industry leaders. Since the launch, more than 2,600 growers have been enrolled from 10 different countries. 1.4M+ acres have been added, and 500,000 tons of carbon was sequestered in the soil. In addition, $4 million was returned to farmers by way of individual payments for practice change on enrolled acres.

The program is slated to expand upon these successes on over 2 million acres in 2022-2023. Sequestering carbon on this land through practice changes such as strip-till, no-till, and planting cover crops will help to reduce greenhouse gas emissions. There are many other benefits that Bayer is leveraging with the launch of ForGround, including:

Social: ForGround brings new revenue-earning opportunities to the rural communities that feed our nation; by entering carbon markets, rural communities advance their socio-economic development in a cost-effective way that allows for carbon trading and stimulates new market opportunities for farmers.

Environmental: Reducing tillage and planting cover crops have on-farm and environmental effects. These practices can increase soil organic matter and improve the physical and biological properties of your soil,[1] which may improve yield stability. Cover crops can help suppress weeds and cycle nutrients by fixing atmospheric nitrogen and scavenging excess soil nutrients. Cover crops and reduced tillage practices can also create lasting positive environmental effects by reducing soil erosion[5] and decreasing sedimentation and nutrient pollution of waterways, as well as reducing water use,[2] while promoting healthier soils for future generations.

Economic: Transitioning to regenerative agriculture may result in lower crop inputs[3] and increased weather resiliency[4] of that crop, decreasing their costs and helping insulate them from extreme weather events. ForGround offers growers additional potential revenue-earning opportunities by allowing them to take advantage of equipment and seed discounts/rebates, discounted crop advisor services, and more, which can be accessed through their FoGround profile online.

SUCCESS AND LESSONS LEARNED

While the Bayer Carbon Initiative was successful in its pilot and launch, there were additional unmet needs from the perspective of both the farmer and upstream companies. Farmers may want to implement regenerative farming and/ or carbon sequestering practices to ensure the long-term sustainability of their operations, but a robust resource library for information, recommendations, and best practices was not available. Upstream companies develop sustainability goals but often lack the 'how' execution of reaching those goals. ForGround is the platform in which those needs are met by providing scientific rigor and scalable solutions required to deliver on sustainability initiatives, climate commitments, and verified offset credits.

Lessons learned throughout the first year of the program are twofold. First, there are numerous early adopters of regenerative agricultural practices that are not currently compensated with the existing carbon market structure. This creates tension with how to build and grow this area into a structure that rewards all good practices and not just those who transition.

Secondly, the transition process to regenerative agriculture practice is long and complicated for farmers. Moving to practices such as no-till, strip-till, and planting cover crops for carbon markets can require up to a 20-year commitment, which is not common practice in agriculture. We anticipate seeing more farmers move to these practices in the near future once they have had extensive time of trial-and-error practice on their operations.

Website:
www.bayer.com/en/us/forground

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Global Agricultural Productivity Initiative

At-a-glance

Objective: To create data-driven policy change, catalyze investment, and increase access to tools that will contribute to sustainable agricultural productivity growth in all world regions.
Lead countries/organization(s): Virginia Tech College of Agriculture and Life Sciences Global Programs
Place: Global

BACKGROUND AND OBJECTIVES

The Global Agricultural Productivity (GAP) Initiative at Virginia Tech brings together expertise from the private sector, NGOs, Virginia Tech and other universities, and global research institutions to create data-driven policy change, catalyze investment, and increase access to tools that will contribute to sustainable agricultural productivity growth in all world regions. The GAP Initiative is housed within the College of Agriculture and Life Sciences (CALS) Global at Virginia Tech.

The GAP Report is the heart of the Initiative. First established by the Global Harvest Initiative (GHI) in 2010, the report tracks the trajectory of total factor productivity (TFP) growth using data sets curated by the United States Department of Agriculture Economic Research Service.

TFP incorporates a range of inputs and outputs in its calculations, revealing detailed trends in agricultural systems. TFP rises when producers utilize innovative agricultural technologies to increase output with the same amount or fewer resources. TFP encompasses three inputs that contribute significantly to agriculture's environmental impact: land, fertilizer, and livestock.

Examples of productivity-enhancing technologies include advanced seed varieties, precision mechanization, and improved animal husbandry. Using various methods and practices, it is possible to increase TFP at all scales of agricultural production. The GAP Report examines the trends driving TFP growth and provides on-the-ground contextualization and proven innovations to create TFP growth through data-driven storytelling by GAP Report partners.

ACTIONS

To sustainably meet the world's needs for agricultural products by 2050, global TFP needs to increase by an average of 1.73% annually. However, during 2011-2020, average annual global TFP growth was only 1.12%, compared to 1.99% annual growth during 2001-2010.

The GAP Initiative convenes stakeholders across the agrifood and public sectors to identify pathways to accelerated and sustainable TFP growth. In 2022, the Initiative hosted two events – in Nairobi, Kenya, and in Washington, DC – to bring together thought leaders, mobilizers, and policymakers to tackle this globally pressing issue.

These gatherings elicited strategic pathways forward. Investing in public agricultural Research & Development (R&D) and extension systems, embracing science and information-based technologies, improving infrastructure and market access for agricultural inputs and outputs, cultivating partnerships for sustainable agriculture and improved nutrition, expanding and improving regional and global trade, and reducing post-harvest loss and food waste were all identified as critical actions for accelerating sustainable productivity growth.

In addition to these stakeholder gatherings, the GAP Initiative also sponsors research and analysis to examine TFP growth in the context of global events. For example, the 2022 GAP Report features analysis on the effects of COVID-19 policies and actions, the Ukrainian conflict, and trade disruptions on sustainable productivity growth. New research conducted by Virginia Tech assistant professor, Wei Zhang, about the effects of extreme weather events on TFP, also premiered in the 2022 report. The GAP Initiative's goal is to increase every farmer's access to every proven tool needed to increase productivity, profitability, and returns to society, the environment, and the economy.

RESULTS

The GAP Initiative brings together policymakers, practitioners, industry leaders, and researchers to consider the social, environmental, and economic implications of sustainable and accelerated agricultural productivity growth through strategic partnerships with technical organizations, data-driven storytelling, and commissioned research on pressing global topics related to productivity.

Social: The 2022 GAP Report featured several successful efforts of partners attempting to improve food security and producer wellbeing. For example, in the midst of civil unrest sparked by food price spikes, the International Maize and Wheat Improvement Center (CIMMYT) focused on averting food emergencies by working to stabilize the wheat supply and promote resilience. A partnership between Mosaic India and the Sehgal Foundation promoted sustainable agricultural practices among smallholders through improved agriculture development, water management, and education within India's rural societies.

Environmental: Understanding the impact of climatic events on the growth trend of TFP is critical for informing investments and mitigation plans to strengthen the resilience of growth. Wei Zhang's new research at Virginia Tech illustrates how extreme weather events negatively impact productivity growth. Extreme climate events are estimated to have, on average, a negative and statistically significant impact on TFP growth rate. These results demonstrate the importance of increasing climate resilience within the agri-food system to sustain TFP growth.

Economic: Research sponsored by the GAP Initiative in 2022 identified critical economic policy issues that need to be addressed to prevent further loss in agricultural productivity, especially in light of global crises such as the COVID-19 pandemic and the conflict in Ukraine. Disruptions caused by supply chain inefficiencies, conflict, and policy intervention diminish the gains from uninhibited trade. Trade restrictions imposed on Russia and their allies during the Russian invasion of Ukraine impacted global grain, oilseed, and fertilizer markets, leading to damaging effects on food security in developing nations.

SUCCESS AND LESSONS LEARNED

In 2022, the GAP Initiative facilitated communication of the GAP Report's key messages through partnerships, institutional cooperation, and events. These efforts culminated in sharing the importance of sustainable agricultural productivity growth, with more than 440 attendees at the 2022 GAP Report launch and a media reach of 9.4 million.

Climate change, conflict, COVID-19, and extreme weather events add additional layers of complexity to sustainably improving TFP. To reach the 1.73% target growth rate, drastic changes and improvements to the agricultural system need to be prioritized. Therefore, governments, the private sector, research institutions, international development organizations, and civil society groups must take urgent action. The GAP Initiative has been able to identify emerging themes to influence collaborations and policy. Increased investment in public agricultural R&D, accessible technology, improvements to agricultural productivity, and partnerships are all key priorities for the future.

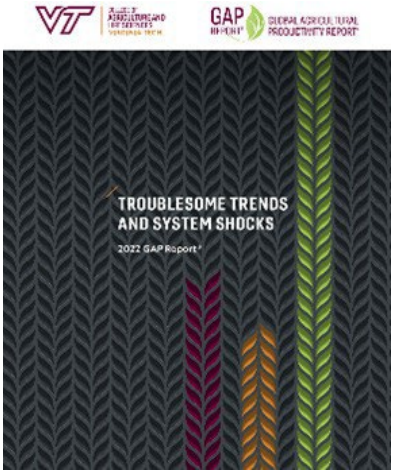
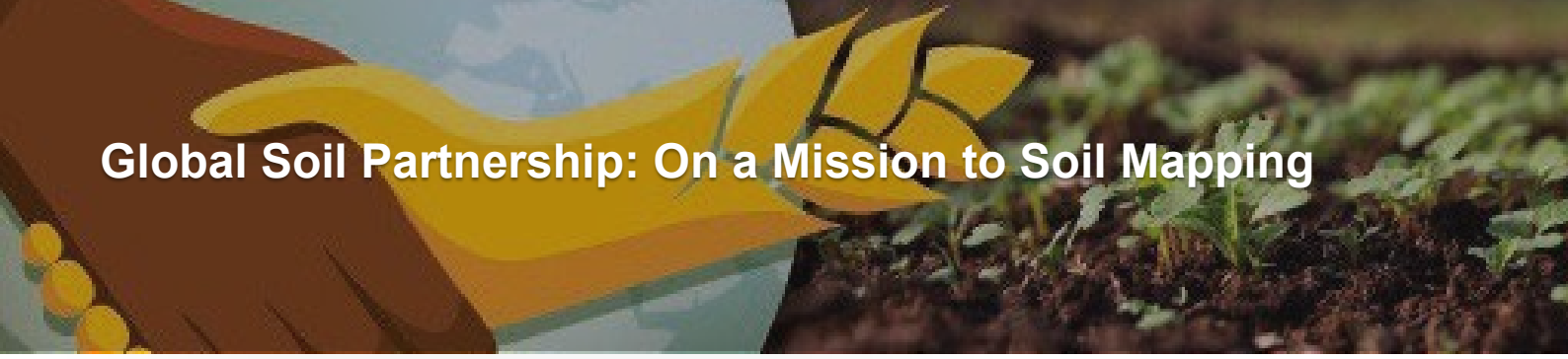


Photo Credit: GAP Report

These themes have also inspired the GAP Initiative's 2023-2025 guiding principle: to focus on ensuring equal access to productivity-enhancing tools for every farmer to improve returns to society, the environment, and the economy. This will involve conducting more intensive policy analysis, deepening regional and customized data analysis and research, advancing advocacy of key priorities at multilateral events and places where investment decisions are made, and convening a broader network of partners, innovators, and influencers.

Website:
www.globalagriculturalproductivity.org



Global Soil Partnership: On a Mission to Soil Mapping

At-a-glance

Objective: To support countries in building national capacities for digital soil mapping, establishing national soil information systems, and developing global maps tailored for all FAO members.
Lead countries/organization(s): FAO members, FAO Global Soil Partnership
Place: Global

BACKGROUND AND OBJECTIVES

About 95% of the food we eat is grown from soil, which is rapidly diminishing due to unsustainable human activity. Around 33% of all soils around the world are degraded and it is our collective responsibility to safeguard this vital resource. In the face of climate change and overuse of fertilizers and pesticides, globally available and dynamic soil information systems are essential. Evidenced-based soil information systems are at the core of a proven soil protection strategy.

Scaling up the use of digital tools and innovative technologies while simultaneously leveraging local expertise are important pathways to addressing climate change and food insecurity. Raising technical capacities at the global scale would also bring countries together to effectively safeguard and improve soil health.

Over the past decade, the FAO's Global Soil Partnership (GSP) has become an internationally recognized mechanism composed of 194 FAO members and over 500 partners committed to sustainable soil management. Its mandate is to improve and maintain the health of at least 50% of the world's soils by 2030 and beyond.

ACTIONS

FAO's GSP has been supporting countries in establishing national soil information systems and developing country-driven global maps, including the Global Soil Organic Carbon Map (GSOCmap), Global Soil Organic Carbon Sequestration Potential Map (GSOCseq), Global Salt-affected Soils Map (GSASmap), and Global Black Soil Distribution Map (GBSmap).

To date, thanks to its global capacity-building program, the GSP has reached more than 1,400 national experts from 130 countries worldwide through more than 70 training workshops. The partnership has supported countries in producing high priority data products, focusing on addressing major soil threats, potential of soil resources to address the impacts of the climate crisis, and tackling food insecurity.

FAO is working with members on the preparation of the Global Soil Nutrient and Nutrient Budget Maps (GSN Map) to boost soil health and productivity. The GSN Map will provide decision-makers with a tool to guide fertility management recommendations and national policies based on the assessment of soil nutrient content and budgets. This initiative will therefore contribute – in the long-term—to alleviating the current hike of food and fertilizer prices as well as the disruption of fertilizer supply chains, by helping to improve fertilizer use efficiency while bolstering agri-food systems.

FAO is also working on the establishment of the Global Soil Information System (GloSIS) together with the International Network of Soil Information Institutions (INSII) and with the support of the Global Soil Laboratory Network (GLOSOLAN). GLOSOLAN works on improving the capacities of soil laboratories, including soil spectroscopy for rapid, cost-effective, and non-destructive characterization of soil properties. The U.S. Department of Agriculture (USDA) is part of GLOSOLAN and INSII, which are supporting global developments in soil characterization, analysis and mapping, and improving national capabilities through GSP actions.

RESULTS

Project impacts on sustainable development include:

Social: Through more than 60 training workshops organized by the FAO/GSP, over 1,200 national experts have been actively engaged and trained to use, generate, and harmonize soil data and information. The Global Soil Organic Carbon Sequestration Potential Map (GSOCseq), for example, is now being used to select hotspot areas for carbon sequestration potential and implement sustainable soil management (SSM) practices through the Recarbonization of Global Soils, or RECSOIL, an initiative that aims to improve soil health and reduce dependence on external inputs.

Environment: The use of up-to-date soil data and information is essential for understanding global, regional, and national trends, as well as for identifying intervention hotspots for scaling up sustainable soil management practices through an evidence-based approach. Over the last decade, the GSP has supported the launch of National Soil Information Systems in Macedonia, Sudan, Afghanistan, Lesotho, Armenia, Cambodia, and the Regional Soil Information System for South America.

The GSP has developed four country-driven global soil property maps, which inform decision-making for the efficient management of natural resources. The GSOCseq, for example, aids in identifying high carbon sequestration potential in areas affected by heavy metal-pollution, so that sustainable soil management interventions aimed at increasing the organic matter content of these soils will also help to immobilize these contaminants and reduce its bioavailability to the crops grown there.

Economic: Soil information and data as an open-source good is crucial for the transition to more resilient and sustainable agri-food systems, which leads to improved food security and economic outcomes. The use of up-to-date soil information at the national scale can help to better plan agricultural and land planning interventions and policies, for example, by excluding areas with higher carbon content or fertility from urbanization plans, or by planning the implementation of irrigation schemes with high quality water in salt-affected areas. At the farm scale, detailed soil information can result in the judicious use of inputs, particularly fertilizers and amendments, appropriate to soil characteristics and crop needs, thus reducing the costs derived from generalized use of these inputs, which in most cases are lost through runoff or leaching and cause environmental problems such as contamination of watercourses and eutrophication.

SUCCESS AND LESSONS LEARNED

The FAO's GSP has enabled development and support of technical capacities and awareness at national, regional, and global levels of dynamic soil systems. To date, 168 countries have nominated a focal point, and around 550 NGOs, universities, research centers, farmers associations, and private sector groups have joined GSP as members. GSP has reached around 1,000 farmers and extension service staff through the Global Soils Doctors Programme.

More than 5,000 participants have benefited from multiple training sessions on digital soil mapping and modelling, and soil laboratory procedures, soil spectroscopy, quality control, and laboratory health and safety. The overall success of this initiative stems from the extensive network of experts that the GSP has succeeded in bringing together and the scientific guidance of the Intergovernmental Technical Panel on Soil (ITPS), which has been instrumental.

Over the next ten years, the GSP will continue to make systemic and cultural changes to realize the full value of data assets and to build an evidence-base to underpin soil research, policymaking, programs, and services to improve outcomes for all members. Moreover, the GSP is moving from a phase of network consolidation and knowledge creation and dissemination to an implementation phase, in which the focus will be on working with farmers at the field level and strengthening the capacity of government technicians, extension services, labs, and researchers.

The Global Soil Organic Carbon Sequestration Potential Map (GSOCseq) – they allow users with useful information to prioritize areas where sustainable soil management practices can be adopted to enhance soil organic carbon stocks and improve soil health. It allows individuals to identify the regions, soil types and farming systems with the greatest potential to offset GHG emissions.

