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ISSUE:	Measures to Mobilize Science to Facilitate Farmer-Scientist Knowledge Flows for Food Security
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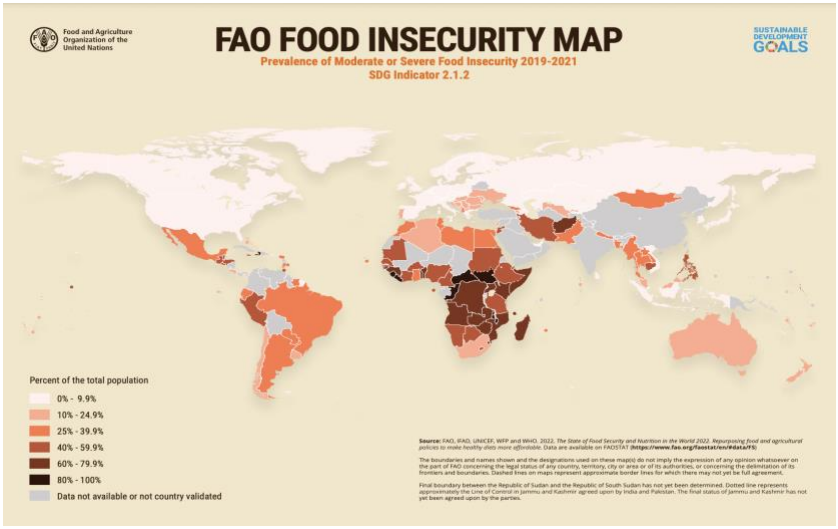
Introduction

Food security, as defined by the Food and Agriculture Organization of the United Nations (FAO), is that all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Achieving food security is one of the key Sustainable Development Goals by 2030 adopted by the United Nations. Unfortunately, millions of people worldwide suffer from food insecurity. In 2020, between 720 and 811 million people globally suffered from hunger, roughly 161 million more than in 2019. Also, 2.4 billion people were moderately or severely suffering from food insecurity. The number of people who are suffering from food insecurity has been rising and has pushed even higher due to the COVID-19 pandemic.



Food Insecurity Map 2019-2021, FAO

Ending food insecurity is a major challenge the world is facing, as it creates enormous social, environmental, and environmental impacts including:

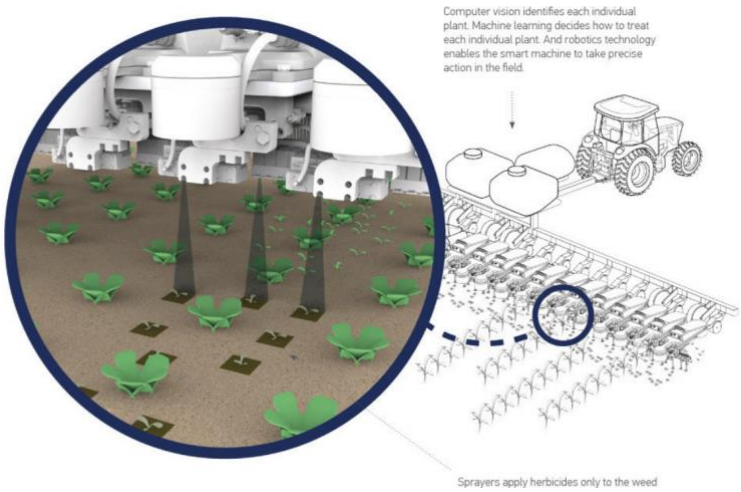
- Undernourishment and famine
- Rising food prices
- Civil unrest
- Soil erosion

- Water pollution
- Lower life expectancy
- Lack of education

Achieving food security by 2030 will require not only innovative applications of science and technology but also effective farmer-scientist knowledge flows. To address food security, there have been several initiatives launched to promote collaboration between scientists and farmers. They have been sharing insights and resources necessary for improving local food production and overall quality of life.

Background

Science and technology can be used in all aspects of food security. Scientists have been using emerging technologies to address the various aspects of food insecurity. Many of the applications of technologies such as synthetic biology, artificial intelligence, tissue engineering, three-dimensional printing, and drones and robotics are currently in the process of research and development or are already demonstrated in More Economically Developed Countries (MEDCs). For instance, a new genome editing approach based on CRISPR (Cas9) technology, a powerful tool for targeted genome modification, has made farmers insert disease-resistant genes from related wild plant species in modern plants. By fixing nitrogen from soil bacteria, such a method allowed smallholder farmers to sustainably increase yields and reduce reliance on synthetic fertilizers. Also, big data, the Internet of Things, drones, and artificial intelligence may catalyze the development of precision farming. Applying novel genetic sequencing and machine learning to detect changes in soil quality and weather can increase crop quality and yield. For example, machine learning is being applied to drone and satellite imagery to build detailed weather models that help farmer



Example of applying robotics and artificial intelligence to farming (Blue River Technology)

These technologies used together can improve productivity while minimizing the need for chemical pesticides. Yet, investments in Research and Development (R&D), infrastructure, and knowledge flows could help recent food insecurity. Continuous research and assessment with flexible regional and international collaboration are expected to play a key role in addressing food insecurity.

