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

Partnering for Innovation

Success Factors for Commercializing Agricultural Research

Lessons from Feed the Future Partnering for Innovation

USAID
FROM THE AMERICAN PEOPLE

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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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Executive Summary

Feed the Future Partnering for Innovation is a USAID-funded program that provides incentive-based grants to de-risk the upfront investments that are necessary to scale and market agricultural innovations for smallholder farmers. The program does this by facilitating partnerships with the private sector, which to date number 50 total partnerships.

This report is the result of a qualitative study across eight of these partnerships that are explicitly commercializing publicly-funded research. Interviews were conducted with nineteen researchers, company representatives, and others involved in the eight partnerships, as well as with five external experts.

The purpose of this report is to:

- Share lessons learned about commercializing innovative products, services, or technologies that were developed through publicly-funded research, based on Partnering for Innovation's eight partnerships referenced above.
- Help guide researchers at agricultural research institutions as well as donors seeking to similarly commercialize these products, services, or technologies in order to benefit smallholder farmers.
- Spark discussion and further research about commercializing products developed through publicly-funded research as a viable pathway for agricultural research to benefit smallholder farmers.

It is *not* a study of best practices across all known instances of commercializing publicly-funded research, but rather a starting point to spark discussion about good practices for ensuring that agricultural research innovations reach their intended end users, smallholder farmers.

Based primarily on lessons learned across the eight Partnering for Innovation partners, this report lays out eight success factors for commercializing products that were developed by publicly-funded research institutions. It is the result of qualitative research and interviews with various stakeholders.

The Eight Success Factors

1. Clearly define the role and funding of research institutions.
2. Address intellectual property from the beginning.
3. Ensure quality control.
4. Recognize that research is just one part of R&D. The development aspect also takes considerable time and resources.
5. View the smallholder farmer as a customer.
6. Appreciate the motivation of the researcher.
7. Value relationships and networking.
8. Involve the private sector in research early on.

The report concludes with a discussion of cross-cutting lessons learned around the common challenges faced by the eight partners, the role that donors and host governments play, and a series of recommendations for donors and leaders of research institutions. The five recommendations are as follows:

1. Develop structures and procedures to engage with the private sector on research early and at a strategic level.
2. Ensure that any donor funding allows for co-creation and co-development.
3. Strengthen linkages between research institutions, companies, and broader agricultural development programs with complementary interests.
4. Support the development and use of intermediaries to bridge the gap between researchers and businesses.
5. Design programs that recognize the financial and time horizon realities of commercialization.

Introduction

This report is designed for researchers and donors who are engaged in publicly-funded agricultural research and have developed innovative products, services, or technologies with the potential to benefit smallholder farmers. Drawing on the experience of Partnering for Innovation, a USAID-funded program, the report highlights success factors for commercializing publicly-funded research and illustrates these concepts through a series of case studies (found in Appendix 2).

The eight success factors are the result of a study to identify common success factors for commercializing publicly-funded agricultural research products, services, and technologies in smallholder markets, based on the experience of eight partnerships under the Partnering for Innovation program. Specifically, the commercialization process across the eight partnerships begins with the "hand-off" of the original research and/or product developed by a publicly-funded research institution to the commercializing entity (normally a business). These success factors can be grouped into three general thematic areas: defining the relationship with the company, understanding the company's value, and recognizing the human element.

As the program only supports innovations that are "off-the-shelf" and do not require further research, this report does not focus on the research phase. It starts at the point where the research has been completed by a publicly-funded research institution (such as Consultative Group for International Agricultural Research [CGIAR] Centers and public universities), and the decision to commercialize has already been made.

Feed the Future Partnering for Innovation

In order to increase productivity and income, smallholder farmers need access to appropriate and affordable technology and services. By developing public private partnerships that bring agricultural innovations and services to smallholder markets, Partnering for Innovation builds sustainable, market-based solutions to food security challenges around the world. The program manages 50 partnerships, eight of which are highlighted in this report for their work to commercialize publicly-funded research.

Purpose of the Study

Through the course of working with research institutions and companies, Partnering for Innovation learned about common challenges in building successful partnerships for commercializing publicly-funded research. With that in mind, **the purpose of the report is to:**

- Share lessons learned about commercializing innovative products, services, or technologies that were developed through publicly-funded research, based on Partnering for Innovation's eight partnerships referenced above.
- Help guide researchers at agricultural research institutions as well as donors seeking to similarly commercialize these products in order to benefit smallholder farmers.
- Spark discussion and further research about commercializing products developed through publicly-funded research as a viable pathway for agricultural research to benefit smallholder farmers.