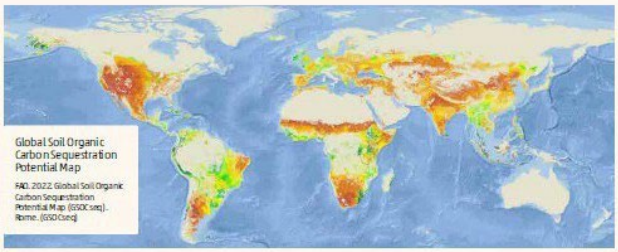


Photo Credits: FAO/Matteo Sala

Website:
https://www.fao.org/global-soil-partnership/en/

He Waka Eke Noa: The Primary Sector Climate Action Partnership

At-a-glance

Objective: To reduce Aotearoa New Zealand's agricultural emissions and build the agriculture sector's resilience to climate change, including developing a pricing mechanism for agricultural emissions.
Lead countries/organization(s): He Waka Eke Noa is made up of the sector, Government and Māori representatives (the Indigenous Peoples of Aotearoa New Zealand)
Place: Aotearoa New Zealand

BACKGROUND AND OBJECTIVES

Agricultural climate action, both mitigation and adaptation, is critical to achieving sustainable productivity growth, feeding a growing global population, and limiting catastrophic climate change and environmental impacts.

Agriculture is an integral part of Aotearoa New Zealand's economy and society. He Waka Eke Noa, which is made up of the Government and Māori representatives (the Indigenous Peoples of Aotearoa New Zealand), is committed to driving sustainable food and fibre production for future generations. Agriculture accounts for approximately half of New Zealand's total emissions. In our Zero Carbon Act, we have committed to reaching net zero by 2050, which includes a commitment to reducing biogenic methane (methane from plant and animal sources) by 10% by 2030 and by 24-47% by 2050. These domestic legislated targets support our recently updated Nationally Determined Contribution (NDC) to reduce our net emissions by 50% by 2030 based on our gross 2005 emissions. To contribute to achieving these targets, the Zero Carbon Act requires agricultural emissions to be priced by 2025 (recognizing all other sectors are already priced within the New Zealand Emissions Trading Scheme).

To support these agriculture-related climate commitments, we have created He Waka Eke Noa – The Primary Sector Climate Action Partnership, also known as The Partnership. The phrase 'He Waka Eke Noa' is a Māori proverb that means "we are all in this together." This proverb reflects the diversity of New Zealand's primary sector and how we must work together to effectively address climate challenges.

ACTIONS

The Partnership is a five-year programme to equip farmers and growers with the information, tools, and support they need to reduce emissions and build resilience to climate change. This includes:

- Establishing recommendations on the development of a pricing mechanism for agricultural emissions (required by 2025 by the Zero Carbon Act);
- Producing guidance on how to measure, manage, and reduce emissions;
- Supporting farmers by providing tools to produce farm plans to manage emissions;
- Developing a system for measuring and reporting on emissions; and
- Producing guidance to support farmers adapting to a changing climate.

This toolkit will align to the greatest extent possible with other on-farm environmental actions, such as protecting and restoring freshwater and biodiversity.

RESULTS

The He Waka Eke Noa Partnership is in its third year and has reached a number of milestones towards its objectives of reducing agricultural emissions and supporting sector resilience.

Social: The Partnership supported farmers and growers to better understand their emissions, including how to measure and manage emissions through farm planning, and develop a plan to reduce these emissions. Not only do farm plans help growers learn from past growing seasons through comparison, they help growers gain greater overall insight and predictability over their own operations.

Environmental: The Partnership documented the annual total of on-farm emissions on 61% of farms, including 92% of dairy farms. It ensured that 21% of farms have a written plan to measure and manage their emissions.

Economic: The Partnership provided recommendations to the New Zealand Government on a pricing mechanism for agricultural emissions from 2025 onwards. The proposed program of action is aimed at ensuring farmers and growers are equipped with the knowledge and tools they need to deliver emissions reductions while maintaining profitability.

Following the He Waka Eke Noa Partnership recommendations and advice from the Climate Change Commission, the New Zealand Government is currently considering the final design of the system.

Photo Credits: He Waka Eke Noa Partnership and Ministry for Primary Industries, Manatū Ahu Matua

SUCCESS AND LESSONS LEARNED

The He Waka Eke Noa Partnership plays a key role in supporting Aotearoa New Zealand's primary sectors' transition to long-term sustainability and success. Reaching the majority of farms – including most dairy farms – and documenting annual total emissions is a major success of the program thus far and will provide the foundation for mitigating such emissions.

This process has illuminated key challenges the sector faces in transitioning to low-emissions. This knowledge has been integral to accurately informing policy decisions around investment, innovation, research and development, as well as Aotearoa New Zealand's broader climate change strategy.

Reflecting on the learnings from the Partnership, the New Zealand Government recently committed $338 million (NZD) over four years to accelerate efforts to reduce agricultural emissions. This includes establishing a Centre for Climate Action on Agricultural Emissions, a joint venture with business to accelerate the product development of tools for farmers to reduce their emissions.

Innovative Soil Management Practices Across Europe (i-SoMPE)

At-a-glance

Objective: To document innovative soil management practices in Europe to provide information on regional and local practices and conditions.
Lead countries/organization(s): European Commission, Wallonia/Belgium, Italy, and Switzerland (coordinators), 50% co-funded by the EU from the "Horizon 2020" framework program through EJP SOIL
Place: 25 countries, including most EU Member States and Switzerland, Turkey, UK

BACKGROUND AND OBJECTIVES

Innovative soil management practices (SMP) and agricultural systems are promoted to enhance ecosystem services and to minimize soil threats and sustain agriculture in the context of climate change. A comprehensive stocktake of SMPs and their possible contributions to agricultural production, ecosystem services, and biogeochemical cycles has not yet been a majority priority across Europe.

Using a surveying approach, i-SoMPE is documenting innovative SMP. The data gathered is synthesized considering technical and ecological constraints and socioeconomic barriers to the adoption of different SMP. Context-specific thematic maps are provided to guide farmers, researchers, and policymakers towards suitable SMP for climate-smart agriculture.

iSoMPE is part of the European Joint Programme Cofund on Agricultural Soil Management (EJP SOIL), which runs from February 2021 to January 2025, and includes a broad range of projects, with the common objective to develop knowledge, tools, and an integrated research community to foster climate-smart sustainable agricultural soil management.

ACTIONS

Inventory of innovative SMP: One hundred different SMP — including agricultural systems, buffer strips and small landscape elements, crop protection, crops and crop rotations, organic matter and nutrient management, tillage and traffic, and water management — were analyzed in relation to their current (2021) application across Europe. Potential areas of application (depending on climate, soil, land use/ farming systems) and adverse or beneficial impacts on soil health was assessed, in addition to other objectives.

Current adoption of SMP: A database on the adoption rate of SMP in the environmental zones of partner countries was established. The database contained 3,690 records, available in static maps (images), reactive maps (app – forthcoming), and open data (data frame with raw data).

Development of a framework to assess the bio-physical limitations of SMP application: Land use, climate, topography, and soil properties as bio-physical limits for the application of different practices were analyzed at the level of agro-ecological zones. Application of this framework was done on the adoption of cover crops.

Analyses of barriers and opportunities: A network analysis (cognitive and social mapping) based on data obtained in qualitative interviews from case studies covering different SMP across partner countries was conducted to identify factors facilitating or inhibiting the uptake of particular practices.

RESULTS

The project provides a complete inventory of the current use of about 50 innovative SMP across Europe and their impacts as analyzed in various previous studies. It also identifies barriers and opportunities for the potential diffusion of climate-smart, innovative practices across different bio-physical and socio-economic contexts.

The different practices documented in the project are all linked to the main challenges on which healthy soils can have a positive impact: sustainable food production, soil biodiversity, and soil functions for ecosystem services. Collectively, they can contribute to all three dimensions of sustainability (based on expert knowledge collected during surveys):

Social: Crop diversification (intercropping, legumes integration, rotation) can increase food availability and positively impact nutritive values of products. Practices linked to the reduction of plant protection products can have a positive impact on farmworker health. Other practices, like conservation agriculture (e.g. reduced tillage), can also reduce the workload of farmworkers, seen as an opportunity for potential adopters. The qualitative analysis emphasizes the importance of networks around farmers, including advisers and other farmers, for sharing knowledge, experiences, and training or farm visits.

Environmental: Most of the documented practices have a positive impact on environmental dimension, e.g. in terms of (i) soil erosion (reduced tillage, cover crops, conservation agriculture), (ii) nutrient use efficiency (variable rate fertilize application, controlled traffic farming), (iii) soil structure (cover crops, crop rotations, grassland with legumes), (iv) water storage capacity (buffer strip, deep rooting plants, undersowing), and, (v) soil organic carbon (low emission slurry spreading, associated beets, associated rapeseed).

Economic: Most of the documented practices have a beneficial effect on crop yields (64%) and on farm profitability (62%), but due to investment costs, the larger farms have a comparative advantage.

SUCCESS AND LESSONS LEARNED

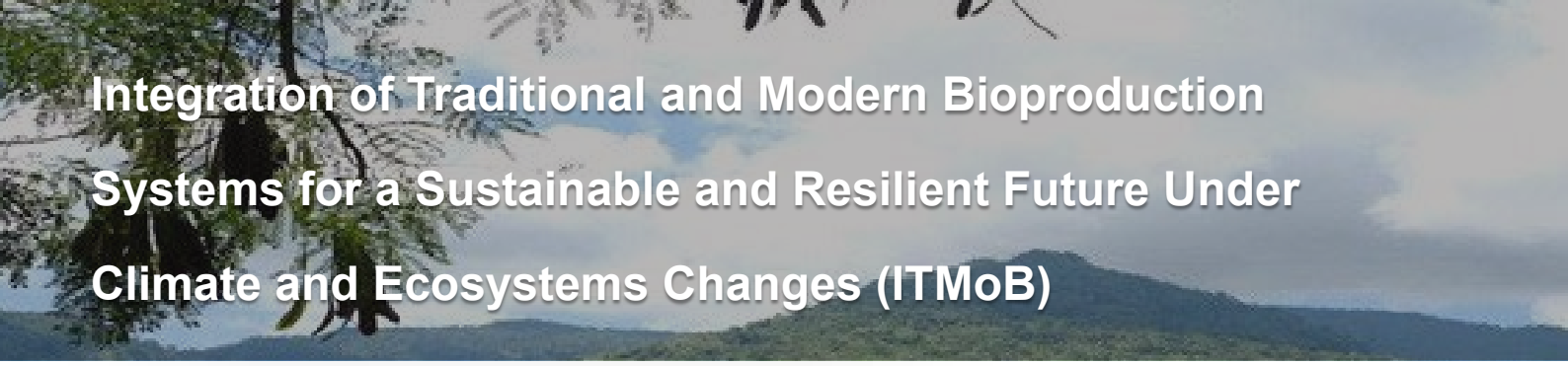
i-SoMPE's survey demonstrated the presence of diverse innovative soil management practices in Europe. While some bio-physical limitations play an important role in the places and farming systems where particular practices are applicable, regional and context-specific socioeconomic conditions need to be considered when designing policies to foster the application of management practices.

The analyses of barriers and opportunities of case studies in i-SoMPE has demonstrated the importance of networks among practitioners and researchers for experience and knowledge-sharing, of investments in machinery, and the consideration of risks taken in adopting innovations. Public policies to support the adoption of innovative practices should consider these aspects.

Within this project, we learned that SMP are highly context specific and that quantitative data can cover highly diverse situations and can be variably interpreted by local experts. On the other hand, the qualitative approach has shown that barriers and opportunities provide sound results that overcome the heterogeneity of the innovative practices and studied agro-ecosystems.

EJP SOIL
European Joint Programme

Photo Credits: Sophie Herremans and Julien Bunckens



Integration of Traditional and Modern Bioproduction Systems for a Sustainable and Resilient Future Under Climate and Ecosystems Changes (ITMoB)

At-a-glance

Objective: To determine which combinations of traditional and modern bioproduction systems – in the study areas – will lead to a sustainable and resilient future.
Lead countries/organization(s): Philippines
This was a multilateral cooperative research project between Japan, Indonesia, and the Philippines under the e-ASIA Joint Research Project, specifically: Japan: Institute for Global Environmental Strategies, University of Tokyo, Osaka University; The Philippines: University of the Philippines Los Baños Interdisciplinary Studies Center for Integrated Natural Resources and Environment Management Indonesia: Pajadjaran
Place: Philippines

BACKGROUND AND OBJECTIVES

In the Philippines, the Integration of Traditional and Modern Bioproduction Systems for a Sustainable and Resilient Future Under Climate and Ecosystems Changes (ITMoB) project is being implemented in two watershed areas – the Pagsanjan-Lumban Watershed in the Laguna de Bay Basin and the Baroro Watershed in La Union. Project implementation is from October 16, 2022 to October 15. 2024.

In anticipation of the threats and changes that may compromise the delivery of various ecosystem services brought on by climate, land use, and socio-demographic changes, which will ultimately affect the welfare of communities, the study aims to determine which combinations of traditional, modern, and hybrid bioproduction systems are most likely to lead to a sustainable and resilient future (by 2050) for the two study areas.

As such, the Philippines-based study will assess traditional, modern, and integrated/hybrid bioproduction systems and how they interact in various scenarios. The bioproduction system scenarios include changes in climate, land use, policy implementation, and sociodemographic conditions. These various bioproduction systems will be subjected to modeling to predict future resilience and sustainability.

It is anticipated that, overall, this action-research-for-development model could advance science-based and multi-stakeholder anticipatory planning and decision-making at the local level to optimize socio-economic gains of varying combinations of bioproduction systems while minimizing ecological and environmental losses in the process.

ACTIONS

The project will determine and characterize the current forestry, fishery and agricultural bioproduction systems in the study sites through a series of meetings and consultations and secondary collection. The team will develop a common framework to create multiple future scenarios following the Nature Futures Framework (NFF), a flexible tool to support the development of scenarios and models of desirable futures for people, nature and Mother Earth. Using modeling tools, impacts of climate, socio-demographic factors, and land use, land cover changes within selected bioproduction systems will be assessed and predicted, and potential synergies and trade-offs between ecosystem services will be identified through the use of modeling tools.

Finally, the project will propose interventions to optimize ecosystem services within each scenario. Results are expected to provide insights into which combinations of bioproduction systems can maximize the supply of ecosystem services in different socioeconomic conditions and help determine the set of bioproduction systems that are most resilient to projected climate changes. Such insights will enable institutions and communities to craft better approaches, strategies, and policies to achieve sustainable and climate-resilient watersheds.

RESULTS

Project impacts on sustainable development include:

Social: The Philippines team received support from the Provincial Government of Laguna and La Union through the creation of Executive Orders to form a technical working group (TWG)/committee on the project's implementation. The members of the TWG are local government officers who will be tapped as partners in achieving the goals and objectives of the project. Through this legal arrangement, the provincial governments ensure full cooperation and participation of designated members to future activities of the project for its smooth implementation. In return, as part of its capacity development component, through a series of trainings and workshops, the project aims to enhance the scenario-based planning of the local government units and other related agencies within the watersheds. In addition, the project is also in the process of creating a Memorandum of Understanding with two universities near the project sites, namely Batangas State University and Don Mariano Marcos State University.

Environmental: For Year 1 implementation, the project has collected baseline biophysical and socioeconomic information related to the watershed areas. Bioproduction systems (BPS) within the watershed were identified, characterized, and mapped out. Through the series of Key Informant Interviews conducted, it was determined that rice-based, tiger grass, and vegetable-based BPS dominate Baroro Watershed, while the majority of the Pagsanjan-Lumban Watershed is covered with coconut-based, rice-based, and vegetable-based BPS. Preliminary ecosystem services including Carbon Storage and Sequestration, Annual Water Yield, and Sediment Delivery Ratio were also modeled using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) model. Moreover, a structured meta-analysis was conducted to scan solutions from case studies in the Philippines and categorize them into the three main perspectives of the NFF.

Economic: For Years 2 and 3, the team will conduct scenario-building workshops and farmer household surveys to determine what the different watershed stakeholders envision in the future. Ecosystem modeling will then be employed to assess changes in the watershed ecosystem services as well as predict the future under multiple scenarios (including changes in climate, land use, policy and sociodemographic conditions). The ability to conduct ecosystem modeling will provide multiple benefits, including important financial planning.

SUCCESS AND LESSONS LEARNED

The challenges imposed by the COVID-19 restrictions, such as difficulty in conducting field work activities due to the travel ban during the initial months of the project implementation, became an opportunity for the project team to strategically optimize its resources and engagements with the local stakeholders of the watershed. Through the creation of a TWG as well as maximizing online services, the project was able to mobilize the data gathering and fieldwork activities.

Additionally, institutional partnerships through a Memorandum of Agreement and Memorandum of Understanding are currently in process with Batangas State University and Don Mariano Marcos State Universities, respectively, situated in both study sites of the projects. A number of young professionals, graduate students, as well as local government officers are involved in the capacity building activities. They are conducted through online training and workshops with the aim of co-learning, co-developing, and co-managing the goals and objectives of the project.

Website:

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

Living Laboratories Initiative: A New Approach

At-a-glance

Objective: To accelerate the development and adoption of sustainable practices and technologies by Canadian farmers.
Lead countries/organization(s): Industry partners are leading living labs projects with scientific support from Agriculture and Agri-Food Canada (AAFC). In parallel, AAFC's Living Labs Division is working with international partners to advance the living lab innovation approach.
Place: The Canadian Agroecosystem Living Labs Network was first established in four provinces: Prince Edward Island, Manitoba, Ontario, Quebec, and is expanding to cover all provinces across Canada.

BACKGROUND AND OBJECTIVES

Addressing agri-environmental issues is complex but essential for improving the sustainability of agricultural production, positioning the sector as a trusted source of food and other agri-based products, and ultimately supporting clean inclusive growth. A new approach is required to enable effective responses to persistent agri-environmental issues with national significance while considering the particular local conditions, the socio-economic environment, and the specificity of different production systems.

