FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

Partnering for Innovation

Designing Agricultural Research that Leads to Commercialization:

Recommendations for USAID

USAID
FROM THE AMERICAN PEOPLE

Fintrac

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ABOUT FEED THE FUTURE PARTNERING FOR INNOVATION

Feed the Future Partnering for Innovation is a USAID-funded program that helps the private sector to scale and market agricultural technologies for smallholder farmers through investing in technology commercialization and knowledge exchange. The program also facilitates partnerships between USAID Missions and the private sector and provides business acceleration tools and services.

DISCLAIMER

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INTRODUCTION & EXECUTIVE SUMMARY

The US Government's Global Food Security Strategy (GFSS) recognizes commercialization as an important pathway for technology-scaling. Designing agricultural research programs that can effectively use that pathway requires a demand-driven approach, institutional capacity for technology transfer, and national and institutional enabling environments that facilitate commercialization. Furthermore, there is an opportunity to leverage the extensive experience and expertise of the United States Department of Agriculture (USDA) and US universities in commercializing agricultural research domestically and internationally to adapt these approaches to Feed the Future countries. This report is intended as a starting point for discussion with Feed the Future/USAID along these lines. Although it is written in the context of Feed the Future and the US government's Global Food Security Strategy, the recommendations may also be of interest to other donors active in supporting agricultural research.

Such discussions are important as we work to better leverage commercial pathways for scaling research that benefits food security in communities were USAID operates. They also foster country self-reliance, as stronger relationships between research institutes and the private sector help bring long-term, market-based solutions that diminish the need for aid.

Context & Purpose

This report is intended to complement two existing series of publications:

- The GFSS Supplemental Technical Guidance documents on Capacity Building, Private Sector Engagement, and Scaling for Widespread Adoption of Technologies and Practices. These three supplements include some discussion of the topic of commercialization. This report adds further detail to those foundations.
- The 2017 Success Factors for Commercializing Agricultural Research: Lessons from Feed the Future Partnering for Innovation (written primarily for a research institute and donor audience) and its companion guides for the private sector and project managers. This series examined eight of Partnering for Innovation's partnerships that involved the commercialization of research that originated at a public agricultural research institution (such as a public university or Consultative Group on International Agricultural Research [CGIAR] Center) and identified common factors that contributed to success. That series of reports focused on research that already had been completed and was ready for commercialization.

Report Structure

The following recommendations to Feed the Future/USAID are designed to complement the GFSS Supplemental Technical Guidance and the Success Factors for Commercializing Agricultural Research reports by **focusing on designing agricultural research-related interventions with commercialization as the intended scaling pathway.** These recommendations to Feed the Future/USAID revolve around two topics:

1. Involving the private sector in strategy setting, program design, and implementation.
2. Facilitating the commercialization process through capacity development and an enabling environment.

Key Takeaways

- The US has a unique opportunity to share best practices and lessons learned from its own experiences, and to support capacity building in technology transfer/commercialization in FTF countries.

- There is no one-size-fits-all approach to commercialization; expertise is required to provide tailored advice. This method requires appropriate human resource capacity.
- Engage with the private sector early and on an ongoing basis. Involve the private sector in identifying strategic priorities for research, in the proposal/project development process, and during the research itself.
- Technology transfer and commercialization requires resources, and such support should be built into research funding.
- Commercialization requires an appetite for risk-taking and a tolerance for failure.

Basis for Recommendations

This report builds on Partnering for Innovation's six years of experience working with 50 private-sector partners to commercialize improved agriculture technologies and services in emerging and underserved markets in 17 countries, engaging with more than 1 million smallholder farmers as customers, suppliers, and entrepreneurs. These recommendations are based on that expertise, research conducted for the Success Factors for Commercializing Agricultural Research reports, and an additional 29 interviews with private-sector, US government, land grant university, and CGIAR representatives.

Key Term

Commercialization is the process by which products, services, and technologies are introduced to the market for purchase.

Limitations

Although this report focuses on commercialization, it should be noted that it is not the only pathway for scaling. Not all research lends itself to commercialization, and the public sector plays an important role in supporting basic research that is often several steps removed from commercial application. The GFSS Supplemental Technical Guidance on Scaling for Widespread Adoption of Technologies and Practices discusses different pathways for scaling and how to determine which pathway is appropriate.