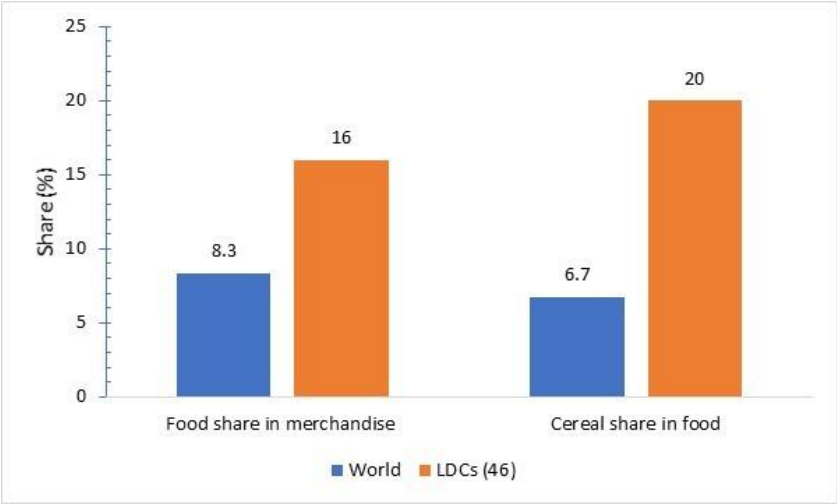
Problems Raised

Limited Innovative Adaptation Potential due to Reduced Sharing of Knowledge

A lack of understanding between farmers and scientists can lead farmers to not adopt improved seed varieties, irrigation techniques, organic farming, or other methods suggested by the scientists. Without proper guidance from scientists, farmers may instead use less efficient methods leading to suboptimal farm output levels. In addition, if smallholder farmers communicate mainly through indigenous languages different from those used by scientists, it could be more challenging to exchange knowledge and technologies and even reduce perceptions about intractable differences rendering conversations. When farmers remain unaware of advances in crop management strategies or novel agroecosystem designs, they cannot apply creative problem-solving skills acquired through generations of experience coping with diverse environmental conditions.

Lack of access to tools due to technology deficits or costs

Acknowledging that developing nations are more subjective to food insecurity due to lack of infrastructure and facilities, it is hard to ensure that all nations have sufficient tools for R&D. Farmers have little support from their governments, with most LEDCs spending only 3% of their budget on agriculture, regardless of the size of the sector in terms of employment and economic activity. Most Less Economically Developed Countries (LEDCs), including Kenya, Nigeria, and Syria, and many rural communities are having difficulties acquiring data associated with the crops due to the lack of tools, such as crop-monitoring systems and extensions between farmers and scientists.



Food Import Dependency (Commonwealth Secretariat)

Furthermore, LEDCs are highly dependent on international trade, as shown in the graph. However, lockdowns during COVID-19 and the war in Ukraine compromised access to agricultural inputs, disrupted food production, blocked transport routes and distribution services, and distorted trade in food products.

International Actions

Crop Watch

Crop Watch and UNCTAD cooperating (UNCTAD)

Food security is at risk partially due to climate change, especially in nations near the equator that have extreme weather variability. Accurate weather forecasts are needed to maximize crop yields. Global systems such as the Global Information and Early Warning System on Food and Agriculture, and Rise Market Monitor (FAO); the Famine Early Warning System Network (United States Agency for International Development); the Early Warning Crop Monitor; and the cloud-based global crop-monitoring system called Crop Watch (Chinese Academy of Sciences) have played critical roles in providing such information. UNCTAD fostered South-South cooperation to teach using satellite data to monitor crop conditions for better agricultural productivity. Afghanistan, Algeria, Kenya, Malawi, Mauritius, Myanmar, Nigeria, South Africa, Syria, Thailand, Turkey, and Zambia worked on using the Crop Watch innovative cooperation program. Crop Watch is a global crop monitoring system that uses climatic and remote-sensing indicators to release agricultural information across the world. Indicators of crop situation, farming intensity, and stress are provided at global, regional, national, and "sub-country" levels. Regional initiatives such as the Trans-African Hydro-meteorological Observatory and the Regional Cooperative Mechanism for Drought Monitoring and Early Warning Asia and the Pacific are also providing high-quality data to improve food security.