The Living Laboratories Initiative, which brings together farmers, scientists, and other collaborators to develop and test innovative practices and technologies, was launched in 2018 as a new approach to agricultural innovation in Canada. Through a network of Living Labs, the initiative focuses on building innovative solutions, such as riparian buffers or cover crops, to environmental issues related to agriculture, including climate change, soil health, water quality, and biodiversity, that can be adopted by Canadian farmers.

ACTIONS

Through the gradual establishment of four sites in Canada, Agriculture and Agri-Food Canada (AAFC) implemented the "Agroecosystem Living Lab" approach, which is based on three core principles:

- Focusing on farmers' needs: As the executers of innovations, farmers are key collaborators throughout the entire process. Farmers not only test the proposed innovations, they contribute knowledge and experience to their development and improvement at every step.
- Broad and diverse partnerships: Farmers, multidisciplinary teams of scientists and researchers, and other collaborators contribute their expertise and resources to develop innovative farming practices and technologies. These collaborators include First Nations, governmental institutions, industry representatives, non-profit organizations, and producer groups.
- Testing in the real-life context: The practices and technologies are tested in the context and scale in which they will be adopted: on local farms under real agricultural production conditions.

These principles, along with an iterative innovation cycle, were applied in the design, experimentation, and evaluation of beneficial management practices applied on the farmers' land. Through this innovation cycle, farmers, scientists, local collaborators, and others come together to discuss farmers' needs and to identify common priorities and objectives. Then, working together, they design innovative new practices or technologies to help address these needs. These innovations are then tested, evaluated, and further improved through a set of repeating steps.

RESULTS

Project impacts on sustainable development include:

Social: The project team studies the social factors, such as demographics, influencing the decision to adopt the living lab innovations in a broader population. Additionally, given the collaborative nature of the partnerships, the Living Labs program enables learning relationships between diverse stakeholders, including those from marginalized groups.

Environmental:

Living Lab – Atlantic (Prince Edward Island)
Protecting soil health, water quality, and potato yield
Co-developing and studying soil and water management strategies, cover and companion crops, rotational practices, and slow-release fertilizers.

Living Lab – Eastern Prairies (Manitoba)
Capturing carbon and improving productivity
Co-developing solutions to prevent nutrient, water and habitat losses; improve tile-drainage practices; enhance habitats for beneficial insects and pollinators; and investigate regenerative grazing for carbon capture and storage in grassland soil.

Living Lab – Quebec (Lac Saint-Pierre)
Collaborating to improve soil health and livestock production
Co-developing solutions that reduce erosion and improve soil health with cover crops, lessen bank erosion and protect diversity through riparian buffers, and reduce the environmental effects of livestock production with improved feed and waste management practices.

Living Lab – Ontario (Lake Erie Basin)
Working together to protect Lake Erie
Co-developing solutions to reduce soil and nutrient runoff through practices like continuous cover cropping and reduced tillage, promote soil conservation and overall watershed health.

Economic: For each of the four active Living Labs projects, a team of social scientists and economists from the Science and Technology Branch and the Research and Analysis Directorate of Strategic Policy Branch has been working alongside researchers from various academic institutions and NGOs to provide information to help farmers understand the costs and benefits of implementing the innovations being co-developed.

SUCCESS AND LESSONS LEARNED

Initial observations from the initiative have already demonstrated early successes. The Living Lab approach is catalyzing space to build trust, develop relationships, and share experiences between participants. The initiative is also showing signs of research integration and eventual transdisciplinarity.

Moreover, participants reported the value of the producer-centered approach, resulting in greater adoption of sustainable practices and technologies by producers. Living Labs are stimulating new and ongoing environmental stewardship and allowing for further resource leveraging from partners, including industry partners.

Several lessons learned can also be identified. Developing a new way of working requires more time and effort. There are signs of culture change, with participants being open to conducting operations differently. Secondly, strong trusting relationships are crucial to partnership building and collaboration, requiring for project partners to clearly identify common group objectives to ensure system-level outcomes.

Flexibility and openness must be encouraged and nurtured by all Living Lab participants. Finally, regular communication is essential to building relationships and establishing trust between partners, along with coordination and leadership skills to synchronize the many participants and perspectives involved.

Through the Living Laboratories Initiative (ongoing until March 2023), the Living Labs approach has shown great success and tremendous promise for accelerating the adoption of beneficial management practices for increased sustainability of the Canadian agricultural sector. As a result, the 10-year Agricultural Climate Solutions – Living Labs program, a $185 million investment launched in 2021, will employ the same Living Lab approach in the fight against climate change.

Website:
https://agriculture.canada.ca/en/science/living-laboratories-initiative

Long-Term Agroecosystem Research (LTAR)

At-a-glance

Objective: To develop national strategies for more efficient agricultural production while improving the quality of the environment and the well-being of America's farming communities.
Lead countries/organization(s): USDA's Agricultural Research Service (ARS)
Place: United States, Canada, France

BACKGROUND AND OBJECTIVES

The world will face significant challenges providing food, feed, fiber, and fuel to support a global population of 9.7 billion people in 2050. Land use changes, increasingly erratic weather patterns, and increased competition for water and other natural resources threaten food security, watersheds, and other ecosystem services that rural landscapes provide. Agricultural lands account for more than 900 million acres (41%) of U.S. land, including 400 million acres of intensively managed croplands, along with pastures and rangelands.

Agricultural intensification involves increasing production while maintaining or reducing the use of system resources such as labor, feed, fertilizer, and land. However, sustainable intensification also needs to balance increased production with the conservation of natural resources, protection of the environment, and enhancing rural well-being. Sustainable intensification will increase our food security while shrinking the environmental footprint of agriculture. These strategies, which strive to maximize yields while simultaneously reducing detrimental environmental impacts, must also be tailored to distinct climatic, ecological, political, and socioeconomic contexts.

The LTAR network is a formal research network to improve agriculture and ecosystem services provided by managed U.S. lands and takes a long-term and transdisciplinary science approach that is essential for understanding how agroecosystems adapt and respond to stressors of agricultural production. Research protocols emphasize co-production of knowledge with diverse stakeholders for defining problems, implementing research, and interpreting results to ensure research translates to action. LTAR meets a critical need to promote U.S. agricultural sustainability by conducting research to develop and test innovative agronomic strategies that increase agricultural productivity and profitability, reduce negative environmental impacts, and promote human well-being. Cross-scale LTAR research improves understanding agriculture from a systems perspective and facilitates optimizing management goals.

ACTIONS

The LTAR network combines strategic research projects with common measurements on multiple agroecosystems (croplands, rangelands, pasturelands) and develops new technologies to address local and national challenges and opportunities. LTAR researchers conduct long-term Common Experiments in cropland and grazing land sites that compare aspirational to business-as-usual management practices to identify, quantify, and understand mechanisms underlying tradeoffs and synergies among ecosystem services. They develop an innovative network data management system and provide core biophysical data from agroecosystems that complement other federally funded national research networks to enable cross-network analyses. The aspirational systems are designed to enhance agroecosystem sustainability in the following ways, and a quantitative assessment framework has been developed to measure progress and tradeoffs among:

- Improved agricultural productivity: To increase production per unit of input such as labor, time, land, energy, water, fertilizer, seed, or feed.
- Rural well-being: To preserve cultural value, reduce reliability on external inputs, improve economic sustainability and resilience, and convey the social and environmental values of grazing lands and croplands.
- Environmental quality: To assess the synergies and tradeoffs among ecosystem services, such as greenhouse gas mitigation, soil health, biodiversity, and water quality and quantity, to provide producers and agencies with important information and hew techniques for management and decision-making.

RESULTS

Producers must feel confident that transitioning to more sustainable production systems will maintain and perhaps increase profits as well as providing ecosystem services essential for future production and natural resource protection. These benefits include:

Social: As agroecosystems change, producers desire to maintain or improve their individual well-being and community well-being. Social scientists assess individual well-being through surveys, focus group discussions, and interviews about self-determination, self-actualization, and mental health. Community well-being is assessed through quantitative and qualitative methods that identify community connections, capabilities, and conditions.

Environmental: As agroecosystems change, it is important to observe the implications of changing management practices on water, land, and atmospheric health. Environmental scientists assess these changes through quantitative measurements of water quality and quantity, biodiversity, soil health, air quality, greenhouse gas mitigation, and temperature regulation.

Economic: Research results will provide producers with information they can use to sustain profitability and financial health. To compare existing agroecosystems and proposed changes, economists assess profitability by measuring net farm income, profit margin, and returns to land, labor, and management. They assess financial health by quantifying financial efficiency, liquidity, and solvency.

SUCCESS AND LESSONS LEARNED

To date, LTAR researchers have defined and presented a range of findings advancing their core missions of identifying practices that enhance ecosystem services in agriculture. These include:

- Developing the Agricultural Performance Indicator Context and Knowledge System (AgPICKS) as a framework for evaluating farm and ranch-level performance compared to benchmarks in production, environmental quality, economics, and societal well-being.
- Launching a new data portal, using Socrata Open Data platform, that has data storing and sharing capabilities and has a story telling feature to share research with stakeholders and the public.
- Publishing 32 protocols for core metrics of the Common Experiment in protocols.io. The protocols describe methodologies implemented across LTAR sites, ensuring systems-level data are collected in a manner that enables robust analyses of agroecosystem attributes.
- Synthesizing multi-site water quality data across LTAR sites and finding that agricultural subsurface drainage water contained 2 to 6 orders of magnitude less microplastics than sampled surface water and laundry gray water.
- Leveraging LTAR resources for other research projects, including the Agricultural Modeling Intercomparison and improvement Project, the Group on Earth Observations Global Agricultural Monitoring project, the Joint Experiment for Crop Assessment and Monitoring, and the Rangelands Pasture and Productivity project.

Website:
www.ltar.ars.usda.gov

Low-Emission Fertilizer Application Through Nutrient Recovery

At-a-glance

Objective: To provide a practical, feasible, cost-efficient and environmentally friendly mobile technical solution for the treatment of liquid manure.
Lead countries/organization(s): EIP OG ARGE Ammosafe; funded EU federal and state governments
Place: Styria, Austria

BACKGROUND AND OBJECTIVES

Agriculture is responsible for 94% of total ammonia emissions in Austria. 50% of these emissions are caused by the spreading of farm fertilizers. This is further increased if the fertilizers are used improperly, which leads to additional emissions into the air and groundwater. To reduce the negative environmental impacts of farm fertilizers, the Directive on the reduction of national emissions of certain atmospheric pollutants (EU) 2016/2284 was implemented in Austria through national regulations. Difficulties for farms arise, for example, in logistics, nutrient efficiency, the legal framework and social compatibility, while at the same time improvements in air, groundwater, and soil protection are required.

To tackle this problem, the EIP Operational Group ARGE Ammosafe was formed by a multi-actor collaboration involving three agricultural farms, Bauer GmbH, and the Styrian Chamber of Agriculture. In addition, the University of Technology Graz, Raumberg-Gumpenstein Research & Development, the Styrian Provincial Government, and the University of Natural Resources and Life Sciences Vienna have also been involved in this project. The aim of the EIP Operational Group ARGE Ammosafe was to promote environmentally friendly, soil-conserving, and socially acceptable agriculture. In particular, the project aimed to find a practicable, cost-efficient, and environmentally friendly mobile technical solution for the treatment of liquid manure. In addition, ammonia emissions from liquid manure spreading and nitrate pollution of the groundwater were to be reduced. By using a suitable technical solution, it was hoped to achieve greater nutrient efficiency on the farms and with this, increase input efficiency.

The project also aimed to reduce the emission of unpleasant odors, thereby improving the social compatibility of liquid manure management. The target group of the project were pig and cattle farms that wanted to practice socially and environmentally compatible farming.

ACTIONS

- A new type of process for the treatment of liquid manure was developed and tested, whereby the practical feasibility, economic efficiency and environmental compatibility of the process were examined in particular.
- A mobile liquid manure treatment plant for the removal of ammonium nitrogen from liquid manure was designed and developed.
- The plant was tested on agricultural farms using cattle and pig manure in three runs each. The efficiency of the ammonia separation was checked by continuous measurements. The experience gained from the first runs was implemented by making improvements to the system for the subsequent runs.
- The ammonia-reduced liquid manure was examined to discern its storability, its odor, and as a fertilizer with regard to its effect on crop cultivation and its effect on the leachate quality. The field trials were carried out at two test sites with different soils.
- Finally, an economic evaluation of the processes carried out was made.

Landwirtschaftskammer Steiermark

RESULTS

Potential and expected impacts include:

Social: The use of this technology reduces the emission of unpleasant odors, which improves the social compatibility of manure management.

Environmental: A mobile liquid manure treatment plant has been developed that can ideally remove more than 90% of the ammonium nitrogen from the liquid manure. After treatment, the processed liquid manure contains mainly organically bound nitrogen. Nevertheless, rapid incorporation of the treated liquid manure is necessary, as the high pH value resulting from the process would lead to rapid outgassing of the remaining ammonia.

The removed nitrogen can be stored in concentrated form as ammonium sulfate in a simple and space-saving manner. This allows farmers to flexibly fertilize their crops with the recovered ammonium sulfate when the crops' nitrogen requirements are at their highest. This represents a more targeted and lower-emission utilization of the nitrogen-reduced liquid manure and increases overall fertilizer management efficiency.

Air emissions such as ammonia and nitrates in groundwater have been reduced following the application of liquid manure. Theoretically, liquid manure could therefore be spread at different times of the year, provided the legal framework conditions allow it.

Economic: The production of ammonia-reduced liquid manure has not yet proven to be economically lucrative under the conditions of the project (13-34 €/m³ depending on the assumption of different variable costs and the capacity utilization). However, this does not yet consider the fact that the plant can still be significantly improved in terms of process technology and that the savings on the purchase of fertilizer through the production of ammonium sulfate and any cost contributions from the public sector are not yet included here. Productivity growth effects through reduced input costs can be expected when the technology is scaled up.

Landwirtschaftskammer Steiermark

SUCCESS AND LESSONS LEARNED

- The tested process has shown that the removal of ammonia with the aid of quicklime and the stripping of ammonia with sulfuric acid also works in principle on a practical scale for cattle and pig manure.
- The treated liquid manure can be used very well as fertilizer. The odor reduction results in greater social compatibility. The reduction in the nitrogen content has a positive effect on emissions during and after spreading as well as on the quality of the leachate.
- It is important to remove the ammonia as completely as possible when using quicklime, as the high pH value would lead to increased emissions of the remaining ammonium nitrogen if stripping is incomplete.
- For the same reason, the treated liquid manure should be used immediately as fertilizer and not stored.
- The EIP Operational Group facilitated co-operation between experts from different fields. This worked well and new solutions were jointly developed on a scientific basis. The involvement of various interest groups in the project has shown that farmers can benefit directly from their involvement in the project, as confirmed by Mr. Loibner (co-initiator of the project and member of the OG and trial farmer).
- Above all, the calculations on economic efficiency showed that there is still a need for further research into the process engineering of the system as well as long-term observations in the field of plant cultivation to achieve a broad implementation of the process in agricultural practice.

Website:
https://eu-cap-network.ec.europa.eu/sites/default/files/2023-10/good-practice-report-EIP-Operational-Group-ARGE-Ammosafe_0.pdf

Manage Resistance Now

Protect your land, one field at a time

At-a-glance

Objective: To increase knowledge and promote adoption of resistance management strategies to ensure sustainable crop production for the future.
Lead countries/organization(s): CropLife Canada
Place: Canada

BACKGROUND AND OBJECTIVES

With ever-increasing pressures of extreme weather due to climate change comes increasing threats from insects, weeds, and diseases. There is a growing importance for pest resistance management strategies to protect crop yield and quality. Protecting the viability of current and future pest control products is critical to ensuring sustainable crop production for the future.

Without all actors playing their part – from the companies selling products, to agronomists giving advice to farmers implementing the practices – resistance can persist quickly and important tools for achieving sustainable farms can be lost. Preserving these tools early is critical, as the discovery and development of new tools to manage pests takes time and so do new solutions.

In 2018, CropLife Canada launched Manage Resistance Now (MRN), a collaborative effort of industry, academia, and government experts. The objective of the platform is to forge partnerships, increase knowledge, and promote adoption of strategies that will lead to a reduction of weed, insect, and disease resistance. In an effort to increase the sustainability of an agricultural system, resistance management is based on integrated pest management (IPM) strategies, which are formulated on a combination of cultural, biological, mechanical, and chemical control methods. Through the variety of resources offered, MRN aims to be a one-stop shop that enables cross-sector sharing of scientific developments and field observations to help farmers manage resistance issues.

ACTIONS

The platform MRN was launched with a herbicide resistance focus, followed by information on fungicides, insecticides, and seed traits. The core sections were completed in 2020, and each year new materials are added to address key pest issues as they arise in Canada. The best practices are developed by CropLife Canada's expert scientific technical Resistance Management Committee with input from an external committee of public scientist experts as well as partner organizations and extension specialists. The recently updated strategies can be accessed and downloaded from the website. Resellers and farmers can quickly search and locate the relevant best practice strategies that provide crucial and timely advice on managing pest resistance. For example, searching on the platform, one can find factsheets on how to manage herbicide resistance in kochia or wild oats, and can view videos on the status of resistance and how to assess the risk. The suite of information is offered in both official languages of Canada.