Given the diversity of research-related interventions that USAID supports in terms of scale, objective, topic area, and geographic focus, the recommendations are intended to serve as food for thought that ideally leads to an approach to engage the private sector early to inform research priorities and increase prospects for commercial application.

INVOLVING THE PRIVATE SECTOR

The GFSS Supplemental Guidance on Private Sector Engagement recognizes the essential role that the private sector plays in development. It notes the need to work with the private sector in designing development interventions. The private sector is a particularly important stakeholder in public agricultural research when commercialization is the targeted pathway for scaling that research. This section builds on the concepts outlined in the Supplemental Guidance by providing additional recommendations for involving the private sector in research strategy and project design.

Key Term

Private sector: profit-making businesses, private grant-making foundations, and philanthropic entities.

More information on private-sector interest in public research can be found in Success Factors for Commercializing Agricultural Research: Companion Guide for Project Managers.

Terminology & Context

The GFSS defines the **private sector** as including profit-making businesses, private grant-making foundations, and philanthropic entities. In the context of these recommendations, the definition is narrower and includes profit-making businesses and groups that represent them (such as trade associations).

When viewing the private sector in terms of agriculture, it is imperative to think in terms of agricultural value chains and the types of companies that participate in them. For example, seed companies, farmers, and food companies are stakeholders in plant-breeding research. Companies of varying sizes and scopes will also have different perspectives and priorities. For example, a large multinational company active in a variety of food and agricultural sectors will have a different perspective on research priorities than a smaller company focused on a single product in a single country. Trade associations, commodity groups, or similar organizations can be useful entities with which to engage for a summary view of private-sector priorities.

Recommendations for Designing Interventions

Including the private sector as a stakeholder in setting research priorities helps to design research programs that are relevant to private-sector needs. The GFSS Supplemental Technical Guidance notes the importance of including the private sector as a stakeholder group for strategy and project design. The Guidance largely focuses on engagement with the private sector with the aim of developing formal partnerships. However, at the research strategy and project design phases, there are opportunities to engage in broader discussions with the private sector about their views on research needs and priorities. Such discussions may or may not lead to concrete partnerships in the near term but will help to better position research for future commercialization.

Interacting with the Private Sector for Strategy Development and Pre-Solicitation

A. **Do not limit engagement to the context of developing formal public-private partnerships through which the private sector is contributing financial or in-kind resources**; the more informal exchange of information, ideas, and viewpoints also has value and enriches program design. For example, donors can attend industry conferences to gain insight into what issues companies are focused on and how they perceive the market. Such informal interactions can be useful to inform the design of smaller projects for which a full stakeholder/private sector input process may not be feasible.

B. **Establish processes for regular stakeholder/private-sector input into research strategy and priority setting.** This effort can take the form of in-person workshops, webinars/conference calls, or surveys as resources and time constraints allow. Depending on the nature of the work, it can be an ad hoc gathering or focus group, or a standing advisory committee. The text box to the right highlights an example of the USDA Agricultural Research Service process. Illustrative questions for discussion with the private sector follow:

   1) What is the main constraint for growth in your agricultural sector(s)?
   2) What do you see as the greatest short-term (less than five years) research needs?
   3) What do you see as the greatest long-term (5 to 10 years) research needs?
   4) What is the best way to communicate new solutions and technologies?[i]

   Since the goal is to gather general input on priorities, not to solicit applications or develop specific partnerships with companies, it is not necessary to include an exhaustive list of private-sector representatives. However, the process should include a representative sample of private-sector stakeholders of varying sizes, industries, and geographies. When possible, trade associations, commodity groups, or other similar bodies can serve to represent a collective view.

Hypothetical Example of Recommendations in Practice:

During a stakeholder consultation, companies note that frequent droughts are a major obstacle to growth in their sector. Larger commercial farms are already using irrigation systems but are concerned about the long-term viability of this option from cost and water access standpoints. Although appropriate technology does exist, smallholder farmers are not using irrigation. As resilience is an area of interest for USAID, there are opportunities to work together to address this issue – both in terms of scaling of existing technology and further research to develop new solutions.

To scale adoption of existing technology, USAID works with irrigation technology companies to help them better reach smallholders.