This report is a starting point for further research rather than an exhaustive study of best practices across all known cases of commercializing publicly-funded research. Hopefully it sparks wider conversation to support the **U.S. Government's Global Food Security Research Strategy** that emphasizes a need for improved coordination between publicly-funded research results and technology scaling efforts[1] to ensure that the benefits of such research reach smallholder farmers.

Methodology

This work is based on lessons learned across eight partnerships where publicly-funded research was commercialized by private companies to benefit smallholder farmers. Data collection included review of secondary sources, and then a series of interviews with 24 individuals as follows:

Nineteen partnership representatives, of which:

- Seven out of eight partnerships are located in sub-Saharan Africa and one in Central America.
- Four of the partnerships involve a CGIAR Center, one involves a US university, and three involve host-country universities.
- All companies involved are based in the country or region in which they are marketing the products.

Five interviewees from outside Partnering for Innovation's partnerships:

- North Carolina State University professor and technology transfer office staff.
- USAID Bureau for Food Security and USAID Global Development Lab representatives involved in managing research.

A Partnering for Innovation program staff focus group was conducted following completion of interviews with the eight partners.

Four case studies resulting from the data collection can be found in Appendix 2.

A Brief Overview of the Commercialization Process

The purpose of this overview of the commercialization process is to provide a basic understanding of the process in order to put the eight success factors and four case studies in context.

Commercialization is the process by which products, services, and technologies are introduced to the market for purchase. From an international development perspective, this is an important pathway to providing smallholder farmers access to transformational innovations.

This report examines cases where research had already been conducted, within a research institution, and then handed off to a company to commercialize. The research phase is therefore not the focus of this report. Generally speaking, research is first framed as a problem or question to be answered through rigorous investigation. For some public-sector funding entities, the potential for

[1] See Nora Lapitan, (2017) *The U.S. Government's Global Food Security Research Strategy: Proceedings of the BIFAD meeting, September 12, 2017*. Washington, DC: APLU/BIFAD Public Meeting. : http://www.aplu.org/projects-and-initiatives/international-programs/bifad/Lapitan-GFS-Research-Strategy-Overview.pdf

commercialization, response to market needs, and/or relevance to the private sector are also important factors.

At a higher level, commercialization of publicly-funded agricultural research to benefit smallholder farmers has much in common with the commercialization of any product, service, or technology for the mass market. Sometimes, the entire commercialization process, from research to marketing, is conducted within a company. Because this study is focused on commercializing publicly-funded research, it assumes that the initial research was conducted by a public research institution.

It is also important to note that the process outlined below is not always linear and necessitates a fair amount of trial and error.[2] The specific details of any research-to-commercialization process will vary based on individual circumstances, and may be achieved through a mix of the below stages at any given time (e.g. a linear pathway through each stage may not occur). However, **the process can generally be described**, particularly for understanding the eight success factors as described below, as follows:

1 **Research**. The research institution (and its collaborators, if applicable) conducts research that ultimately leads to an innovative product, service, or technology that the researchers believe has the potential to be commercialized. This research may or may not have been conducted with the goal of commercialization in mind – depending on the requirements of the funder, mission of the research institution, and interests of the researcher.

2 **Product development process.** Generally speaking, the commercializing entity (usually a company), leads commercialization; however, research institutions may play a role in certain aspects. The development process includes a wide range of activities, including:

- Conducting market research (assessing demand, market potential, etc.)
- Designing and establishing processes and facilities to produce the product at scale
- Building a supply chain
- Determining distribution channels and related logistics
- Designing and implementing a marketing strategy (including customer segmentation and pricing strategy)
- Complying with regulations

What about farmer adoption in the commercialization process?

It must be understood that farmer adoption of technologies distributed through commercial channels is a separate, but related, issue within the commercialization process. Smallholder farmers are customers and their purchasing decisions impact the product's profitability and success.