In 2021, a partner initiative was launched that allowed various organizations, such as commodity groups, to collaborate on the development of new materials. The initiative was put in place to address more specific resistance management issues, leverage and communicate with a wider network, and accelerate the development of resources. The first partner project was published in 2022 in collaboration with four commodity groups across Canada.

MRN is openly accessible and is promoted through social media, paid media, and through a growing network of seed companies, academics, extension specialists, grower groups, and commodity organizations.

RESULTS

MRN is mobilizing stakeholders to work together to drive awareness and implementation of resistance management practices, resulting in benefits across the three pillars of sustainable development.

Social: A critical outcome of MRN is driving awareness and implementation of agricultural practices. Through grower surveys, CropLife Canada has been able to track this over time. In 2021, one year following the launch of the best practices for Bt corn section on MRN, record high levels of awareness of rotation, scouting, and record-keeping were noted, following a dip in 2019. The user stats continue to grow as we expand our content and partnerships, with currents stats as follows:

- 22,181 new users have visited the site
- Average users view 1.5 pages per session
- Twitter: 2,044 followers (English and French)
- Facebook:1,976 followers (English and French)

Environmental: With increased awareness often comes increased implementation, as also noted in the grower surveys. Implementation of IPM strategies to delay resistance also reduced overall pest pressure and the need for pesticide application, which results in multiple environmental benefits, including maintaining natural enemies of pests.

Economic: Effective control of pests and maintaining relevance of pest control tools can help reduce the devastating impact pests have on farm income, particularly as pest pressures evolve with climate change. Proactive resistance management strategies can have greater upfront costs but have shown to pay off in the long term. Estimates show that herbicide resistance costs producers from $1.1 to

1.5 billion annually in terms of increased herbicide use and decreased yield and quality. Modelling over a 20-year period has shown resistance management can result in profit losses in the first year of implementation, but by year two it pays for itself in profits of 14-17% over 20 years.

In 2019, MRN won Best Stewardship Program at the International Agribusiness Intelligence Crop Science Forum & Awards.

Input across academia, government, and industry was critical to providing different perspectives and increasing credibility of the resources. In the third year of the program, efforts to expand reach were implemented through partnerships with regional and national commodity associations and by adding content relative to specific regions. This resulted in a significant number of new unique users and a momentous increase in social media reach, including:

- Twitter impressions
    - English: 60K (3,800% increase); French: 121K (62,000% increase);
- Facebook post reaches
    - English – 4,000 (7,000% increase), French – 46K (331,000% increase)
- Website: 1,272 new users

A lesson learned was that continuous annual investment is required to keep content current, which can be done by adding new materials to address emerging issues and staying active on social media.

There is an opportunity to further expand MRN's reach. In 2022, MRN will launch its first grower contest where growers can submit stories of implementing resistance management strategies for a chance to win prizes. The goal is to:

- Drive more traffic to the MRN site
- Identify peer-to-peer influencers
- Expand partnership opportunities
- Encourage resistance management dialogue

Websites:

https://croplife.ca/
https://manageresistancenow.ca/

SUCCESS AND LESSONS LEARNED

MIDORI Strategy for Sustainable Food Systems

At-a-glance

Objective: A comprehensive strategy to transform agriculture and food systems by sustainable productivity growth.
Lead countries/organization(s): Ministry of Agriculture, Forestry and Fisheries (MAFF)
Place: Japan

BACKGROUND AND OBJECTIVES

Japan is an archipelagic country which is rich in water and forest resources, but densely populated and largely covered by hilly and mountainous terrains. In such a country, meeting a strong food demand driven by increases in population and income in the post-war era was a challenge. Given the limited endowment of flat lands, this task was mainly achieved by productivity growth. Thereafter, as the economy matured and the total population turned to decline in 2011, strong growth in total food demand is no longer expected. Yet today, productivity growth is highlighted from another perspective; the farming population in Japan is decreasing at a much faster pace, recording almost 30% down from 2010 to 2020. To maintain food production with fewer farmers, productivity growth is again a vital issue in policy discussions.

Agriculture is a unique industry in that its interaction with nature is direct and intense. It can impact and be impacted by many natural factors such as water, soil, the air, and ecosystems, to a tremendous degree. As such, expectations are high for agriculture to reduce environmental burdens and contribute to positive outcomes, such as water retention and biodiversity conservation. Production increases in the past have been greatly helped by mechanization and intense use of pesticides and fertilizers that had negative impacts, but agriculture in the future cannot take that same path for growth.

ACTIONS

The “MIDORI Strategy” (MIDORI means “green” in Japanese), launched in 2021, is the response from agricultural policy to this dual task of sustainability and productivity growth. Its objective is to make food systems more sustainable and productive. Concrete KPIs (Key Performance Indicators) and targets for 2050, enabling tracking and assessment, include:

- Zero CO2 emissions from fossil fuel combustion in the agriculture, forestry, and fisheries sectors
- 50% reduction in risk-weighted use of chemical pesticides
- 30% reduction in chemical fertilizer use
- Increase in organic farming area to 1 million ha, equivalent to 25% of total farmland

Innovation is the key to the transformation above. Technology is now transitioning from production-based outcomes to production that utilizes less inputs and creates less environmental burden. Under this new strategy, the focus of research and development is on greener materials and machines, development of plant varieties with less environmental impact (for example, more pest-resistant or requiring less fertilizers), and long-term carbon sequestration into farmlands, forests, and oceans. Introduction of advanced machines, such as automated harvesters and mowers, drones, and remote controlling helps save labor and input use by labor substitution and precision application of pesticides and fertilizers. This is a typical example of contribution to both productivity and sustainability.

Institutional schemes are also mobilized. Producers (including farmers, fishers, and foresters) can be certified for their environmentally friendly practices and technologies aligned with the “Basic Plan,” which is formulated at subnational levels and tuned to specific regional needs and conditions. Financial benefits such as tax credits are available for certified producers and business operators.

The J-Credit Scheme, in which the amount of reduced and removed greenhouse gas emissions are certified as “credit,” is in place. Now its coverage extends to agriculture, further encouraging farmers toward climate change mitigation.

RESULTS

Potential and expected impacts include:

Social: The strategy is in essence a sustainable transformation of agriculture, forestry and fisheries, which are all deeply rooted in local societies. Innovative attempts and creative undertakings in these sectors will attract the younger generation, create job opportunities, and thus stimulate and encourage rural communities. Additionally, strengthened domestic production by productivity gain is an enhancement of food security. The basic principle of MIDORI Strategy, "food systems harmonized with environment," was integrated into the revised Basic Law on Food, Agriculture and Rural Areas in 2024.

Environmental: Zero CO2 emissions by 2050 from fossil fuel use in agriculture, forestry, and fisheries is a significant contribution to the realization of a carbon neutral society.

- Reduced use of chemical pesticides is a conservation and restoration of biodiversity.
- Lowered use of chemical fertilizers is an alleviation of environmental burden on soil and water.
- The total area of organic farming shows a strong expansion, increasing by 14% from 2021 to 2022.
- The prolongation of midseason drainage was approved for the J-Credit Scheme in March 2023 in a related development. Credits for GHG reduction are now certified by the adoption of extending midseason drainage in paddy fields, as the practice can reduce methane emissions by 30%.

Economic: Initiatives centered on agriculture will trigger new activities in regions, translating into more business opportunities in rural communities. Shifts to green technology can facilitate investment in innovation, and its economic spillover can be expected. Technologies for environmental burden reduction in the area of agriculture, forestry and fisheries are dramatically developed by a variety of sectors and certified under the MIDORI Act.

Photo: Rice transplanter using recycled paper mulch

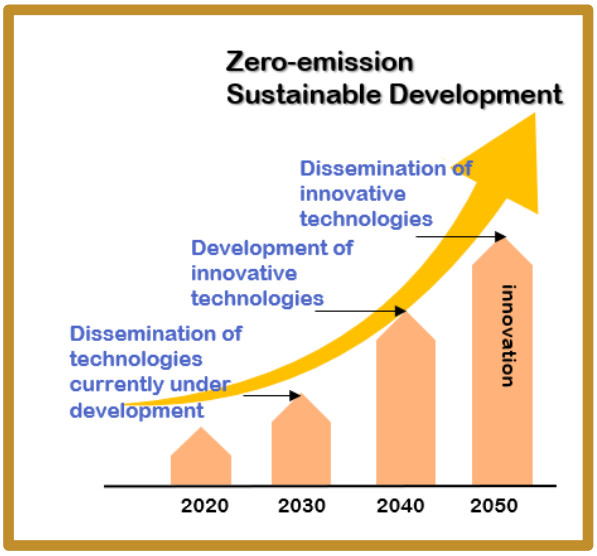
SUCCESS AND LESSONS LEARNED

The MIDORI Strategy is not all about technology and innovation. At its core is the participation by farmers, fishers, and foresters and relevant stakeholders.

For example, farmers show strong interest and willingness to join the project. Since 2023, more than 17,000 farmers in 46 prefectures (as of August 2024) have been certified for their environmentally friendly practice, including the utilization of recycled material.

The J-Credit Scheme, mainly developed in the industrial sector, now has 35 registered projects that have farmers' participation, as of August 2024.

MAFF takes the lead in promoting further engagement in cooperation with businesses, local governments, producer organizations and consumer associations.



Website:
www.maff.go.jp/e/policies/env/env_policy/midori.html

NUTRIent MANagement and Nutrient Recovery Thematic Network (NUTRIMAN)

At-a-glance

Objective: To improve the promotion of novel N/P nutrient management and recovery potential for the ready-for-practice cases, which are still not sufficiently known by practitioners and market players.
Lead countries/organization(s): European Commission, 3R-BioPhosphate Ltd. (HU); funded by EU
Place: Hungary, Belgium, Spain, Netherlands, France, Germany, Italy, Poland

BACKGROUND AND OBJECTIVES

The agriculture and food industries have a high dependence on resources in their production and strive for long-term sustainability. There is an urgent need to optimize resource use and smooth the transition to knowledge-driven practices. Therefore, it is essential to spread knowledge and information about the insufficiently exploited Nitrogen/ Phosphorus (N/P) recovery innovations (technologies, products, practices) that have already reached matured and post-research innovative results and are market "ready-for-commercial practice."

The objective of the NUTRIent MANagement and Nutrient Recovery Thematic Network, or NUTRIMAN, is to improve the promotion of these commercial and market ready-for-practice qualified cases of N/P nutrient management and recovery potential that are not yet sufficiently known or used by practitioners. This promotion will create new opportunities for farmers to develop connections between matured research results with market-competitive and commercially useful results and farming practice in the priority area of nutrient management and nutrient recovery. NUTRI-MAN takes a bottom-up approach to identify incentives and bottlenecks for adoption and to prioritize technologies/products that will ensure greater willingness to utilize matured innovations and improve multiplier effects. The project targets large-scale uptake of the recovered N/P innovative fertilizers produced from unexploited resources of organic or secondary raw materials in line with the circular economy model, and of which are efficiently used by farmers from both economic and environmental standpoints.

ACTIONS

Identification of technology readiness level (TRL) 6 and above of matured and post research innovative results made in the field of N/P recovery. Over 1,000 EU27 recent research results have been identified that are close to being put into practice, but are not yet sufficiently known by agricultural practitioners.

Market-driven evaluation of innovative N/P nutrient recovery technologies and novel N/P fertilizer products and practices, both by internal and external experts and by the potential end-users as well.

Compilation of "ready-for-practice" knowledge in the form of European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI) practice abstracts, info sheets, multi-lingual (eight languages) product application and training materials, audio-visual materials, and infographics.

Sharing and disseminating the collected knowledge to agricultural practitioners (farmers, farmer organizations, advisory services) using online webinars and face-to-face workshops across Europe.

Long-term operation (up to year 2031) of an interactive practice-oriented NUTRIMAN farmer platform in eight languages that is maintained to support EU27 farmers and all stakeholders.

RESULTS

The NUTRIMAN Farmer Platform has created an inventory of 80 innovative fertilizer processing technologies and recovered phosphorus/nitrogen products. 150 field test showcases and workshops have been organized for farmers across EU to demonstrate novel applications to farmers and other practitioners. At least 1.5 million farmers and stakeholders are connected to the NUTRIMAN info network. More than 50 articles in journals, newspapers, farmer magazines, and newsletters have been published on the technologies.

Social: Networks like NUTRIMAN are important awareness-raising platforms in Europe that engage different actors. Thus far, over 1.5 million farmers have been connected. NUTRIMAN achieved and supported greater user acceptance of collected solutions and a more intensive dissemination of existing knowledge. The project also serves practical educational and training purposes with technical information about innovative N/P recovery solution opportunities. Socio-economic and gender dimensions considered in the development of promotion.

Environmental: The project supports the implementation of 2030 EU targets for Circular Economy, Green Deal, and environmental and climate sustainability, while improving food safety and security. It provides tools to the European agricultural sector to become more productive and manage natural resources sustainably while preserving the environment through zero emissions and energy independent solutions. It provides different solutions for biobased by-products to be upcycled into different fertilizing products.

Economic: The NUTRIMAN Farmer Platform is supporting farmers with economically sustainable, market-competitive solutions to improve farm practices. Application of more efficient and advanced solutions supports a more rapid economic recovery and the creation of new jobs. In this context, the novel solutions open new technical, economic, and environmental opportunities.

SUCCESS AND LESSONS LEARNED

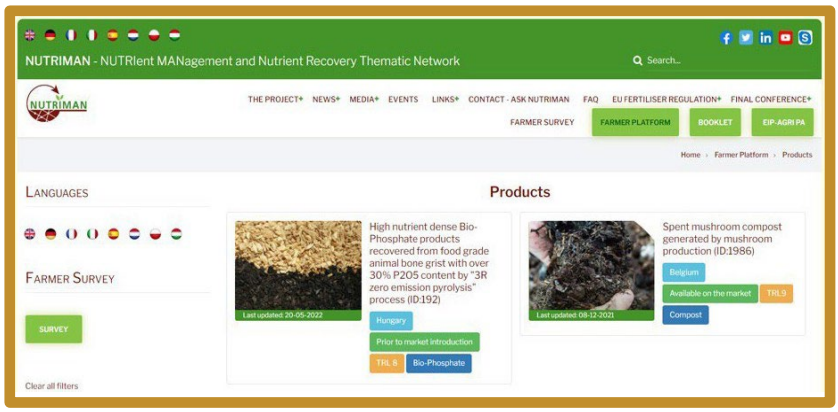
Developing trust and knowledge across the entire value chain is key to increasing farmer adoption of bio-based fertilizers. So far, basic research programs have yet to interest farmers, as farmers are often more drawn to “ready-for-practice” innovations that have already been demonstrated under real field conditions with market competitive performance.

The Farmer Platform lists and presents these ready-for-practice and close-to-market novel recovery technologies and products, focusing on the most urgent needs of farmers. The database is continuously expanding, presenting all innovative solutions with a status just before they are introduced to the market or early stage of market introduction. New updates are highlighted on the web at www.nutriman.net.

NUTRIMAN has already contributed to large-scale adoption of innovative, recovered nitrogen and phosphorus fertilizers. These include, for instance, a zero-emission and energy independent technology that enables phosphorus recovery with economical high nutrient density from food grade animal bone grist at industrial scale. Another example is the Poul-AR® technology, which enables the production of ammonia sulfate/nitrate from poultry manure.

Conversion and scale-up of research and innovative results into market competitive solutions and viable products is a highly challenging venture. However, there is an increasing market demand for practical N/P nutrient solutions and products that are safer, less costly, more environmentally friendly with better resource and energy management than the traditional ones on the market.

Website:
https://cordis.europa.eu/project/id/818470



Open Technology Ecosystem for Agricultural Management (OpenTEAM)

At-a-glance

Objective: Create open-source, accessible, and equitable toolkits to provide stakeholders access to data, technology, and communities for improved soil health, productivity and climate resilience.
Lead countries/organization(s): Wolfe's Neck Center, Foundation for Food & Agriculture Research
Place: United States

BACKGROUND AND OBJECTIVES

Despite the abundance of decision-making tools available to farmers and ranchers, the lack of interoperability makes it challenging to use these tools for effective decision-making and inhibits data sharing to advance on-farm research. Creating an integrated toolkit that allows for communication across technologies is essential for motivating the adoption of management techniques that improve soil health, decrease greenhouse gas emissions, boost productivity, and build climate resilient communities. OpenTEAM (Open Technology Ecosystem for Agricultural Management) was created to fill this gap.

OpenTEAM is committed to improving soil health, increasing productivity growth, and decreasing greenhouse gas emissions through shared knowledge, collaborative frameworks, and open-source technologies. The data-sharing infrastructure collects and integrates diverse datasets, including field-level carbon measurements, soil health metrics, digital management records, input and economic management data, and remote sensing data, to support predictive analyses. This allows farmers and ranchers to share information with each other and researchers collaborating on the project. The data-driven approach enables precision agriculture and adaptive management to reduce resource use while achieving higher yields. By integrating these datasets, OpenTEAM accelerates the development of new tools, enhances their accuracy, and enables adoption of soil health management practices suitable for farms of all scales, geographies, and production systems.

ACTIONS

Launched in 2019, OpenTEAM is a collaborative of farmers, ranchers, scientists, researchers, engineers, farm service providers, and food companies. The project—which received over $12 million in combined funding from public and private partners—generates community-driven solutions that make data collection, sharing, and analysis accessible for farmers and ranchers. OpenTEAM creates shared goals and priorities and distributes new agricultural knowledge to community members. The developed technology and shared knowledge provide farmers and ranchers more sovereignty than traditionally competitive environments, and the community and tools help them track their progress, increase productivity, reduce emissions, and sequester more carbon, thus accelerating the adoption of regenerative agriculture practices.