To develop new solutions, USAID funds a public research institution to conduct genetics research on drought tolerance, which results in discovery of a relevant gene. Next, the research institute works to incorporate this gene into varieties with characteristics that appeal to smallholder farmers as well as those preferred by larger commercial farms (again based on stakeholder input). Following release according to host-country procedures, the varieties can be licensed to seed companies. Some companies may sell only to larger-scale operations or exclusively to smallholders, while others may be active in both markets.

Partnering with the Private Sector on Specific Activities

A. **Establish and clearly communicate centralized points of contact for the private sector to engage**, and encourage research institutes/programs to do the same. It is helpful to have a relationship manager or "one-stop shop" to help companies navigate learning about and working with an organization in a variety of capacities. The GFSS Supplemental Guidance on Private Sector Engagement also makes point about relationship management. This central point of contact can help the company to make connections across different but complementary programs that may be of interest. For example, a relationship manager could connect a company involved in a USAID-supported research project with an incubator/accelerator project that would help them to commercialize that research and a broader agricultural development project that is training farmers (potential customers for the product). Through the

relationship manager, the donor and company can engage in a two-way conversation to identify areas of mutual interest.

B. **Focus activities on solving a problem or set of problems rather than on a development goal or on the transfer of a specific technology.** This approach allows for flexibility and creativity by the research institute and the private-sector partner. Encourage them to develop ideas collaboratively during the proposal process rather than waiting until post-award. Addressing a problem that the private sector has identified later helps make a business case for commercialization of that technology.

C. **Allow for discussion between the donor and the private-sector partner during the proposal process.** Recognize that focusing exclusively on smallholder markets and low-income areas is unlikely to generate returns significant enough to interest the private sector. For products with broader appeal, consider flexible design that allows for products to be commercialized for larger markets in addition to smallholder markets. For example, companies noted that flexibility to work with the Innovation Labs to also reach more commercially-oriented farmers and/or also work outside the FTF zone of influence would be useful to bring new technologies to market in a sustainable way. Being able to have a conversation with the private sector during the proposal process can ensure that both donor priorities and company needs for commercial success are met. Companies' desired levels of involvement in the research itself will vary based on company size and capacity as well as industry norms for that area of research. These expectations and any limitations should be made clear during the proposal process.

Programming in Practice: USDA/ Agricultural Research Service (ARS) Stakeholder Input Process

The following section illustrates current practices in use by the USDA/ARS to involve stakeholders in its research. The process ultimately informs both research conducted by USDA/ARS scientists and research conducted by other organizations with USDA/ARS funding. The USDA/ARS implements its 16 National Programs[ii] on a five-year research cycle that involves four stages: ***assessment***, ***input***, ***planning***, and ***implementation***.

Stage 1 - Assessment: Retrospective Review

As a five-year program nears its conclusion, USDA/ARS initiates a retrospective review, during which an external, anonymous (except for the chair) review panel assesses progress toward the major goals and research that were established in the program's five-year action plan. The review panel includes representatives from the public and private sectors (domestic and international) that have undergone an USDA/ARS Ethics Office review to identify any conflicts of interest. The review panel looks at both delivery on the commitments detailed in the program's action plan and strength of collaboration with other organizations. The review panel's findings are then presented to USDA/ARS senior staff.