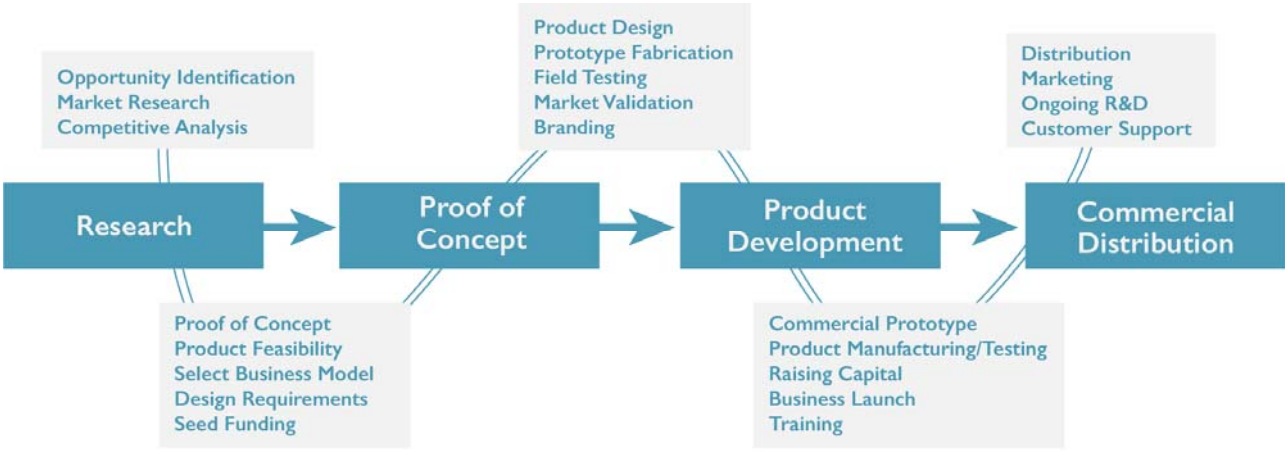
While the report does touch on aspects of responding to (smallholder) customer needs, it does not detail obstacles or incentives to purchasing goods or services from the farmer's perspective. Rather, the focus is on the interplay between the research institution and company, and processes internal to the company, for getting publicly-funded research commercialized.

[2] This can also be framed as "adaptive research," or testing of potential research and resulting products for their commercial potential.

3 **Commercial distribution.** If product development is successful, it ultimately results in a commercially viable product, service, or technology that can be made readily available in the marketplace. A product, service, or technology is said to be commercially viable, from the company's perspective, when it competes effectively with other, similar products and is profitable.[3] **These concepts and the unique challenges for smallholder markets will be discussed further in the main body of the report.**

The basic commercialization process discussed above, and illustrated in the graphic below, provides background for better understanding the specific success factors found across eight of Partnering for Innovation's partners. While it is not an exhaustive discussion of the complex commercialization process, it provides an understanding of how a research institution and a company can successfully work together to commercialize publicly-funded agriculture research.

Diagram 1: The details of the commercialization process vary on a case-by-case basis. However, in the experience of Partnering for Innovation, where research and commercial entities partner after research and some phases of product development have already taken place, the process has generally proceeded as illustrated in this simplified diagram. **The blue boxes denote major phases of the process. The white boxes are an illustrative list of activities undertaken by the commercializing entity. See Appendix 1 for more details.**



[3] Cambridge Business English Dictionary (2017). "Commercial Viability". Dictionary.cambridge.org

Success Factors

Based on this study of Partnering for Innovation's experience, and supported by the literature and outside interviews culminating in the attached case studies, eight success factors for commercializing agricultural research have been identified and are detailed in the following pages. As noted previously, the success factors are at the commercialization stage where the initial publicly-funded research, and in some cases preliminary product development, are already complete, and the decision to commercialize with a business partner has already been made.

About the Success Factors

Success factors one, two, and three below are interrelated and are critical to establishing the relationship between the research institution and the commercializing entity. These three success factors focus on the role of the research institution in the commercialization process[4], intellectual property issues, and ensuring quality control. It is important for researchers to carefully consider, and be upfront about, the kind of relationship they want to have with a company. Is this a one-time transaction to transfer technology? An ongoing supplier-client business relationship? The beginning of a longer-term collaboration on research and agricultural development projects? The company will have its own perspective as well, and this can be the basis for a conversation. The answer to these questions will influence how the research institution and company approach these three success factors.

The next two success factors, numbers four and five, highlight the role of the company in commercialization because, often, researchers believe that their work is "off-the-shelf" and therefore ready for commercialization with relatively minimal additional work on the part of the commercial partner. This is rarely the case. Most research innovations require a fair amount of additional development work from the commercializing entity before becoming viable.

At the same time, the (re)development process for commercialization purposes is often where a company's intellectual property and competitive advantage lies. Therefore, to the outside observer, their development process may seem like a "black box." For example, from the vantage point of the researcher, it can sometimes seem like a company is taking a needlessly long time to bring the result of their research to market. However, behind the scenes, the company is making a significant investment of resources – financial, time, and staff.