A community of practice drives the innovation process, and this takes form in OpenTEAM's development of working groups and collabathons. Working groups are made up of interdisciplinary group of experts from the public and private sector who provide expertise into how to better develop the tools and community. OpenTEAM also organizes 'collabathons', which are intensive collaborative sustained sprints designed to foster innovations and accelerate the development of solutions. These collabathons bring together diverse stakeholders to tackle specific challenges and co-create tools that benefit the community.

RESULTS

OpenTEAM has built trust among diverse stakeholders, enabling them to collaboratively create tools, open-source protocols, and standards for more sustainable and regenerative agricultural practices. They are developing the foundation for a common agricultural knowledge system that benefits everyone. This collaboration improves soil health and resilience to climate change, and directly supports productivity by using a community-centered approach to build and improve precision agriculture tools. These tools enhance efficiency, improve productivity, and optimize resource use on stakeholder farms and production systems.

Social: OpenTEAM has both established new and strengthened existing collaborations across stakeholders in the agricultural sector. The development of the Ag Data Glossary, Data Fiduciary Oath of Care for Agricultural Professionals, Agriculturalists' Bill of Data Rights, and Data Hosting and Storage Agreements have given producers greater control over their data, increased data transparency, and generated trust among participants.

Environmental: OpenTEAM works to increase food system resiliency using shared knowledge, collaborative frameworks, and open source connected technologies. OpenTEAM's work has built climate change resiliency and created communities that can thrive in the face of environmental stress. The project's infrastructure provides access to environmental claims information and measurement, reporting, and verification systems necessary for developing thriving ecosystem marketplaces, including carbon markets. These tools allow producers to more effectively manage soil health, track carbon sequestration, and improve overall ecosystem health.

Economic: By laying the groundwork for more productive and resilient agricultural practices, OpenTEAM has created a shared knowledge infrastructure that allows farmers and ranchers to make better-informed decisions to increase yields and decrease costs. By creating the infrastructure to generate ecosystem services data, OpenTEAM facilitates access to additional markets that prioritize adoption of sustainable practices. Additionally, the development of economic tools and models helps producers better understand the financial implications of management decisions and supports informed and economically beneficial practices that maximize productivity gains.

SUCCESS AND LESSONS LEARNED

OpenTEAM's success lies in developing a shared technology and knowledge ecosystem utilizing FAIR (findable, accessible, interoperable, and reusable) principles, and is broadly supported by researchers, farmers, ranchers, farmer and rancher groups, corporations and nonprofits. OpenTEAM's collective impact model is crucial, as it brings together members that share the belief that agriculture is a shared human endeavor requiring interdisciplinary collaboration and communication. By creating shared technology and knowledge infrastructure, OpenTEAM demonstrates how agricultural knowledge systems can be a powerful solution to climate change.

While adapting technology is important, it is only a small part of a successful agricultural knowledge ecosystem. Building trust and social contracts among diverse stakeholders is essential for sustaining meaningful impact. Fostering these relationships and collaboratively developing tools and standards is essential for creating technology that meets community needs, drives adoption, and delivers improved outcomes.

For future sustainable productivity growth and open technology ecosystem initiatives, engaging members early and frequently in developing governance structures is vital. Creating a community charter structure and shared principles fosters stronger collaboration and purpose among members. Similar projects can refer to and adapt the governing documents available on OpenTEAM's website to meet their needs.

Website:
https://openteam.community/

Regreening Africa: Phase 1

At-a-glance

Objective: To scale up evergreen agriculture, using locally appropriate techniques and to equip eight African countries with the surveillance and analytical tools for land degradation that support strategic decision-making and monitoring.
Lead countries/organization(s): ICRAF, World Vision; GIZ, ELD; CRS, CARE, Oxfam, Sahel Eco, Evergreening Alliance, EU
Place: Ethiopia, Ghana, Kenya, Mali, Niger, Rwanda, Senegal, Somalia

BACKGROUND AND OBJECTIVES

83% of people in sub-Saharan Africa are dependent on land for their livelihoods, yet two-thirds of the land is highly degraded, threatening livelihoods and the food and nutrition security of the poorest, most vulnerable farmers and pastoralists.

Tackling this challenge demands an ambitious but proven and effective approach: incorporating trees into cropland, communal land. and pastoral areas. This will speed up the reclamation of Africa's degraded landscapes. Agroforestry has already been successfully deployed to reverse land degradation throughout sites in Africa. The challenge now is to scale up relevant practices across the continent.

The first core objective of Regreening Africa is to scale up evergreen agriculture using locally appropriate techniques including farmer-managed natural regeneration, tree planting and other forms of agroforestry and complementary sustainable land management interventions.

The second core objective of the program focuses on strategic decision-making for scaling which entails working across the eight countries to collect and apply evidence in multi-stakeholder engagement and policy processes.

ACTIONS

The following practices and actions were supported in the eight participating countries:

- Farmer-managed natural regeneration
- Assisted natural regeneration
- Pastoral-managed natural regeneration
- Home gardening with trees
- Soil and water conservation practices
- Grafting
- Tree nurseries
- Rural resource centers

Using these actions, Regreening Africa aimed to reverse land degradation among 500,000 households and across one million hectares in eight countries in sub-Saharan Africa: Ethiopia, Ghana, Kenya, Mali, Niger, Rwanda, Senegal and Somalia by 2023. It aimed for a 5% decrease in soil erosion, a 10% increase in tree cover, and a 10% increase in average household income. The benefits of regreening include:

- Increased carbon storage above and below ground enhancing land health and agricultural productivity
- Slows strong winds and shades heat, boosting crop and grass yields
- Reduced erosion because tree roots improve the structure of the soil
- Trees that fix nitrogen in the soil provide fertilizer for crops
- Increased ability for soil to absorb and retain water
- Supports the production of food, fuelwood, fiber, fodder, resins, timber and medicine, which can improve incomes, food security, and nutrition

Funding:

- **Phase 1, 2017-2023:** EUR 21,550,891
- **Phase II, forthcoming**: EUR 15,000,000

RESULTS

Regreening Africa reached 607,088 households; 404,076 households in direct intervention areas, and 203,012 households in leveraged sites.

Social: Across all eight countries, the percentage of households reporting the consumption of fruit and nuts increased from 19% to 37%, with significant increases observed only in Ghana, Mali, Niger, and Rwanda. Project continuation may promote better outcomes for nutrition and dietary diversity.

Environmental: The project reached 954,440 hectares of land for regreening, including 700,536 ha from direct intervention areas and 253,904 ha from leveraged sites. Across all household land use areas, the total estimated number of trees increased from an average of 67 to 129 trees.

Economic: While the overall average income remained stable during the program, the number of households earning additional income from trees significantly increased from less than 600 to over 1500 over the program period. The sale of tree-related products increased from 8% to 20%, with significant variation across countries. In Ghana and Mali, there was a noticeable increase in the percentage of households selling fruits and nuts, rising from 8% to 30% and 14% to 28%, respectively. Similarly, the percentage of households that reported selling fuelwood increased from 3% to 12% in Ghana and from less than 1% to 3% in Mali.

SUCCESS AND LESSONS LEARNED

Over five and a half years, and across eight countries and multiple partners, five overarching lessons emerged from Regreening Africa Phase I that can inform future regreening efforts:

- **THINK BIG:** Large-scale, impactful restoration is achievable. Regreening Africa has shown us that large-scale land restoration is possible at a much lower cost for return than was previously thought possible. Restoring livelihoods through landscapes delivers on climate, biodiversity, and land objectives.
- **THERE'S NO MAGIC BULLET:** No single practice works in all situations, and we must match options to local contexts. It is essential to adapt and tailor restoration practices to the specific conditions and needs of each area.
- **BREAK DOWN SILOS:** Close working partnerships across the science-practice-policy interfaces are crucial. We need to collaborate with civil society, community, government, private sector, research, and donors, as each brings something valuable to the effort. It is important to work at the local level, utilizing local structures, community groups, and farmer trainers.
- **INTEGRATE SCIENCE AND EVIDENCE FOR LEARNING:** Scientific tools and evidence integrated into the process make it far more effective and efficient. Science and evidence from multiple sources have a central role to play in enhancing implementation and informing wider practice and policy. Adaptive management and flexibility, based on evidence and engagement, lead to greater impact.
- **PROVIDE FAIR ECONOMIC, LIVELIHOOD, AND POLICY INCENTIVES:** Inspiring people and communities to engage requires fair economic, livelihood, and policy incentives. Enabling policies and equitable value chains that enhance livelihoods are critical drivers of restoration efforts.

Websites:

https://regreeningafrica.org/

Final Project Report

Scaling Sustainability Outcomes Across Agriculture

At-a-glance

Objective: To deliver third-party certification of sustainable farmland management and improve sustainability outcomes in agriculture.
Lead countries/organization(s): Leading Harvest
Place: Global, featuring a case study in Tulare County, California

BACKGROUND AND OBJECTIVES

Leading Harvest launched on Earth Day 2020 but its story begins in 2017 when a group of farmers, landowners, conservationists, and sustainability experts came together to create a scalable program for independently verifying sustainable farm management and environmental, social, and governance (ESG) outcomes. After workshopping its program with over 50 stakeholder groups across the U.S. and conducting field-tests on 25,000 acres of cropland, Leading Harvest launched as its own independent nonprofit to serve the broad agricultural community. Leading Harvest provides educational programs and farmland management certification standards to improve sustainability outcomes and create transparency in agriculture globally. Leading Harvest's inaugural Farmland Management Standard is the first universal, outcomes-based sustainability standard that focuses on farm management and continual improvement. The Standard requires farmland owners and producers to follow best management practices for 13 outcome areas ranging from soil health to the well-being of local communities.

By implementing our Farmland Management Standard, Leading Harvest hopes to advance sustainable productivity growth, especially as it relates to soil health, water resources, and crop protection. Objectives 2 and 3 of the Standard directly call for the protection of soil health and water resources for efficient agricultural productivity. Objective 4 addresses the use of crop protectants to enhance productivity and reduce crop losses. Leading Harvest provides a scalable, industry-wide solution to urgent issues facing us – from climate change and biodiversity to the resilience of croplands and communities.

ACTIONS

Leading Harvest creates the educational materials necessary to understand, interpret, and implement the Farmland Management Standard, those materials of which management authority for farmland use to apply the Standard to their particular operating context. Leading Harvest does not prescribe practices necessary to conform with the Standard; rather, it provides family farmers and farm managers the flexibility to select best practices for sustainable outcomes.

Objective 3 of the Standard focuses on water resources. In collaboration, FarmTogether and Green Leaf worked to protect water resources and manage water for efficient agricultural productivity, in conformance with the Leading Harvest Standard.

When Green Leaf took over the management of Chester Farm, they began to upgrade the irrigation system on the farm. On average, the ranch's irrigation infrastructure was only able to deliver water with about 60% efficiency to its crops, and the ranch team noticed a major lack of uniformity, as large as a 30-40% differential in water delivery between some sprinklers.

The Green Leaf team installed both updated filter stations as well as new fan jet sprinklers and aimed to more rigorously evaluate the efficiency and uniformity of water delivery. Instilling these changes has allowed Green Leaf to maintain an 85% or greater efficiency standard across all of Chester Farm for water delivery, as well as to improve water quality and meet Leading Harvest's performance measures for water use and water quality.

These actions and others allowed FarmTogether to be in conformance with the Standard. To ensure its conformity with the Standard, FarmTogether engaged a third-party Certification Body to conduct a certification audit. Upon successful completion of the audit, FarmTogether achieved certification to Leading Harvest's Farmland Management Program.

RESULTS

To date, Leading Harvest has 1.5 million acres enrolled in its Farmland Management Program, covering 100 different row and permanent crop types over 31 U.S. states. Conformance to the Leading Harvest Standard leads to improved sustainability outcomes across agriculture. Each user of the Standard renders its own unique and innovative approach but must be in conformance with the Standard's 13 principles, 13 objectives, 33 performance measures, and 71 indicators that address economic, environmental, social, and governance issues. Third-party auditing conducted by independent and accredited certification bodies is used to verify whether the practices applied are sufficient to conform with an outcome described by an indicator.

Social: The Standard requires contribution to social networks and health of local communities. It also requires consideration and respect of the rights of local communities and Indigenous Peoples, as well as demands that safe and healthy working environments are provided. Examples of how users of the Standard achieve positive social outcomes include participation in local agriculture-related organizations and local governments, employee recruitment programs targeting women and marginalized groups, employee training around the rights of local communities and Indigenous Peoples, and professional development training opportunities for employees.

Environmental: The Standard requires practice of sustainable agricultural stewardship, enhancement of soil health, protection of water resources, conservation of energy, and conservation of biodiversity. Examples of how users of the Standard achieve positive environmental outcomes include application of regional agricultural Best Management Practices (BMPs), use of regional water use conservation programs, and low-emissions technology.

Economic: The Standard requires contribution to the economic well-being of local communities and fair compensation and training for personnel. Examples of how users of the Standard achieve positive economic outcomes include local employment and procurement, financial support for agricultural scholarships, and a living wage for personnel and contract management company employees.

SUCCESS AND LESSONS LEARNED

Leading Harvest is taking steps to expand its program into new regions and work with partners within the supply chain to increase sustainable outcomes. In 2021, Leading Harvest launched its first international pilot in Australia and will publicly launch its Australian program in 2023. In 2022, Leading Harvest began to work with Nestle USA to certify sustainable and regenerative farming practices in its tomato and soy supply chains.

As part of Leading Harvest's own continual improvement process, the Leading Harvest Farmland Management Standard learns from its users and undergoes a revision process every five years to ensure its rigor and relevance to the current landscape of sustainable agriculture and best management practices. As the landscape evolves and becomes more rigorous, users of the Standard, such as FarmTogether, may be held to a higher standard than they had previously.

Website:
www.leadingharvest.org

Soil Health & Plant Nutrition

At-a-glance

Objective: To achieve healthier soils and plants for a food-secure and environmentally sustainable world.
Lead countries/organization(s): IFDC
Place: Benin, Burkina Faso, Côte d'Ivoire, Egypt, Ghana, Mali, Niger, Nigeria, Senegal, Togo, Burundi, Ethiopia, Kenya, Mozambique, South Sudan, India, and Nepal

BACKGROUND AND OBJECTIVES

Fundamental improvements in soil and plant nutrition will be required to meet the challenge of sustainably feeding 10 billion people by 2050. Global population growth will drive a substantial increase in food demand, while climate change is already accelerating risk to food production, especially in resource-restricted regions. Major changes in agricultural systems, especially improvements in nutrient use efficiency, will be required to meet our shared challenge of creating a more food-secure, environmentally sustainable world.

Achieving impact at scale requires research and technology adapted to smallholder needs. IFDC experts and their partners work across the discovery-to-consumer continuum, which involves the testing of advanced fertilizers and related nutrient management technologies; design of fertilizer manufacturing and quality control processes; market systems development; gender and youth empowerment; and applied policy and regulatory analysis.

With an emphasis on working with strategic partners and strengthening local capacity, IFDC bridges the traditional gaps between research, technology dissemination, and market systems that often undermine efforts to innovate, achieve results, and sustain impact at scale. IFDC's strategy focuses on coordinating and integrating project-level research and development efforts across four priority areas:

- Develop, test, and adapt technologies that improve soil health and plant nutrition
- Strengthen market systems to scale technologies and improve livelihoods, environmental outcomes, and climate resilience.
- Enable impact by improving policies, strengthening capacity, and sharing knowledge.
- Increase farm productivity, profitability, and sustainability of target smallholder agricultural systems.

ACTIONS

IFDC brings together innovative research, market expertise, and strategic public and private partners to identify and scale sustainable solutions for soil and plant nutrition that benefit farmers, entrepreneurs, and the environment. To improve soil health and plant nutrition, IFDC's work in more than 20 countries in sub-Saharan Africa and South Asia includes:

- Developing more nutrient efficient, environmentally sound fertilizers
- Identifying soil and crop system nutrient deficiencies
- Scaling up the production and adoption of new fertilizers
- Refining and scaling Integrated Soil Fertility Management (ISFM)

To increase farm productivity, profitability, and sustainability of smallholder systems, IFDC is:

- Conducting on-farm research and demonstrations focused on new fertilizers and complementary seed, pest management, and post-harvest practices
- Expanding engagement of women and youth
- Using innovative behavior change and information and communications technology (ICT) to scale and sustain adoption of improved technologies for market products and prices, weather and pest forecasts, crop management advice, and business management information

To strengthen market systems and improve livelihoods, environmental outcomes, and climate resilience, IFDC is:

- Conducting scaling assessments to identify opportunities to develop inclusive markets
- Developing agribusiness clusters to drive the development of target commodity systems and scale technology adoption

To enable impact by improving policies, strengthening capacity, and sharing knowledge, IFDC is:

- Supporting global, regional, and national dialogues on fertilizer policy, food systems, and soil health
- Strengthening national and regional capacity to develop and implement evidence-based policies and regulations with stakeholder engagement through establishing and supporting regional networks

- Improving the technical capacity of public and private sector partners through international and specialized training programs on topics such as subsidy programs and linking farmers to markets
- Making its research open access

RESULTS

IFDC's work in 2021 has resulted in significant social, environmental, and economic benefits for smallholder farmers.