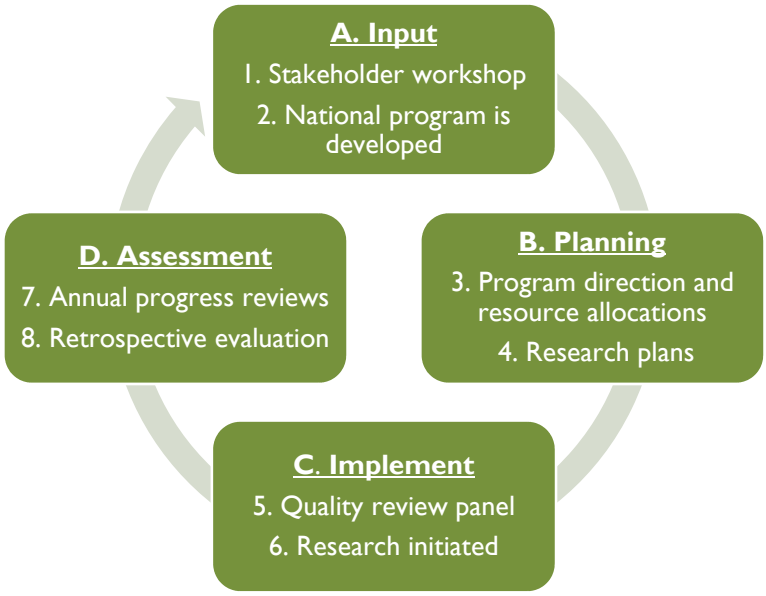


***Diagram**: USDA/ARS 5-Year Research Cycle, adapted from https://bit.ly/2Pk7cGi.*

Stage 2 – Input: Customer/Stakeholder Workshop

The next step is to conduct a customer/stakeholder workshop, during which the chair of the review panel shares the assessment of the current program and participants provide input into strategic priorities for the next five years. When possible, this effort will consist of both a one-day, in-person meeting of customers/stakeholders (who fund their own travel) and a separate webinar for those customers/stakeholders who cannot attend in person. In developing invitation lists, National Program leaders seek a representative sampling of key customer/stakeholder groups, which can include other government agencies, academia, foundations, and the private sector (which can include individual companies, trade associations, or commodity groups). Leaders seek to be as inclusive as possible while also keeping in mind practical considerations such as space limitations for in-person meetings. Depending on the preferences of the National Program leaders, these workshops/webinars can start with a blank slate for open brainstorming or with a rough draft of priorities for feedback and additional input.

Stage 3 – Planning: Action Plan and Individual Projects

Following the workshop/webinar, National Program staff present both the results of the retrospective review and the customer/stakeholder workshops to the USDA/ARS researchers whose work contributes

to the program. USDA/ARS researchers then contribute to drafting the next five-year Action Plan, which is then shared with customers/stakeholders and other ARS scientists for feedback before being finalized.

Once the Action Plan is finalized, individual scientists write their five-year project proposals, which focus on objectives that will contribute to attaining the goals of the Action Plan. In doing so, they are expected to reach out to customers/stakeholders that are more specific to their line of research to ensure that their work is relevant to the sector. Projects are then submitted to the USDA/ARS Office of Scientific Quality Review, which convenes anonymous panels of external public and private-sector scientists to review them. These reviewers are also screened for conflicts of interest, as described previously.

Stage 4 - Implementation

During implementation of the research project itself, the level of private-sector engagement will vary depending on the nature of the work. However, higher levels of engagement are common; for technology transfer, commercial success is how research outputs are evaluated.

Conclusion

Overall, the time from the start of the retrospective review to the approval of individual research projects is about 18 to 24 months. Although USDA/ARS primarily focuses on US customers/stakeholders, its process also includes international participants, and there are opportunities for other US government agencies to leverage this work and draw on USDA/ARS knowledge when setting priorities for research programs with an international focus.

For Further Information

The National Program on Aquaculture website includes a summary of the last Retrospective Review, notes from the customer/stakeholder workshops (including discussion questions), the current Action Plan, and information on current projects.

Point B on page 3 of this report identifies some of the key elements of this stakeholder input approach that can be adapted and applied to other contexts.

Facilitating the Commercialization Process

As research becomes ready for commercialization, individual and organizational capacity is needed to facilitate that process. Such capacity is needed to support the research institute (developing a commercialization strategy, making connections with companies, managing intellectual property, and representing the research institute's interests) and in some cases to support the company (incubator/accelerator services, technical assistance on business issues). Similarly, there needs to be an enabling environment that supports the commercialization of publicly-funded research through policies and organizational culture. This section complements the GFSS Supplemental Technical Guidance on Capacity Development by discussing specific capacities needed to facilitate commercialization.

Key Terms

- ***Bridging institutions***: stakeholder platforms, agricultural extension, and contractual arrangements that serve as links between research institutions and businesses.
- ***Technology transfer offices***: manage a research institute's intellectual property; seek to generate revenue; facilitate private-sector funding for research; support researchers in the commercialization or technology transfer process; support regional economic development
- ***Enabling environment***: norms, customs, laws, regulations, policies, international trade agreements, and public infrastructure.