The final three success factors, numbers six, seven, and eight, focus on the role that individuals play in the process of "handing off" publicly-funded research for commercialization purposes. This is because the path to commercialization is long and winding, and generally takes highly motivated people to see it through and stay positive in the face of setbacks. Ultimately, these individuals are at the heart of any and all of the processes for taking publicly-funded research to commercial scale, resulting in promising products for smallholder farmers. Individual researchers, business executives, and staff members of both entities all play a critical role in successful commercialization. The final three success factors illustrate this theme.

[4] After the researcher has conducted high quality, rigorous scientific studies that resulted in a potentially commercial viable product that a company can bring to market.

Success Factor #1: Clearly define the role of the research institution as a resulting product is handed off to a company, including how its role is funded.

There are several roles that a research institution can play in the commercialization process, as well as several options for how its role is funded. Which role and what type of financial arrangement is most appropriate will vary depending on circumstances. Available options will also depend on the legal framework, policies, and capacity of the research institution. The size and internal capacity of the company will also be a factor. Additionally, roles can depend on the stage at which the research is and if significantly more research will be necessary to produce a marketable product. Roles also can evolve over time as priorities and options change (for example, see the first case study in Appendix 2).

Potential Researcher Roles in the Commercialization Process

Research institutions participating in Partnering for Innovation partnerships have played the following roles, which are elaborated on further in the below text: production of the final product in-house; licensor; supplier/service provider; and consultants.

Other possible roles, found in the literature, include spin-off/start-up companies (to which the research institution licenses the innovation and may sometimes own an equity stake), contract researcher (research funded by a company for a very specific purpose), or collaborative researcher (broader public private partnership on research).[5] These roles are not necessarily mutually exclusive and it is possible for a research institution to play more than one role simultaneously (licensor and consultant, for example).

- As a manufacturer/producer of a product: When a research institution opts to produce the products in-house, it assumes responsibility for much of the development process. While in-house production does allow the researcher to maintain control over the process, it can also stretch his/her capacity and that of the institution. It is unlikely that any one person (or research group) would have all the skills required to successfully commercialize a product (engineering, marketing, supply chain management, regulatory compliance, financial management, etc.). Larger, more diversified research institutions (such as universities) may have this expertise within other departments, but smaller or focused research institutions may not. However, even when theoretically possible, in-house production rarely occurs in practice as it can be challenging to fund and distracts researchers from core job responsibilities such as conducting research or teaching. Development also requires a significant financial investment, and research institutions may have more limited financing options available to them than a company would. However, maintaining the production in-house can help to meet educational (workforce development) or research (proof of concept) objectives – at least in the short term. Of the Partnering for Innovation partnerships, the University of Nairobi originally manufactured the BIOFIX product (see Case Study 1) in-house, and Zamorano University is currently manufacturing the NemaPower product (although it is using private companies as distributors). Zamorano sees the in-house production model as serving an educational purpose for students and allowing for continued research and refinement of the product. However, it has encountered challenges with the marketing strategy aspect as this is outside the team's area of expertise.

[5] Technically, there is an example of a spin-off company within the Partnering for Innovation portfolio; PICS Global is a spinoff from Purdue University. However, this company is essentially acting as a manager of the licensing process rather than producing the product or service itself.

- As licensor: Another option is for the research institute to serve as a licensor – authorizing a company to use the innovation, which then takes responsibility for commercializing it. Generally, a licensing agreement outlines the compensation, terms of use, length of the agreement, and customized terms such as who bears the costs of changes. Normally the licensing agreement is developed by the research institution because they are typically the originators of the innovation. A license is normally accompanied by some level of training or consulting to make sure that the knowledge is properly transferred, and such services can be short-term or long-term in nature. The University of Nairobi is currently using this licensor model (see Case Study 1 on BIOFIX) as is Purdue University (see text box on next page). For universities in the US, acting as licensor is the preferred option.[6] The CGIAR System generally does not act as a licensor, given the public good nature of its research, but can in some circumstances.
- As a spin-off company: When permitted by the research institution, a spin-off or start-up company can be a hybrid of the above two options. The research institution grants a license to the spin-off company in which the researcher can be involved in some capacity. The research institution may also take an equity stake. This opens the door to other options for addressing the financing and human resources needs for production, but allows the researcher to remain directly involved and exercise some influence on the process. The researcher would need to reach an agreement with his/her employer regarding conflict of interest and ethics considerations. This option may also be appropriate when it is clear that significantly more research will be needed to develop a marketable product, and/or it is a completely new innovation (as opposed to an improvement or variation on an existing product). Such instances require greater investment and risk-taking, and it may be difficult to attract an existing company to license an innovation at such an early stage of development.
- As a supplier/service provider: The research institution can opt to provide the commercializing company with a particular good or service. In the case of Partnering for Innovation partnerships, this is most commonly seen when the innovation being commercialized is a variety of planting material, and the research institution is providing the company with foundation seed (see Case Study 3 on cowpea and soya in Zambia, and Case Study 4 on StrigAway in East Africa). The research institution may also be contracted to provide related training or technical assistance to staff, suppliers, or customers. The supplier/service provider relationship can be short-term or long-term in nature depending on the company's longer-term strategy.
- As a consultant: The research institution, when taking on the role as a consultant to the commercializing entity, advises the company during the development process. Some examples from Partnering for Innovation include the International Livestock Research Institute (ILRI) advising Niji Foods on equipment design for animal feed processing or Purdue University advising PICS distributors on production and marketing strategy.