Key Players

China

China's government has sponsored R&D for agricultural means since 1995 and has been increasing its investment by 15 percent annually. Such action from China helped the adoption of advanced technologies by poor farmers. China also offers financial support for its African partners to develop agriculture infrastructure such as seed production zones and irrigation schemes. By bridging formerly isolated local communities, China has been contributing towards global food security.

FAO (The Food and Agriculture Organization of the United Nations)

FAO's purpose is "*to ensure fairness for those who produce our food*" according to Maria Fernanda Espinosa Garces. UN FAO works closely with other organizations and governments to promote sustainable agricultural development worldwide. It works with farmers, policymakers, research institutions, and other agricultural sectors to enhance food security.

UNFAO enhancing Food Security with the European Union Food Facility Project (UNFAO)

CGIAR (The Consultative Group on International Agricultural Research)

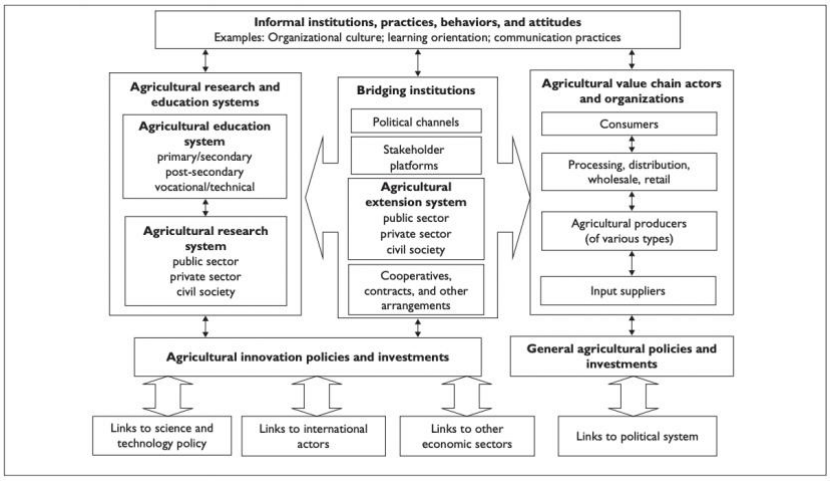
CGIAR focuses on international collaborative research directed toward global issues related to agriculture for development. By investing in research targeted at addressing challenges faced by people in developing nations, the consortium is focused on empowering producers in Africa, Asia, Latin America, and the Caribbean alike. CGIAR has proposed a new framework to identify new and creative solutions to the challenges of agricultural development, aiming to reduce poverty, improve food and nutrition, and security for health, and improve natural resource systems and ecosystem services. The resulting framework includes:

- Agri-food systems today are not sustainable, nor do they provide healthy food for all.
- Poor diets are the leading cause of ill health in the world.
- There is a serious and escalating global environmental crisis affecting the agricultural sector.
- Massive un(der)employment of young people in rural areas is a key challenge.
- Radical and fast transformation is urgently needed to meet these daunting challenges.

This strategy involved four main themes, which are mitigating and adapting to climate change risks and shocks, ensuring gender and youth equity and inclusion, strengthening the policy and institution-enabling environment, and developing the capacity of national partners and beneficiaries. Considering these backgrounds, CGIAR is aiming to solve food insecurity issues by 2030.

Possible Solutions

Develop Agricultural Innovation System



Agricultural Innovation System, 2009 (Larsen)

Agricultural Innovation System involves a network of promotion of agricultural research and education systems; bridging institutions; agricultural value chain actors and organizations; agricultural innovation policies and investments; and general agricultural policies and investments. This network links to science and technology policy; international actors; other economic sectors; and the political system. Developing a strong agricultural innovation system helps address research priorities, evaluate implications of innovations for food security, promote participation of smallholder farmers, recognize local agricultural knowledge systems, etc. The data can provide policymakers with a broad framework for a better application of science and technology on food security.