Terminology & Context

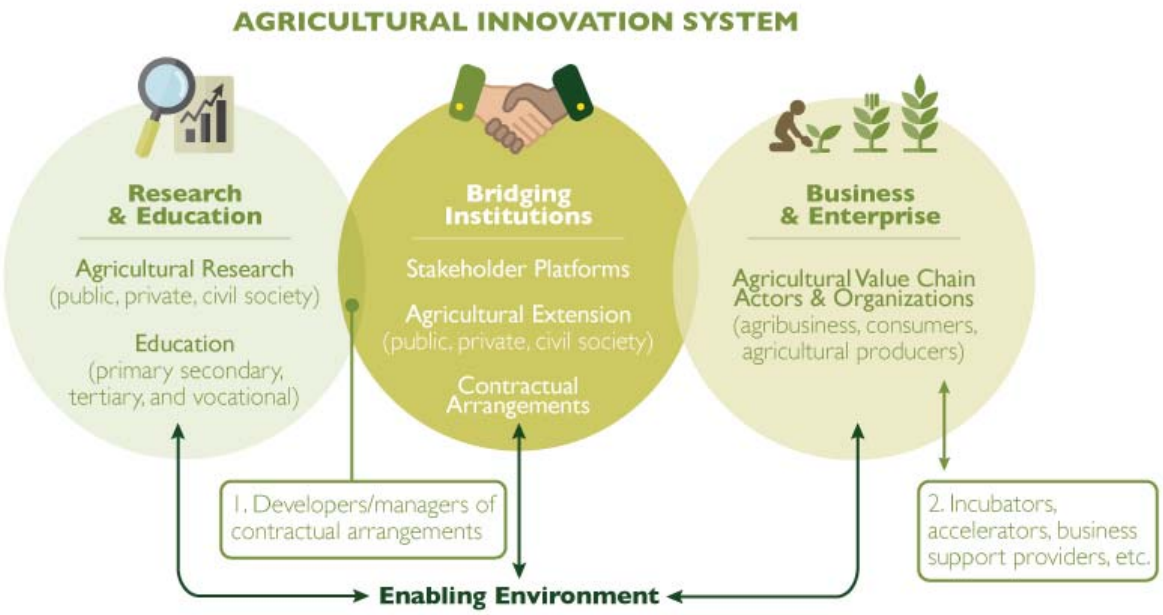
The GFSS Supplemental Guidance on Capacity Development discusses the concept of the Agricultural Innovation System, which has four components:

1. Research and education
2. Business and enterprise
3. Bridging institutions
4. Enabling environment

In the guidance, **bridging institutions** are defined as including stakeholder platforms, agricultural extension, and contractual arrangements that serve as the link between research institutions and businesses. This section focuses on two additional sets of entities that facilitate the development of contractual arrangements (one type of bridging institution) as well as entities that support businesses in their work to commercialize that research:

1. Entities that develop and manage those contractual arrangements (normally internal to the research institute).
2. Entities that support businesses and economic development.

Diagram [next page]: The Conceptual Framework for an Agricultural Innovation System, (a modification of a version presented in GFSS Supplemental Guidance for Capacity Development), overlaid with research to commercialization support entities (new additions are noted in rectangles). Developers/managers of contractual arrangements fall in between research organization and bridging institutions; business service providers support business and enterprises.



Managing Contractual Arrangements

One of the most common entities that develops and manages contractual arrangements is the **technology transfer office** (normally internal or closely tied to the research institution). These offices generally manage the research institute's intellectual property (such as the patent application process, licensing agreements, and legal matters related to intellectual property); seek to generate licensing revenue or other income; facilitate private-sector funding for research; support researchers in the commercialization or technology transfer process; and, in some cases, support regional economic development.[iii] Note: US readers may be most familiar with the term *technology transfer office* in the context of US universities or federal labs. However, use of this term is not limited to the US context and is not intended to imply a recommendation to replicate the US model. Some research institutes also have an industry liaison office that serves as a central point for initiating and managing strategic relationships with the private sector (not limited to commercialization).

Promoting Business & Economic Development

A variety of entities support local/regional economic development through support to businesses and entrepreneurs. These entities can be third parties or closely tied to the research institute; they may be permanent institutions or shorter-term projects. As noted in the report, "Success Factors for Commercializing Research: Lessons from Feed the Future Partnering for Innovation," companies face several challenges during the commercialization process – many of which are beyond the assistance capacity of the research institute. For example, companies may lack access to financing or have difficulty developing an appropriate marketing strategy to reach smallholder farmers. Similarly, small and medium-sized enterprises in FTF countries may be unaware of opportunities to commercialize public research. Entities (both institutions and projects) that support local/regional economic development can assist with addressing both issues. Examples of common types of entities that fall into this category include:

- **Business incubators or accelerators** that provide business support services to promote the growth and success of new businesses.
- **Business innovation centers** that provide small and medium enterprises with guidance and support on projects.