Social:

- 408,557 farmers trained (53.4% women): Direct
- farmer participants in short-term capacity building on management practices and/or technologies.
- 4,054 outreach activities: Dissemination activities – workshops, forums, stakeholder consultations, publications, and print, radio, and television media.
- 9,383 demonstration plots established to test management practices and/or technologies in farmer fields for dissemination.
- With increased yields and sales, farmers, especially women, are sending children to school, affording medical care, and generally improving their livelihoods

Environmental:

- 527,003 farmers applying good agricultural practices-integrated soil fertility management (ISFM practices) on 419,652 hectares, compounded with Climate-Adaptive technologies, such as climate-smart fertilizer products and practices on 302,482 hectares

Economic:

- 245 public-private partnership agreements between public and private firms/actors and research, academic, civil society, and stakeholder organizations.
- 14,242 new jobs created as a result of agribusiness interventions in 2021.
- 8,376 private agri-enterprises (SMEs, MSMEs) improved to produce, transform, and supply quality food products to local, national, and regional end-user markets, including Base of the Pyramid consumers.

Photo Credits: IFDC

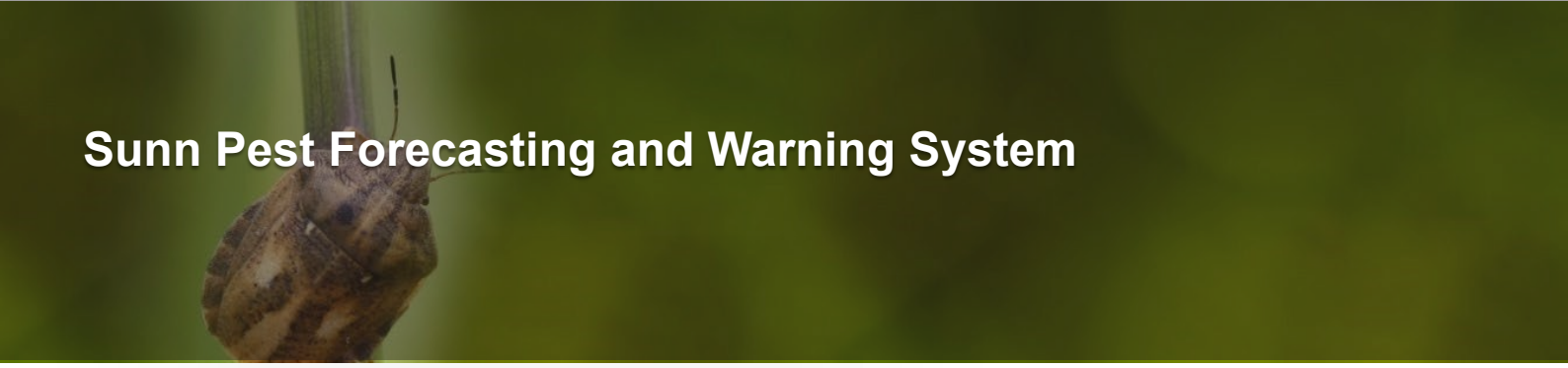
SUCCESS AND LESSONS LEARNED

Global energy and crop markets, already unstable from the COVID-19 pandemic, have been dangerously disrupted by the Russia-Ukraine conflict. Global fertilizer and food prices continue to rise. Many low-and middle-income countries, dependent on food imports, face malnourishment or even starvation as a result of significant increases in basic commodity prices. The drop in the amount of fertilizers reaching the African continent will result in decreased production equal to 30 million tons of grain—enough to feed 60-90 million people for a year. Without sufficient nutrient inputs into African soils, production will continue to decrease and chronic hunger will continue to increase.

Fertilizer and food self-sufficiency for African nations is a critical component for long-term food security and resilience. IFDC's mission, to identify and scale sustainable solutions for soil and plant nutrition, seeks economically viable solutions for a food-secure and environmentally sustainable world. Improved soil health will support the most vulnerable and provide a foundation upon which to build resilience against climatic and economic shocks.

Website:

www.ifdc.org



Sunn Pest Forecasting and Warning System

At-a-glance

Objective: To develop an artificial intelligence-based digital forecasting warning system to be used in the management of the Sunn pest, which causes significant yield and quality losses in wheat.
Lead countries/organization(s): Republic of Türkiye Ministry of Agriculture and Forestry
Place: Central Anatolia Region

BACKGROUND AND OBJECTIVES

In order to ensure sustainability in agricultural production, practices that both increase productivity and reduce costs are necessary.

Digital agriculture can ensure the automation of sustainable production. One of the important areas where digital agriculture is used is for the development of forecast warning systems for managing plant diseases and pests that threaten yields. The artificial intelligence-based Sunn Pest Forecasting Warning System has been developed for the management of the Sunn pest, which causes significant yield and quality loss in wheat, which has economic and strategic importance in the world and in the Central Anatolia region. Damage rates can reach up to 100% with high density of the pest population and when not controlled. The system can predict outbreaks of the Sunn pest, severity of the epidemic, estimated outbreak areas, survey times, and the time of insecticide application with very high accuracy rates. Necessary warnings are announced through the main page of the Warning System (https://sunetahminuyari. tarimorman.gov.tr). The system also includes a web-based Economic Injury Level Module, where the user can see whether the Sunn pest has reached the economic damage threshold (the number of spike per m2, the number of grains per spike, and the number of nymphs per m2).

ACTIONS

The Sunn Pest Forecasting Warning System is a machine learning model, which is a system that learns by looking at examples or through the assistance of tutorials. To train these models, meteorological data measured in the past, data on the phenology of wheat, and the bio-ecology data of the Sunn pest (label data) on the dates corresponding to these measurements were combined. Measurement data are considered as sample questions/sample conditions, and data on Sunn pests are qualified as correct answers/ correct labels. Sample questions and their answers are collectively called training data.

After the training data is prepared and presented to the computer, machine learning algorithms run, resulting in a model that has learned to give correct answers to the questions asked. After the models are created and tested, models are ready for use. If the measurement data to be collected (new questions) are given as input to the model, the model can predict the correct answers (correct labels) to these questions. Historical data was used for the model creation phase. For the forecasting phase, up-to-date data are entered into the system and the predictions of these data are carried out regularly. The system was piloted in two different regions for two years where the density of the Sunn pest population is high. The infrastructure of the system has been established and implemented in three provinces with intensive wheat cultivation areas, and it is planned to be extended throughout the country.

RESULTS

Project impacts on sustainable development include:

Social: Wheat, which is a staple crop and a vital source of carbohydrates, has an important place in our daily diet. The quality and quantity losses caused by the Sunn pest can be prevented by targeting pest control at the necessary place and time, ultimately aiming to increase yields and improve food security. Given that three out of every four farmers in Türkiye, approximately 650,000, grow wheat, increases in yield brings increases in income for local families and the community at large.

Environmental: This forecasting warning system promotes the use of Integrated Pest Management (IPM), which includes practices that help reduce heavy reliance on pesticides. IPM aims to minimize losses caused by diseases and pests, while also protecting human health and a pest's natural enemies.

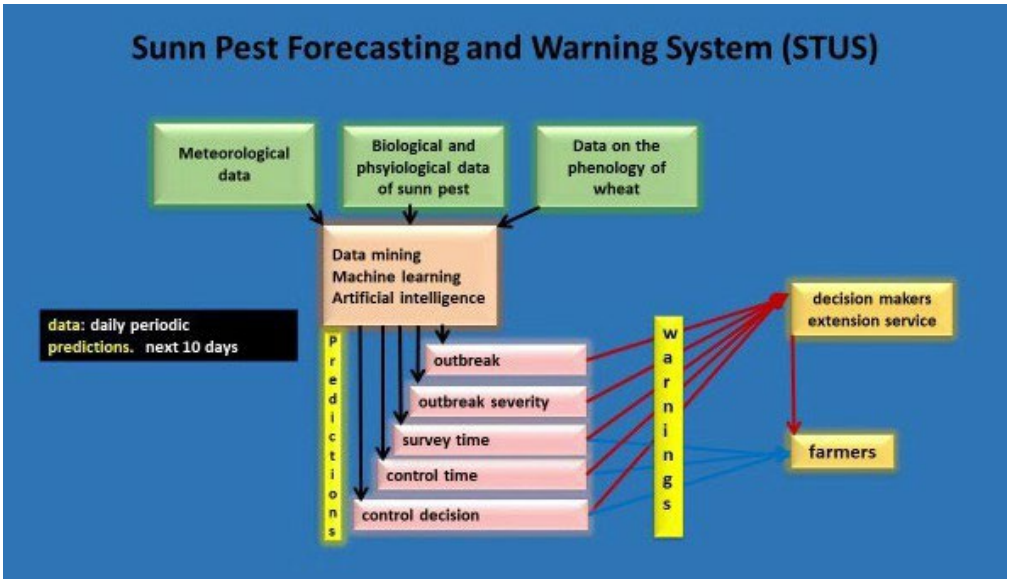
Economic: Up to 100% of damage to wheat can be prevented by using the System. In 2022, as a result of the national Sunn pest control, a success rate of 99% was achieved in the region and a contribution of $5.6 billion was made to the economy. The economic value of the 1% loss in quality is approximately $1.9 million. Thus far, the Sunn Pest Forecasting and Warning System has been applied within 10% of the national Sunn pest control areas.

SUCCESS AND LESSONS LEARNED

Sunn Pest Forecast Warning System has been successfully implemented in approximately 550,000 ha of wheat cultivation area in Konya with application by approximately 650,000 farmers. The system helped predict the Sunn pest outbreaks, curbed the severity of a potential epidemic, estimated outbreak areas, proposed surveillance times, and proposed times of insecticide application.

Photo: Application area

Website:
https://sunetahminuyari.tarimorman.gov.tr/



Support to Sustainable Productivity Growth Through Innovation and Investments in the EU

At-a-glance

Objective: To improve EU agricultural productivity sustainably.
Lead countries/organization(s): European Commision and EU Member States
Place: European Union

BACKGROUND AND OBJECTIVES

EU agricultural productivity has been growing over the past several decades. Total factor productivity (TFP) for the EU depicts stable growth since 2010, increasing at an average annual rate of 0.6% and cumulatively 9.1% higher in 2023, with the highest growth rates in Eastern Member States. The relatively slow growth – in some cases stagnation – in agricultural productivity has become a challenge in some EU Member States and is exacerbated by high costs (especially for labor and land) in some sectors.

The EU Common Agricultural Policy Strategic Plans (CSPs) prioritize productivity growth and adoption of innovative practices and technologies, e.g. almost 400,000 beneficiaries (4% of EU farms) are expected to benefit from support for productive (mainly on-farm) investment. The CSPs of all EU Member States envisage such support. This signals an increased joint effort to modernize farms, strengthen the sector's competitiveness and address environmental, climate, and animal welfare challenges. Investments oriented towards climate adaptation and improving the environmental conditions that support productivity – such as soil health – are growing in importance and will require greater attention.

ACTIONS

Numerous drivers and policy tools are available to trigger productivity gains in EU agriculture, such as research and innovation programs, new technologies, rural development and infrastructure, efficient advisory systems, and continuous training of farm managers.

Innovation: The interactive innovation model promoted by the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) promotes the co-creation and dissemination of innovative solutions to be used in practice and is a key pillar of the Agricultural Knowledge and Innovation Systems (AKIS).

Investments: The use of on-farm investment support is planned in all 28 CSPs. On-farm productive investments have been planned at agricultural holdings (e.g. modernization or construction of farm installations) and 23 Member States have planned for on-farm non-productive investments. In total, 134 interventions have been designed by Member States to support on-farm productive investments. The main types of on-farm investments that will be supported by Member States are those in agricultural holdings (e.g. modernization or construction of farm installations etc. – 28 Member States) and environmental, climate, animal welfare, or antimicrobial resistance (green investments – 26 Member States). 15 CSPs have furthermore opted for investments in irrigation, or for investments in preventive actions in the agricultural sector against climate and other risks, and investments in processing and/or the marketing of agricultural products. Most of the interventions linked to irrigation concern the improvement of existing irrigation installations (49 interventions against 20 interventions for investments resulting in a net increase of the irrigated area (new irrigation).

RESULTS

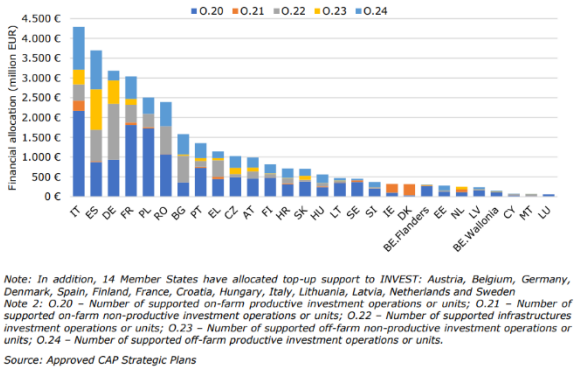
All 28 CSPs foresee support for investments, including on-farm and off-farm productive and non-productive investments, as well as investments in infrastructure and irrigation. Italy, Spain, Germany, and France have the highest financial allocations to investment support (INVEST); all are investing over 3 billion EUR for the 2023-2027 period.

Member States have allocated 2.1 billion EUR for knowledge exchange and innovation. This will support three times more European Innovation Partnership operational groups than in the past. More than 3,200 EIP-AGRI Operational Groups have been established since 2014, and over 6,600 projects are planned for the period 2023-2027. Many of the groups focus on sustainably enhancing productivity.

Social: Investments can help to increase productivity along the value chain as well as the value created by agriculture and thereby contribute to growth and jobs.

Environmental: Member States will support more than 200,000 independent advisors under the cross-cutting objective, which will advise farmers on environmentally sustainable production methods.

Economic: Investment support at the farm level is mainly targeted by on-farm productive investments (78% vs. 22% for non-productive investments). Close to 400,000 farms are expected to benefit from productive investments in the 2023-2027 programming period. Productive investments generally lead to an increase in profitability and/or value, thus strengthening farm-level competitiveness.



Note: In addition, 14 Member States have allocated top-up support to INVEST: Austria, Belgium, Germany, Denmark, Spain, Finland, France, Croatia, Hungary, Italy, Lithuania, Latvia, Netherlands and Sweden
Note 2: O.20 – Number of supported on-farm productive investment operations or units; O.21 – Number of supported on-farm non-productive investment operations or units; O.22 – Number of supported infrastructures investment operations or units; O.23 – Number of supported off-farm non-productive investment operations or units; O.24 – Number of supported off-farm productive investment operations or units.

Source: Approved CAP Strategic Plans

Figure: Total public financial allocation to INVEST by Member State and O.20-O.24, 2023-2027, (million EUR)

SUCCESS AND LESSONS LEARNED

TFP is often used as an indicator of changes in productivity and competitiveness for a sector. TFP integrates the impacts of partial productivity indicators, such as land, labor, intermediary inputs, and capital. The figure below shows growth in TFP development within the agricultural sector over the last 10 years across the Member States. As the levels of TFP among Member States are difficult to compare, the figure signals only information on the relative position of Member States and changes therein during the last decade.

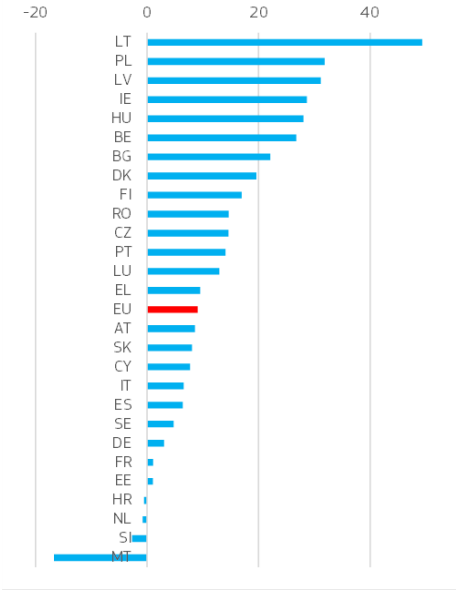


Figure: Change in TFP from average 2010-12 to average 2021-23* across EU Member States - %. *2023 is provisional as land data is missing.
Source: DG AGRI calculation based on Eurostat Economic Accounts for Agriculture

Some of the Member States with typically high productivity levels (i.e. the Netherlands and Germany) did achieve low growth in terms of TFP over the past decade, and, hence, have become relatively weaker in terms of their competitive position vis à vis other Member States. Due to environmental pressure, the Netherlands have invested quite heavily in recent years in environmental measures which possibly has influenced the evolution of farm productivity levels. Some of the newer EU Member States have invested heavily in farm modernization, and thereby realized large productivity gains, which had a positive effect on TFP growth rate levels.

Website:
Mapping and Analysis of CAP Strategic Plans

Sustainable Forest Management Impact Program on Dryland Sustainable Landscapes (DSL-IP)

At-a-glance

Objective: To foster the resilience of dryland production systems, promote restoration and rehabilitation, and improve livelihoods through an integrated landscape approach.
Lead countries/organization(s): Food and Agriculture Organization of the United Nations (FAO). In partnership with the World Bank (WB), the International Union for Conservation of Nature (IUCN), the World Wildlife Fund (WWF), the World Overview of Conservation Approaches and Technologies (WOCAT), the United Nations Convention to Combat Desertification, and regional knowledge platforms
Place: Angola, Botswana, Burkina Faso, Kazakhstan, Kenya, Malawi, Mongolia, Mozambique, Namibia, Tanzania, United Republic of Zimbabwe

BACKGROUND AND OBJECTIVES

Climate Change, a growing population, and rising global demand for livestock are driving land degradation. Dryland systems contain 44% of the world's agricultural land (58.4% of that in Africa alone) and supply about 60% of the world's food production. With 2 billion livelihoods dependent on these fragile ecosystems, the importance of promoting healthy drylands around the globe is essential.