Increase Investments in Agricultural Research and Development at the Global and National Levels

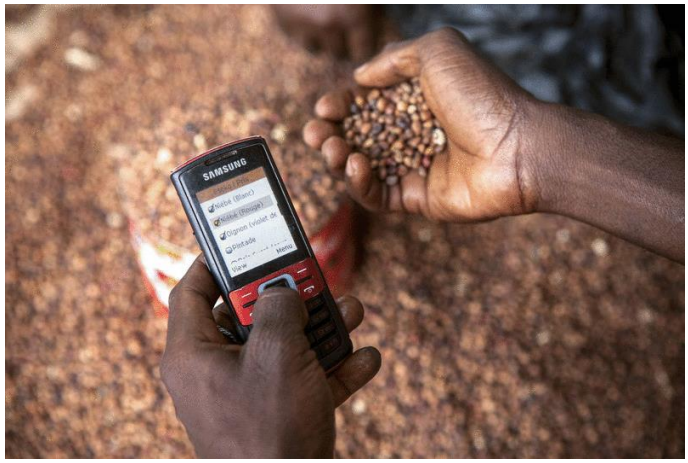
Previous economic studies have shown that R&D-driven improvements in agricultural productivity helped decrease global poverty rates. To maximize the productivity and quality of the food produced, specialized R&D centers operating on public funds and continuous national and global R&D for ecological, biodiversity, and environmental contexts are needed. These contexts are constantly changing and cannot be predicted simply without deep understanding. United Nations has predicted that FAO, IFAD, and WFP would require additional 267 billion dollars annually for the R&D. According to estimates made by the United Nations Environment Program green economy models if 0.16 percent of global GDP is invested in agricultural context per year, it can provide significant returns.

Cooperative Research among Farmers and Scientists

To address complex social, economic, and ecological contexts of smallholders, applications of participatory and empowering methodologies to farmers are needed. The methodologies should consider institutional priorities, the impact of their work, and funding. For example, extension services can help develop cooperative context specific approaches. However, the main challenges lay in communication institutional stability and durability. For instance, the Europe Aid-financed project Syprobio (2011-2015) had established Innovation Platforms (IPs) near local farms to address declining soil fertility, low yields,

and inappropriate seeds for small-scale organic farmers, and other technical institutional constraints. Farmers participated in these IPs met several times per year to exchange experiences and coordinate actions. Complex interactions and knowledge flows between farmer groups allowed fast development and application of new technologies. As a result, farmers improved their ability to analyze and identify the best working technologies, with each of them having the potential to increase the yields by over 10 percent.

Improve Extension Services and the Farmer-Scientist Interface



Example of ICT used (Science)

It is important to ensure that indigenous people who are disadvantaged have full participation in relevant decision and planning processes. Currently, poor research and extension are given to poor farmers. Thus, increasing investment in research and advisory extension services that are coherent with models of productions adapted to farmers' needs is needed. Information and communications technologies (ICTs), which provide how-to videos for farmers and participatory radio campaigns, can improve the reach of extension services. This service is not sophisticated as it can be deployed with the use of mobile phones. For example, Access Agriculture provides high-quality training videos translated into 74 local languages for farmer-to-farmer capacity building. Digital Green, the non-governmental organization also provides locally produced how-to videos for farmers living in remote locations. Similarly, participatory radio campaigns such as Farm Radio International let farmers exchange agricultural knowledge, allowing the farmers to translate such knowledge into better agricultural practices. FAO and CGIAR centers may help in extending the interface.

Glossary

CGIAR (Consultative Group on International Agricultural Research)

A global research partnership for a food-secure future.

CRISPR-Cas9 (Clustered Regularly Interspaced Short Palindromic Repeats and CRISPR-associated protein 9)

A gene-editing technology that allows for the highly specific and rapid modification of DNA.

FAO (Food and Agriculture Organization of the United Nations)

A specialized agency of the United Nations that leads international efforts to defeat hunger and improve nutrition and food security.

Food insecurity

The condition of not having access to sufficient food, or food of an adequate quality, to meet one's basic needs.

Food security

The state of having reliable access to a sufficient quantity of affordable, nutritious food.

IFAD (International Fund for Agricultural Development)

An international financial institution and a specialized agency of the United Nations dedicated to eradicating poverty and hunger in rural areas of developing countries.

Information and Communication Technologies (ICT)

A diverse set of technological tools and resources used to transmit, store, create, share, or exchange information.

Innovation Platform (IP)

A space for learning and change.

Internet of Things (IoT)

The interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data.

Sustainable Development Goals (SDGs)

A collection of seventeen interlinked objectives designed to serve as a "shared blueprint for peace and prosperity for people and the planet, now and into the future".

UNCTAD (United Nations Conference on Trade and Development)

An intergovernmental organization within the United Nations Secretariat that promotes the interests of developing countries in world trade.

WFP (UN World Food Programme)

An international organization within the United Nations that provides food assistance worldwide.

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