- **Science parks or technology hubs** that promote technology transfer and new business opportunities in a specific region.
- **Territorial development enterprises** that bring together scientific, organizational, and financial resources to support product development and entrepreneurship in a defined geographic area.[iv]

Enabling Environment

The GFSS Supplemental Guidance on Capacity Development defines **enabling environment** as including "norms, customs, laws, regulations, policies, international trade agreements and public infrastructure." It also notes that it can refer to formal and informal rules, including "practices, behaviors, mindsets and attitudes." In the context of this section, the term "enabling environment" focuses on policies and organizational culture.

Recommendations for Designing Interventions

Individual & Organizational Capacity

A. **Incentivize research institutes to facilitate commercialization and technology transfer.** Facilitating technology transfer and commercialization requires additional work on the part of the research institute. Research institutes need staff specifically dedicated to this purpose – managing intellectual property, developing and negotiating licensing agreements, finding potential commercial partners, and working with researchers to develop plans specific to their field of study. In the context of research that benefits Feed the Future countries, research institutes generally have at least some of this capacity (at a minimum managing intellectual property and agreements) but have some limitations when it comes to identifying commercial partners and developing commercialization plans.

   While licensing revenue/royalty income can be a source of funding support for this work, in a developing country and/or smallholder-focused market, such funding likely will be insufficient to fully support such costs. It should be noted, for example, that even in the United States — a highly-developed market for commercial agriculture — revenue from commercialization covers only a portion of the USDA/ARS Office of Technology Transfer's costs. There often is also a need for funding for additional research-related activities and/or market outreach work that is necessary to transfer technology to a company. Examples include market studies, additional field testing under specific conditions, and collection of data required for regulatory approval. Donors often overlook these intermediate steps between research and scaling.

   In a report on US universities, the Milken Institute recommends the establishment of a commercialization fund (through which universities demonstrating successful commercialization receive additional research funding) and matching grants to increase capacity of technology transfer offices.[v] Similar concepts could be adapted to the Feed the Future context.

B. **Build individual and organization capacity to develop commercialization plans for their areas of research.** Commercialization plans and processes will vary based on field of research, industry norms, and target market. The point at which a technology is ready for commercialization varies widely depending on the type of product, sector, and country. These differences include, for example, when the private sector becomes involved in the research and in what capacity, how far the research needs to progress before it can be commercialized, expectations for data collection, and intellectual property rights and licensing issues. Commercialization plans need to be tailored to the circumstances, which requires that research institutions have this expertise either in-house (for example through a technology transfer office) or externally. Some industries will want to see the research progress through proof of concept or regulatory approval stages before committing, while others will be willing to take on such work

themselves. This effort requires some flexibility from donors and research institutes to follow industry norms on R&D for that sector, and it requires that the research institutions have the expertise (through staff, advisors or consultants) to determine the best course of action.

C. **Support regional networks of research, agricultural development, and economic/business development initiatives.** Through such networks, research institutes, companies, and NGOs can connect with each other to get the services they need. A key component of the network would be incubator and accelerator initiatives, as well as regional/national economic development agencies. These entities can help provide businesses with the support services they need to succeed at commercialization and help to connect more companies with research institutes. When successfully engaged in commercialization, research institutes can serve as engines of job creation and economic development, particularly in the areas where they are located.[vi]

D. **Continue to support business accelerators, incubators, science parks, etc**. Through Feed the Future, USAID supports a variety of projects and initiatives that provide technical assistance and financial de-risking to companies that offer market-based solutions to smallholder farmers. With alignment and coordination with research programs, these initiatives have the potential to provide highly complementary support.

E. **Develop regional technology transfer brokers to support all Innovation Labs and/or CGIAR centers working in a region of FTF countries.** These brokers would supplement the services already provided by the universities' technology transfer offices, or CGIAR legal/agreements staff and would focus on filling key gaps in knowledge and services. These regional brokers would not necessarily need to be large, standalone entities. They could take the form of a few staff or consultants housed within an existing organization. They would help navigate regulatory issues, identify market opportunities, and liaise with companies. They could serve as a central contact point for companies to connect them with relevant Innovation Labs or CGIAR centers and to package complementary technologies developed by different Innovation Labs or CGIAR centers.