The Sustainable Forest Management Impact Program on Dryland Sustainable Landscapes (DSL-IP), with USD $104 million funding from the Global Environment Facility (GEF) along with over $800 million in co-financing, will assist 11 countries across Africa and Asia in fostering resilience of production systems in drylands, promoting restoration and rehabilitation, and improving livelihoods through a comprehensive landscape approach. It will also support countries in the implementation of their Land Degradation Neutrality Strategies under the United Nations Convention to Combat Desertification (UNCCD).

ACTIONS

The DSL-IP covers the Miombo and Mopane ecosystems of Southern Africa, the Savannas of East and West Africa, and the temperate grasslands, savannas, and shrublands of Central Asia. A few country examples of the global program include:

In Angola, the objective of the project is to support a transformational shift towards sustainable and integrated management of multi-use dryland landscapes of the Miombo and Mopane ecoregions of Okavango and Cunene river basins. The project will establish a land degradation monitoring system and development of a land restoration strategy to regain ecological functionality. Up to 5,000 people (45% women) will benefit directly from the project's activities within the two selected landscapes in southern Angola.

In Kenya, the goal of the project is to restore degraded rangeland resources, forests, wildlife, soils, and water, thereby restoring the integrity of the ecosystem and improving wildlife conservation and people's livelihoods, while building resilience. The project is implementing an ecosystem-based adaptation for pastoral risk management and capacity development to anticipate and monitor threats through early warning systems. Improved ecosystems management and governance systems will attract more investments in tourism and livestock value chains that will increase payments for ecosystem services and goods.

In Tanzania, the Program in partnership with the International Fund for Agricultural Development (IFAD), will champion sustainable bee keeping and honey production in the Kondoa district, improving the income generation of 500 households through increased quantity and quality of products and services derived from bee keeping. The project will see 700 direct beneficiaries and 1,800 indirect beneficiaries.

In Kazakhstan, the Resilient Agroforestry and Rangeland Project will focus on the management of degraded pasturelands and pasture forage production. The broader project will scale up sustainable management practices that minimize pressures and negative impacts on natural resources to reduce risks and vulnerability and enhance capacity of rural

communities. In particular, smallholders will gain access to financial services through enhanced public and private investments; women will receive certified training, allowing them access to land; and existing and forthcoming degradation will be reduced and prevented through sustainable pasture management and rotational grazing.

RESULTS

The DSL-IP promotes integrated landscape management to reverse degradation and support sustainable natural resources management and value chains.

Social: The program will reach close to 1 million direct beneficiaries, enhancing their livelihood streams by increasing access to ecosystems services and goods. The program will especially increase women's access to training, land, and finance, and aim to out-migration and conflict due to environmental degradation. Finally, the program will aim to increase the capacity of the national Ministries to collect, analyze, and change land use patterns to better detect areas with degradation.

Environmental: 12 million hectares of drylands will be under sustainable land management, including 1.1 million hectares primarily benefitting biodiversity and preventing deforestation of 10,000 hectares of high conservation value forests. In addition, the program will improve the management effectiveness in 1.6 million hectares of protected areas and restore 0.9 million hectares of degraded land in the drylands. All these activities will result in total greenhouse gas (GHG) emission reductions of 34.6 million tonnes of carbon dioxide (CO2) equivalent (tCO2e).

Economic: The program will enhance livelihoods by providing access to resources within agroecosystems and forest ecosystems and training on sustainable business practices for dryland commodities. It will increase land productivity by introducing sustainable land-use practices, while building resilience to economic shocks.

Photo Credits: Alessio Romenzi, FAO

SUCCESS AND LESSONS LEARNED

In Southern Africa, the program established the Sustainable Landscapes Production Framework, which encompasses three flagship FAO approaches: the Forest and Farm Facility, the Farmer Field Schools, and the Community Seed Banks. The Framework is designed to address the inherent challenges that forest and farm producers (FFPOs) grapple with on a day-to-day basis in the targeted mixed land use region, particularly challenges related to extension services, sustainable and adapted seed supply, market access, and business incubation, thereby advancing business opportunities for dryland commodity value chains.

The implementation of harmonized and linked systems for mapping and monitoring at the landscape scale will result in reliable, relative, and timely information on trends in conditions and impact that will be helpful to inform stakeholders and policymakers.

Taking advantage of existing global and regional platforms, the work done on sustainable dryland management and restoration will serve to generate synergies and increase cumulative impacts, while limiting the risk of duplication or conflicts between projects.

The project has highlighted that for dryland landscapes to be sustainable:

- They must be resilient, adaptive, and biologically functional;
- Their management must be responsive to social and landscape trends over time and capable of generating food, income, and services in a sustainable manner; and
- Effective governance conditions must exist for the goods and services that they generate to be distributed equitably among different stakeholder groups.

Websites:

https://www.fao.org/in-action/dryland-sustainable-landscapes
https://www.fao.org/3/cc2326en/cc2326en.pdf
https://www.iied.org/dryland-sustainable-landscapes-impact-programme

Sustainable Pesticide Management Framework

At-a-glance

Objective: To protect human health, safeguard the environment, and optimize crop production through improved pesticide management.
Lead countries/organization(s): CropLife International, CropLife Africa Middle East, CropLife Asia, CropLife Kenya
Place: Global, current focus on Kenya and Morocco

BACKGROUND AND OBJECTIVES

Crop Life International's Sustainable Pesticide Management Framework (SPMF) is a proactive, long-term engagement that supports low- and middle-income countries to develop and advance local capacity in line with the Food and Agriculture Organization (FAO)-World Health Organization (WHO) Code of Conduct on Pesticide Management. The SPMF combines best practices in regulations and stewardship, creates an enabling environment for innovation, and builds an infrastructure that supports sustainable pesticide management through poison centers, incident reporting, container management programs, and anti-counterfeit activities.

SPMF activities are focused on three key pillars to achieve sustainable pesticide management: reducing the reliance on Highly Hazardous Pesticides (HHPs); making innovation available to farmers; and ensuring the responsible and effective use of pesticides.

Sustainable agriculture depends on sustainable pesticide management. In order to safeguard our natural resources and move toward climate-smart agriculture, we must ensure safe and effective use of pesticide products while promoting benefits of new technologies through direct farmer engagement. The SPMF has a long-term commitment to driving this transition, focusing on low-income countries to ensure that not only is there a license to operate in target communities, but that all products on the market are safely regulated and understood by distributors and users.

This program will strengthen crop protection infrastructure so that strategic decisions, based on evidence and sound science, can enable increased access to innovation and responsible use support. By tapping into the extensive CropLife network and facilitating new partnerships with governments, extension providers, and other stakeholders, the SPMF will expand delivery of the vision outlined in the International Code of Conduct on Pesticide Management. SPMF will bring an additional focus to incident reporting, including support for more and better poison centers across target regions.

ACTIONS

The SPMF launched in Kenya in 2021. The first 12 months of the project focused on analyzing the baseline situation of pesticide management in country, identifying key engagement opportunities, coordinating with local stakeholders, including government officials, policymakers, farmer organizations, extension officers, and more, and implementing programming activities. The baseline studies are described below:

Pesticide Use Survey Report: A sample survey revealed Kenyan farmers are using a variety of pest management practices. However, the survey identified opportunities to increase farmer understanding of label recommendations, promote the need for personal protective equipment (PPE) and increase access to affordable PPE, and build capacity in sprayer calibration and the overall responsible use of pesticides.

Baseline Study on Pesticide Residues in Vegetables: 98% of vegetable samples for local Kenyan markets complied with the maximum residue levels (MRLs) set by the Codex Alimentarius, the international standard for trade, ensuring that the food is safe to eat.

Study on Illegal Pesticide Market in Kenya: Nearly 20% of pesticides available on the Kenyan market are counterfeit, demonstrating the need to train farmers and customs officials in illegal pesticide identification.

RESULTS

Based on the findings from the baseline surveys, the Kenyan team concentrated its Year 1 efforts to maximize social, environmental, and economic impacts:

Social:

Building Capacity of Regulators

CropLife Kenya is collaborating with regulators to build capacity in support of the government's new pesticide legislation. We conducted a series of training events to support evidence- and risk-based decision-making as laid out by the International Code of Conduct on Pesticide Management, and to modernize the country's dossier review process.

Strengthening Poison Centers

Under SPMF, CropLife is establishing a network of poison centers in Kenya to expand access across the country. We are also training employees of poison centers in improved recordkeeping to better track incidences. By strengthening data management of poison incidents, we can better focus stewardship activities to where there are the biggest risks and to identify specific products or practices causing issues.

Environmental:

2022 Safety Week

In June, National Safety Week featured activities promoting risk management of pesticides, both during and after use. The Kenyan team also facilitated an empty pesticide container collection drive and the distribution of PPE to help safeguard both human health and ensure proper environmental stewardship.

Economic:

Counterfeit Detection Trainings

To address the prevalence of illegal pesticides on the Kenyan market, CropLife Kenya trained customs and regulatory officers at Mombasa port on detecting counterfeit products. With trainings and radio spots, we reached 100,000 farmers to increase awareness of the danger of counterfeit pesticides. The use of counterfeit products can result in both increased risk to health and safety and reduction in income. Manufacturers of agricultural inputs lose significant value annually to counterfeit agricultural inputs.

SUCCESS AND LESSONS LEARNED

Early successes have strengthened SPMF activities in Kenya moving into the second year of programming. Next steps include:

- Expansion of partnerships, including on climate-smart agriculture
- Broadened messaging to include resistance management and pollinator safety
- Sharing of collected poison data with stakeholders and continued expansion of call center network
- Refining HHP hotspot identification
- Building awareness on registration and use of biologicals
- Exploring opportunities for precision farming and responsible pest management

In November 2022, the SPMF officially launched in Morocco, with hundreds of industry representatives, government officials, and partner organizations gathering to discuss innovative solutions to food security and the climate crisis, including the safe and responsible use of agrochemicals. Thanks to lessons learned in Kenya, the team engaged early and often with key stakeholders such as the Secretary General of the Ministry of Agriculture and leaders from national agricultural associations, poison centers, and technology companies, all of whom expressed their full support for the guiding principles of the SPMF during the launch event.

The Power of Cashew to Build a More Climate-Resilient and Prosperous West Africa

At-a-glance

Objective: To enhance the resilience and livelihoods of West African cashew farmers by increasing productivity and incomes while combating climate change through sustainable practices.
Lead countries/organization(s): USDA Food for Progress, Cultivating New Frontiers in Agriculture (CNFA)
Place: West Africa – Benin, Burkina Faso, Côte d'Ivoire, Ghana, Nigeria

BACKGROUND AND OBJECTIVES

Climate change associated with increasingly erratic rainfall, rising temperatures, and soil degradation has severely affected West African farmers. The PRO-Cashew Project is addressing this challenge by promoting cashew cultivation as a climate-resilient, sustainable income source. Each year, a single cashew tree captures an average of 10–15 kg of CO_2, the greenhouse gas primarily responsible for climate change. The tens of millions of these trees across Benin, Burkina Faso, Côte d'Ivoire, Ghana, and Nigeria – the countries where the project has worked – have the potential to capture millions of tons of CO_2 and help mitigate the effects of global warming. The project, funded by USDA Food for Progress and implemented by CNFA, shows farmers how to optimize this natural process, among other climate-smart practices, to increase productivity, incomes, and resilience.

ACTIONS

PRO-Cashew's multi-pronged approach to sustainability and climate resilience incorporates agroforestry, composting, intercropping, beekeeping, water management, and carbon capture initiatives. Through agroforestry, the project encourages farmers to plant native trees, such as shea and tamarind, alongside improved varieties of cashew trees. This strategy enriches the soil, promotes biodiversity, and enhances CO_2 sequestration. Composting efforts convert cashew waste, green debris, and animal manure into nutrient-rich fertilizer, which further boosts soil health and productivity. Additionally, intercropping with soybeans and groundnuts not only improves soil quality but diversifies farmers' income streams.

The project further supports sustainable practices through beekeeping, which is enhancing pollination for cashew trees, leading to heavier fruiting and improved yields while offering an additional income source through the sale of honey and wax. For water management, farmers implement technologically appropriate drip irrigation systems using recycled plastic bottles. This ensures the orchards receive optimal amounts of water, even during droughts.

Lastly, in Benin PRO-Cashew supported farmers to measure the CO_2 sequestration achieved through these practices, creating opportunities to generate additional revenue through carbon credit sales.

Together, these initiatives form a comprehensive approach to building resilience and promoting sustainable agriculture in West Africa.

RESULTS

Potential and expected impacts of visualization on the three dimensions include:

Social: The PRO-Cashew Project has had a profound social impact by empowering women and youth in rural West African communities. Women and young people are embracing climate-smart agricultural practices and are leading the adoption and promotion of these methods within their communities, for example, by operating nurseries that produce and sell improved cashew seedlings and demonstrating best cultivation and post-harvest practices. Their active engagement has brought women economic independence, strengthened their influence over household decisionmaking, and provided greater financial stability. As these groups continue to promote sustainable techniques, they foster a culture of resilience and adaptability that permeates their communities. By diversifying income streams and implementing strategies that better equip farms to adapt to climate fluctuations, community resilience has grown. This resilience is particularly valuable in rural areas where the effects of climate change can be especially destabilizing.

Environmental: The environmental benefits of the PRO-Cashew Project are equally significant. Cashew orchards serve as natural carbon sinks, actively capturing CO_2 and contributing to climate mitigation efforts across West Africa. The project's agroforestry approach, which involves planting native trees like shea and tamarind alongside cashews, not only enriches biodiversity but also creates a more balanced ecosystem that supports soil regeneration. Composting and intercropping further enhance soil health, enriching it with organic matter and nutrients that allow for sustainable, long-term productivity. By promoting agroforestry systems and sustainable land management, PRO-Cashew demonstrates that agriculture can be both productive and environmentally responsible, helping mitigate climate impacts while restoring natural resources.

Economic: Economically, the project has transformed the livelihoods of many farmers. Thanks to improved agricultural practices, cashew yields have risen by an average of more than 13%, and some farmers report income increases of 50–70%. Income diversification through the sale of carbon credits and climate-smart agricultural practices such as intercropping and beekeeping has provided farmers with additional, reliable revenue streams, making them less vulnerable to market fluctuations and price volatility in the cashew value chain. With multiple sources of income, farmers can better weather economic challenges and invest in the improvement and expansion of their orchards and businesses. This economic stability is crucial for rural households, allowing them to improve their standard of living, access better resources, and sustain their communities.

SUCCESS AND LESSONS LEARNED

PRO-Cashew has effectively demonstrated cashew cultivation's capacity to tackle economic and environmental challenges for West African farmers. Key successes and insights include:

- **Community-Led Knowledge Sharing:** Farmer-led, community-driven approaches integrate traditional practices with modern techniques, fostering knowledge sharing.
- **Economic Stability:** Income diversification through agroforestry, intercropping, and beekeeping enhances economic resilience for farmers.
- **Carbon Market Potential:** PRO-Cashew highlights carbon markets as a promising opportunity for sustainable growth, supporting climate goals and adding economic value.

Visualization of Farmers' Efforts Toward Sustainability

At-a-glance

Objective: Farmers' efforts to reduce environmental burden are to be visualized, acknowledged, and appreciated.
Lead countries/organization(s): Ministry of Agriculture, Forestry, and Fisheries (MAFF)
Place: Japan

BACKGROUND AND OBJECTIVES

Sustainability is not without cost. The adoption of green technologies, the application of environmentally friendly practices, and introduction of new crop varieties can all be new financial burdens on the part of farmers. Productivity growth, that is, more quantity and/or higher quality with less inputs, can be a solution to this threshold.

Foods produced with more sustainable methods have the potential to gain higher evaluation in markets. In fact, in the public opinion poll by the Japanese Cabinet Office in 2023, nearly 80% of respondents showed their willingness to purchase sustainable agricultural products. For this potential to be realized, sustainable products need to be identifiable. This is the motivation for the visualization initiative. If visualization is clearly recognizable, then consumers are enabled to make choices based on their preference for environmentally friendly agricultural products, and farmers can be rewarded for their efforts with higher sales and prices. This can drive farmers toward sustainable productivity growth, and lead to a positive economic cycle in which efforts for sustainability generate more financial resources available for the further greening of agriculture.

Among the 20% who conveyed no interest in sustainable agricultural products, around 60% responded that they were not confident which products were environmentally friendly. As such, credible visualization initiatives by the government were necessary.

ACTIONS

Following a pilot project started in 2022, MAFF launched a full-scale implementation of "Visualization of Farmers' Efforts on Environmental Burden Reduction" in March 2024. In this scheme, farmers' efforts for greenhouse gas (GHG) emission reduction and biodiversity conservation are evaluated and then signified by "stars," which are then indicated on a given product's label.

A simplified calculation spreadsheet is available for farmers or relevant stakeholders to evaluate GHG emissions and carbon sequestration. By inputting their farming data, such as chemical fertilizer and pesticide use, fossil fuel consumption, biochar application, and water management of rice paddy fields, farmers obtain their emission estimate automatically. Today, this tool is applicable for 23 products, including rice, green tea, fruits, and vegetables.

According to the magnitude of contribution to GHG emission reduction calculated, farmers obtain a blue label, with more stars meaning greater emission reduction, such as one star for 5% reduction and three stars for 20% reduction and more relative to conventional farming in each region.

[Left]] The label indicates contribution to GHG emission reduction.
[Right] The label, which only applies to rice, indicates both contribution to GHG emission reduction (blue) and biodiversity conservation (green).

Rice paddy has an important role in providing and maintaining rich semi-natural ecosystems. Reduction in the use of chemical pesticides and fertilizers, winter flooding in paddy fields, and field margin vegetation management can be valuable contributions to biodiversity. As such, the efforts toward biodiversity conservation in paddy fields are graded and labeled in green.

RESULTS

Potential and expected impacts of visualization on the three dimensions include:

Social: Labels are a clear message from farmers to consumers, enabling them to convey what they do on farms, how, and why. This facilitates discussion and dialogue on sustainability in society. Efforts in rural communities may be more widely perceived and appreciated, linking consumers closer to farmers and agriculture.

Environmental: Impacts of environmentally friendly practices are calculated, evaluated, and made distinct and visible to consumers by labeling. The scope covers several production practices. For example, water management of rice paddy fields, especially prolonging midseason drainage, can reduce methane emissions. Reduction in the use of chemical pesticides and fertilizers contributes to a reduction in GHG emissions and biodiversity conservation. In addition, the application of biochar to the soil enhances carbon sequestration.

Economic: As shown by several surveys, demand for sustainable foods is significant. The visualization initiative can develop this potential market. If foods produced by sustainable methods are chosen and purchased at higher prices by consumers, farmers are more encouraged to promote these environmentally friendly practices, and new markets will be further developed.

[Above] Vegetables sold in a market with the Visualization Label.

SUCCESS AND LESSONS LEARNED

Since March 2024, about 600 stakeholders, including retailers, restaurants, and other businesses, have already entered the sale of agricultural products with the Visualization Label. Consumer surveys in 2023 revealed that 95% of respondents had a favorable impression of such stores that sell agricultural products with the Visualization Label.

Efforts by stakeholders are continuing to step up these trends by further popularization of labels and expansion of sales of sustainable agricultural products.

Sustainable agricultural productivity is necessary to ensure food security and at the same time maintain and improve environmental sustainability. The question is how to support and promote sustainability in a way that is fair and efficient. Visualization is crucial to answering this question. It can create and realize demand for sustainable products, and reward farmers' efforts for seeking less environmental harm. Visualization can contribute to establishing a positive economic cycle, in which sustainable farmers receive higher revenue, thereby providing incentives toward more environmentally friendly agriculture.

Website:
www.gov-online.go.jp/pdf/hlj/20240401/hlj_202404_24-25_visualization-and-labeling-of-environmental-impact-reduction-efforts.pdf

WaPOR: Monitoring Agricultural Water Productivity with Remote Sensing

At-a-glance

Objective: To provide open-access and open-source remote sensing data for near real-time global monitoring of agricultural water productivity at different scales.
Lead countries/organization(s): Food and Agriculture Organization of the United Nations (FAO), International Water Management Institute (IWMI), IHE Delft Institute for Water Education
Place: Global

BACKGROUND AND OBJECTIVES

n the face of increasing water scarcity and disruptions in the water cycle, effective water management at various scales is crucial. Reliable and timely data is essential to achieving this goal and minimizing the impacts of climate change and unsustainable resource use patterns.

Focused primarily on agriculture – the sector that consumes the largest share of water globally –WaPOR addresses the longstanding challenge of data availability in the effective management of water resources by leveraging open-source remote sensing data and advanced methodologies. WaPOR provides near real-time monitoring of key variables at a global scale: water productivity, evapotranspiration, precipitation, soil moisture, net primary production, among others.

Since its inception in 2016, the WaPOR database has evolved continuously and is now accessible through the new FAO WaPOR portal and other platforms (API, GEE). The ongoing evolution of both the portal and database reflect a commitment to refining methodologies, thus integrating technological advancements in remote sensing and enhancing the accessibility of WaPOR data.

ACTIONS

FAO, IHE Delft, and IWMI collaborate to tackle the challenge of insufficient data hindering sustainable food production, which drives the work of WaPOR. With an emphasis on local relevance, the project focuses on integrating WaPOR data into the operational frameworks of regional, national, and local institutions. This integration includes robust capacity building and collaborative application development based on local and WaPOR data.

Now in its second phase, the WaPOR project leverages partner institutions' expertise to implement targeted actions to improve water productivity. National staff play a crucial role in identifying and engaging local stakeholders across thirteen partner countries. Pilot areas within each country were selected by these stakeholders to produce near real time high-resolution WaPOR data (20m resolution) that will support applications of most local relevance.

Practical, on-the-job, and tailored trainings increase understanding of WaPOR data concepts and applications, and progressively build on existing capacity. Workshops foster collaboration among stakeholders, thereby facilitating the development of practical data-based tools. The project also involves the private sector to amplify impact and advocates for WaPOR data use in existing initiatives.

To expand its reach beyond the initial thirteen partner countries, the project supports other initiatives and continues to enrich a diverse portfolio of free online educational resources like videos and MOOCs. These resources empower users globally with skills to leverage WaPOR data.

By the end of 2023, WaPOR released version 3 of its dataset – bolstered by an updated methodology – on a new portal integrated into the FAO Hand in Hand platform. This platform enhances WaPOR data utility through improved exploration, analysis, and contextualization with other FAO spatial datasets, benefiting stakeholders worldwide.

RESULTS

WaPOR delivers significant impacts across the three dimensions of sustainable development:

Social: WaPOR has conducted fifteen country and regional trainings and developed five self-paced online courses through IHE-Delft. These initiatives continue to strengthen national and local institutions and individuals' capacity to use data for the effective management of water. By including smaller stakeholders – with particular attention to gender and age – in training and tool development, WaPOR fosters inclusivity and empowers communities to own these tools to implement better agricultural practices, including improved irrigation. This not only enhances food security but also supports sustainable agricultural development, and contributes to social equity and resilience.

Environmental: The project's focus on capacity building and collaboration facilitates the current co-creation of twenty-four specialized tools. In Sudan and Mali, tools focus on drought monitoring, while in Jordan and Iraq the focus is on irrigation performance assessment and monitoring. Once fully operational, they will contribute to more sustainable water use practices, which is crucial to maintaining environmental flows that support local ecosystems.

Economic: Irrigation performance tools and others such as the area yield index insurance tool in development in Ethiopia contribute both to improving agricultural productivity and farmer financial protection, which in turn boosts incomes and improves livelihoods. Data-driven interventions in agriculture – supported by WaPOR data – can optimize field practices that enhance and sustain soil health, biodiversity, and yield outcomes. WaPOR's gender strategy ensures these benefits reach diverse groups, promoting gender equality and economic empowerment in agriculture.

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SUCCESS AND LESSONS LEARNED

Successes

- A new WaPOR portal and version 3 dataset with an enhanced methodology and global coverage;
- in 2021: WaPOR was recognized as a Digital Public Good;
- in 2022: WaPOR was given a Dakar label award at the 9th World Water Forum;
- in 2023: GEO SDG award;
- multi-lingual open courses in the IHE Delft open courseware platform;
- Nile River Delta covered with high resolution WaPOR data (20m).

Lessons

- Integrating WaPOR into local university curricula ensures sustained technology adoption;
- co-designing and co-developing tools with local stakeholders is crucial in enhancing usability and relevance;
- embracing open-source principles plays a pivotal role in promoting widespread adoption of WaPOR technology.

Website:
www.fao.org/in-action/remote-sensing-for-water-productivity/en

WASAG: The Global Framework on Water Scarcity in Agriculture in a Changing Climate

At-a-glance

Objective: To support measurable, significant, and sustainable progress on improving and adapting agricultural systems in conditions of increasing water scarcity and a changing climate, using the combined expertise and resources of the Partners.
Lead countries/organization(s): U.S. Department of Agriculture (USDA) and the Food and Agriculture Organization of the United Nations (FAO)
Place: Global

BACKGROUND AND OBJECTIVES

Water scarcity is one of the greatest challenges of the 21st century. Agriculture is both a cause and a victim of water scarcity, accounting for an estimated 70% of global freshwater withdrawals. Even more frequent and severe water extremes are expected in the future due to climate change, including droughts and floods, while rising temperatures translate into increased water demand in agriculture.

Water withdrawals grew at almost twice the rate of the population increase in the 20th century, and a 50% surge in food demand is expected by 2050. It is clear that there is an urgent need to address water scarcity, now and into the future.

Recognizing the importance and difficulty of ensuring global food security in the face of water scarcity and climate change, the project objective is to address the following important and relevant work areas at international and country levels, working with a number of entities, including governments, United Nations (UN) bodies, research institutes, universities, civil society organizations, private sector and professional organizations:

- advocate for political prioritization;
- cooperate on work programs;
- share and disseminate knowledge and experience;
- develop new or improved solutions;
- promote sustainable and integrated water resources management;
- build capacity of partners, countries, and other stakeholders;
- contribute to consistent monitoring systems.

ACTIONS

USDA in partnership with FAO, under the umbrella of the Global Framework on Water Scarcity in Agriculture in a Changing Climate – or WASAG – established a collaboration to foster overarching strategic learning and contribute to policy impacts and joint outputs. WASAG is a framework that strengthens collaboration between countries and key stakeholders to accelerate progress towards achievement of regional and national sustainable development priorities to address water scarcity.

The partnership established six working groups (sustainable agriculture water use, financing mechanisms, drought preparedness, water and nutrition, water and migration, and saline agriculture) as key delivery mechanisms in implementing the following key action areas of the WASAG Strategy for 2021-2024:

- Development of initiatives to address water scarcity (project development/implementation, pilot projects, resource mobilization).
- Innovation and data (technology development, new methodologies, tools, data collection, GIS and integration of remote sensing inputs in decision process).
- Research and training (guidelines and best practices, trainings, capacity building materials and methodologies, technical publications, workshops and webinars).
- Awareness raising about topical issues in water scarcity in agriculture (conferences/seminars, high level panels, international events, webinars and online consultations, building a nexus between policymakers and financers for adoption of better practices, youth engagement).

RESULTS

WASAG provides a blueprint that will guide the actions of partners in furthering collaboration to turn water scarcity in agriculture into an opportunity for agricultural production, food and nutrition security, and environmental, social, and economic sustainability, with results expected across the following dimensions of sustainable development:

Social: WASAG promotes water productivity and nutrition, reduces vulnerability to droughts and migration, and links agriculture management to water, sanitation, and hygiene. Addressing water scarcity will have a major livelihood strengthening effect, as water remains connected to nearly every industry. In addition, WASAG has promoted community and indigenous knowledge for climate change adaptation with a focus on water scarcity in agriculture.

Environmental: Capacities of institutions are strengthened to cope with water scarcity in agriculture and adoption of practices – such as drought resilience, including in the context of COVID-19, saline agriculture, sustainable agriculture water use, and dryland agriculture. In the face of climate change, these coping strategies sustainably increase production and productivity and address environmental degradation.

Economic: WASAG supports farmers and farmers' associations with improved access to financing and water management practices, promoting innovative financial mechanisms through the WASAG publication on finances for water and agriculture and through a circular economic approach that aims to stimulate concrete actions on the ground and promote investment in capacity development.

SUCCESS AND LESSONS LEARNED

Since its establishment in 2017, WASAG has been endorsed and supported at various international meetings and its partners have increased from 34 to more than 70. This collaborative approach demonstrates the importance of strengthening partnerships to accelerate progress towards addressing water scarcity.

As a result, WASAG is recognized as an Agenda 2030 Partnership Accelerator for advancing effective partnerships for the Sustainable Development Goals. The Committee on Agriculture consistently requests WASAG to continue to support countries and report back on progress, confirming the need for its contributions. Initiatives at country levels, though hindered by COVID-19, have seen targeted support to Cabo Verde, an arid Small Island Developing State (SIDS), in adopting saline agriculture and benefiting from training offered by Italy on pressurized irrigation to cope with water scarcity.

WASAG's mandate has been further strengthened during the second WASAG International Forum jointly organized by Cabo Verde and FAO with the support of Switzerland. The forum adopted the Praia Call for Action, which recommends that all member countries become partners of WASAG, and agreed on 17 actions which should now be supported through the four key actions areas of the WASAG Strategy.

Website:
www.fao.org/wasag/en/

2SCALE Inclusive Agribusiness

At-a-glance

Objective: To improve access to nutritious food for at least 1.5 million Base-of-the-Pyramid (BoP) consumers; improve the livelihoods of 1,000,000 smallholder farmers; develop inclusive business with 15,000 MSMEs; scale over 72 public-private partnerships.
Lead countries/organization(s): IFDC, Embassy of the Netherlands
Place: Burkina Faso, Ethiopia, Ivory Coast, Ghana, Kenya, Mali, Niger, Nigeria, Egypt, South Sudan

BACKGROUND AND OBJECTIVES

The 2SCALE program incubates and accelerates inclusive business through partnerships with companies (predominately African small- and medium-sized enterprises [SMEs] and Dutch/international companies).

These business champions build inclusive, commercially viable African food industries through:

- Sustainable sourcing based on mutually beneficial relations with smallholder farmers, and
- Meeting demand for nutritious foods in local and regional Base-of-the-Pyramid (BoP) markets, which comprise the global economy's lowest income segment of around 4 billion consumers who live on less than $4 per day.

Through these inclusive partnerships, 2SCALE is improving access to nutritious food for BoP consumers, improving the livelihoods of smallholder farmers, and developing sustainable, inclusive value chains with local MSMEs.

ACTIONS

2SCALE supports agribusinesses and farmer groups to produce, transform, and supply quality food products to local, national, and regional end-user markets, including BoP consumers. At the same time, the program develops fair and sustainable relationships with smallholder farmers and other local entrepreneurs.

2SCALE builds agribusiness clusters around business champions. Champions are either entrepreneurial producer organizations or local SMEs that trade or process farmers' produce. By providing support to these clusters, 2SCALE is developing products and markets for local consumers, preferably at the base of the pyramid. Some of the support services that we facilitate are marketing and branding technical assistance, brokerage of finance, linkage to service providers and additional markets, among others.

2SCALE has successfully incubated inclusive businesses and will begin to accelerate inclusive business, through replication of partnerships and business models and by developing stronger relations with policymakers and industry- and community-leaders, to facilitate inclusiveness in target sectors and industries.

RESULTS

Project impacts on sustainable development include:

Social: 2SCALE has grown the number of BoP consumers included in the food system from 145,752 (2019) to 432,652 (2020). In 2021, this number reached 956,517 consumers, an achievement of 95.7% of the overall target. BoP consumers are important because, typically due to their low purchasing power, they do not have access to a range of nutritious and affordable food programs. Given the large demographic in Africa that can be characterized as being BoP, providing this target market with nutritious food is essential to us amplifying our impact. Additionally, in 2021, the program supported the creation of additional non-farm employment opportunities for 9,152 youth, including young women (3,503) and men (5,649). Some of the jobs that were created include jobs in marketing and distributing value-added food products, for example, in Cote D'Ivoire, where youth are employed to help sell packaged attieke (cassava flour) in the markets. Additionally, 4,411 young MSMEs (2,548 male, 1,863 female) were linked to agribusiness partnerships. Being linked to the partnerships is beneficial because of the range of different interventions that the program has that potentially creates opportunities for meaningful engagement. For example, in Nigeria in the sorghum partnership, thanks to the linkages introduced, mechanized threshers now ease the threshing process. This is a new innovation in the value chain and it is largely youth who gain meaningful employment through the activity.

Smallholder farmer inclusion in competitive value chains has also continued to increase. As of 2021, 419,819 smallholder farmers have improved their productivity and gained market access, allowing 2SCALE to ensure the inclusion of more than 454,000 members of producer organizations over the last three years.

Environmental: 2SCALE supported the scouting, screening, and piloting of several green innovations. More than 60 pilots were implemented in 8 countries, the majority of which were in Nigeria and Kenya; Côte d'Ivoire and Niger had the least number of pilots. Most of the pilots (62%) were related to on-farm good agricultural practices and climate-smart farming techniques. For example, in Ghana and Nigeria, we are partnering with Ignitia to provide SMS-based weather alert services to farmers, which enable them to prepare their farms with real-time data on the forecasted weather.

Economic: Over 80% of public-private partnerships face challenges to accessing financial services from formal sources. 2SCALE supported the formation of Village Savings and Loans Associations (VSLAs) to reach segments (e.g., women and youth) that are often excluded from banking services. VSLAs help smallholder farmers to access credit by facilitating group savings. This means the farmers can access more money from financial institutions to scale up their agribusiness ventures.

SUCCESS AND LESSONS LEARNED

Since the start of the second phase of the program, 2SCALE has facilitated enhanced access to affordable and nutritious food for over one million BoP consumers. By virtue of creating bigger markets in the BoP, we have also enabled nearly one million farmers to improve their agricultural productivity. In 2020, COVID-19 had a major impact on 2SCALE's work and affected business champions' ability to invest. In 2021, the pandemic continued to wreak havoc globally, but some 2SCALE countries also experienced political instability. In Ethiopia, Mali, Niger, and Nigeria, activities could not be implemented occasionally because of insecurity. The 2SCALE program adjusted some of its procedures to allow for more flexibility. Business champions were able to adjust their plans, when necessary, in response to the changing environments.

Strong agricultural business clusters (ABC) are the backbone of 2SCALE's work. Maintaining the sustainability of these clusters was a challenge during 2021. Boosting the motivation of the business support service (BSS) and community coaches through repeated capacity building sessions was crucial to ensuring complementary partnerships. In 2021, the program trained 275 ABC coaches (63% youth, 25% women).

Of the 62 active public-private partnerships developed, 42 were part of 2SCALE's incubation activities; 20 were part of replication activities. To support the public-private partnership actors based on the priority of the partnerships, 38 cross-cutting agreements introducing new technologies, expertise, and innovations were signed with supportive partners.

Website:
www.ifdc.org