Enabling Environment

A. **Support the development of an enabling environment for technology transfer/commercialization for national agricultural research institutes.** For plant-breeding programs, variety release is normally conducted through national agricultural research institutes, and commercialization is governed through national policies. Countries have varying capacities and levels of experience in engaging in commercialization and working with the private sector. Some capacity building work is happening through these national agricultural research institutions' work with CGIAR centers and/or FTF Innovation Labs (particularly on release of new crop varieties resulting from CGIAR or Innovation Lab research) and FTF Strengthening Agriculture Innovation Capacities, but more work focusing on commercialization and technology transfer would be beneficial. Government-to-government communication and information exchange would be meaningful in areas, as the United States has significant experience with commercialization and related policies through federal labs and public universities.

B. **Encourage a culture of experimentation – trying new approaches to commercialization and technology transfer.** In one example, the International Institute of Tropical Agriculture (IITA) has established a Business Incubation Platform to support spinoffs and startups based on IITA research. This approach to commercialization is widespread within the US university system but is a novel concept within the CGIAR system. In another, the International Livestock Research Institute (ILRI) collaborates with the Global Alliance for Livestock Veterinary

Medicines (GALVMed) platform to commercialize vaccines and will be setting up a contract research organization.

Programming in Practice: USDA/ARS Innovation Fund

To overcome obstacles to commercialization and technology transfer, USDA/ARS has established an Innovation Fund that is supported through a small percentage of licensing revenue. Through a competitive process, the Innovation Fund awards small grants of up to $25,000 to USDA/ARS scientists to move a technology or research outcome closer to adoption by stakeholders. This work could include activities like hiring an external expert to conduct a market study or conducting additional data analyses to respond to industry requirements.

Trying New Ideas - IITA Business Incubation Platform

In 2013, IITA started a Business Incubation Platform to facilitate commercialization of IITA technologies and promote entrepreneurship around those technologies. At present, the platform focuses on commercializing four technologies, primarily in Nigeria, and on working with young entrepreneurs to encourage youth engagement in agriculture. Some initial export is occurring, and technology transfer agreements are in place with partners in other countries. The Business Incubation Platform has an advisory committee that includes private-sector representatives and is led by an executive with business experience. Although the platform was initiated with seed funding from the Bill & Melinda Gates Foundation, it is designed to be self-sustaining and self-financing. The primary focus is on IITA-developed innovations; however, one business in the incubation stage will produce breeder and foundation seed for a portfolio of varieties that several different CGIAR centers developed. This business will ultimately allow seed companies to purchase breeder and foundation seed for several different crops at the quality and quantity they need from a single source. The seed is certified by the National Seed Council. The company IITA GoSeed will pay the CGIAR centers a percentage of the turnover back as compensation for their variety development.

CONCLUSION

To summarize the two topic areas presented in the report, key takeaway messages follow:

A. **The US has a unique opportunity to share best practices and lessons learned from its own experiences, and to support capacity building in technology transfer/commercialization in FTF countries.** The US is seen as a leader in commercialization of public research; in the 1980s and 1990s there were significant changes in legislation and government policy that enabled universities and the federal government to commercialize publicly funded research. The US has served as a model for other Organization for Economic Co-operation and Development (OECD) countries and some developing countries in developing their own policies on technology transfer and commercialization of publicly funded research.[vii] USDA/ARS has provided technical assistance to countries such as Brazil, Armenia, and Uzbekistan on technology transfer, and FTF Innovation Labs often highlight the model in which USDA/ARS, US universities, and companies work together. In addition to the examples highlighted in this report, the Recommended Further Reading list includes reports and studies with additional detail on the US experience and lessons learned.

B. **There is no one-size-fits-all approach to commercialization; expertise is required to provide tailored advice.** Depending on the type of research/technology, common practices in the industry, mission of the research institute, and country of focus, different approaches will be necessary in terms of when and how the product is commercialized. The nature, level, and timing of private-sector involvement also will vary.

C. **Engage with the private sector early and on an ongoing basis. Involve the private sector in identifying strategic priorities for research, in the proposal/project development process, and during the research itself.** The nature of private-sector engagement may change over the course of the research program. For example, earlier phases of identifying strategic priorities may involve trade associations or other industry groups, whereas later stages of research may involve only the company that will commercialize the product.

D. **Technology transfer and commercialization require resources, and incentives should be built into research funding. Research institutes incur real costs in transferring technology and commercializing research, and this work must be resourced adequately.** This effort includes functions such as developing a commercialization plan, managing intellectual property, identifying and developing agreements with private-sector partners, and any additional data collection or regulatory approvals that may be required. Regional technology transfer brokers could help supplement the capacity of individual international research institutes' internal staff resources and offices to initiate commercialization. Capacity building of host-country governments and their national research institutes is also necessary; this work includes developing an enabling environment (in terms of policies and institutional culture) that facilitates interaction with the private sector and allows for commercialization of publicly-funded research. Linkages to complementary support-services for companies (through business incubators, accelerators, and so on) will also help research institutions to refer private-sector partners to expert resources to address issues not directly related to research.

E. **Commercialization requires an appetite for risk-taking and a tolerance for failure.** Sometimes, despite the best efforts of all involved, attempts at commercialization will fail. Perhaps the product is ahead of its time, another pathway for scaling is more appropriate, market conditions changed, or a better alternative came along. Donors seeking to support commercialization need to recognize that it will not always work according to plan, and that failure will happen.

In conclusion, for commercialization to be a viable, sustainable pathway for scaling publicly funded agricultural research in FTF countries, donors must adequately support the processes and structures that facilitate commercialization and technology transfer. This work begins with private-sector engagement to identify strategic research priorities and flexible program designs that recognize private-sector needs and ways of operating, and it continues with financial support for research institutes to manage their part of the commercialization/technology transfer process. FTF, as a whole-of-government initiative, has great potential to serve as a global leader in commercialization of agricultural research by leveraging significant domestic experience and working with host-country government and international organization partners to develop locally appropriate solutions.

[i] Questions are adapted from the USDA/ARS and NIFA Aquaculture Research and Extension Stakeholder Workshop held in 2013 to inform the 2015-2019 research program.

[ii] Examples of National Programs include: Plant Genetic Resources, Genomics & Genetic Improvement; Human Nutrition; Animal Health; and Grass, Forage, and Rangeland Agroecosystems.

[iii] OECD. "Policies to enhance the transfer and commercialization of public research." In *Commercializing Public Research: New Trends and Strategies.* OECD Publishing. 2013.

[iv] Examples are drawn from the following publication, which includes a longer list: OECD. "Policies to enhance the transfer and commercialization of public research" in *Commercializing Public Research: New Trends and Strategies.* OECD Publishing. 2013.

[v] DeVol, R., J. Lee and M. Ratnatunga. Concept to Commercialization: The Best Universities for Technology Transfer. Milken Institute Center for Jobs and Human Capital. April 2017.

[vi] DeVol, R., J. Lee and M. Ratnatunga. Concept to Commercialization: The Best Universities for Technology Transfer. Milken Institute Center for Jobs and Human Capital. April 2017.

[vii] OECD, "Policies to enhance the transfer and commercialization of public research" in Commercialising Public Research: New Trends and Strategies. OECD Publishing. 2013.

Recommended Further Reading – An Annotated List

Association of Public and Land Grant Universities. *Technology Transfer Evolution: Driving Economic Prosperity.* A Report of the Technology Transfer Evolution Working Group of APLU's Commission on Innovation, Competitiveness and Economic Prosperity. November 2017.

This report looks at the strengths and weaknesses of US universities regarding technology transfer and offers recommendations for improvement. The APLU website also includes tools for measuring a university's economic impact, which includes technology transfer and other impacts.

Bahar, M., Griesbach, R.J. "A New Strategic Approach to Technology Transfer." *Innovation Magazine* 2016: 14(3).

This paper gives an overview of the USDA/ARS approach to managing technology transfer, including its work to customize plans for individual research projects.

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This book, also available as individual chapters, looks at technology transfer and commercialization policies, practices, and models across OECD countries. It includes helpful reference graphics on types of intermediaries and channels for technology/knowledge transfer, as well as case study examples from different OECD countries.

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This literature review looks at aspects of research institutions' organizational behavior/culture and human resources management as they relate to commercialization and technology transfer.