Potential funding for research roles in the commercialization process

A related issue to defining the role of the researcher is **how the research institution's role is funded**. Regardless of whether a short-term or long-term role is envisioned, the research institution will incur costs. The funding options available will largely depend on the policies of the research institution. Some have the capacity to offer a variety of options such as royalties, fee-for-service, project funding, or

[6] Litan RE, Mitchell L, Reedy EJ. (2017) Commercializing University Innovations: A Better Way. AEI-Brookings Joint Center for Regulatory Studies. Related Publication 07-16. May 2017.

sponsored research. Others will be more limited and may only be able to operate in a project structure (funded by international development donors, research grantors, or the private sector). It is important for researchers to understand the policies of their institutions and what options are available when entering into discussions with companies. For example, a company would need to know that the research institution's services are only possible because of a project that will end in a few years. That company would need to plan accordingly to build internal capacity such that the services would no longer be needed; find an alternative provider; or budget to pay for those services directly.

Deciding on a role and funding arrangement can be a complex process. Many larger research institutions have offices that are dedicated to these issues and can provide advice and support. Those with a lot of experience in commercialization have likely narrowed the list to a few preferred options that work best for them. In the case of the CGIAR Centers, options are particularly limited given the public good nature of its research and reliance on project funding for most of its work.

For smaller or less experienced research institutions, the advice of a neutral third party can be helpful to ensure that both sides (research institution and company) think through the issues and options. As an example of the latter, Case Study 1 highlights the role the British Council played in facilitating the licensing agreement between the University of Nairobi and MEA, a Kenyan fertilizer company, for the production of BIOFIX.

The case of Purdue University and PICS grain storage bags is an example of matching roles with funding sources. Purdue owns the patent for the PICS bags and has granted an exclusive license to a spin-off company called PICS Global. The company manages the sub-licensing process to manufacturers and distributors in a number of different countries. PICS uses short-term donor project funding to enter new markets. During the project term, the royalty fee is waived, giving companies the opportunity to test the product's market viability. Project funding supports the hiring of local business consultants who advise the company on product development issues such as production, supply chain, marketing strategy, etc. At the end of the project, the licensee begins paying royalties and project support for the consultants ceases. However, it is common for the companies to hire these individuals as staff or continue to engage their consulting services.

Success Factor #2: Address intellectual property from the beginning.

There are three key aspects of intellectual property to discuss from the beginning of any research institution-commercial company partnership for commercializing publicly-funded research:

1. The research institution's intellectual property and terms of its use.
2. The company's intellectual property and how it will be protected.
3. The implications for the researcher's ability to continue research and publications on this topic.

Across these three aspects of intellectual property, intellectual property discussions can become more complex if multiple research institutions were involved in the development of the innovation, the research institution and company are located in different countries, and/or the company is seeking to sell or produce the product in multiple countries.

The research institution's intellectual property and terms of its use

The researcher needs to **be familiar with the intellectual property policies that apply to his/her institution and work**. In the US, and most OECD countries, the research institution owns the intellectual property rights to innovations resulting from publicly-funded research. In other countries this policy varies, but for the universities involved in the Partnering for Innovation projects studied, all owned the intellectual property.

The researcher, in collaboration with the appropriate office at his/her institution, will need to **determine the nature of the arrangements with the company**. Within the context of this study, all of the institutions that owned the intellectual property rights to their innovations chose to retain those rights and either produce the product themselves (Zamorano) or license to others (Purdue, University of Nairobi). In some cases, it may be possible for a research institution to sell the patent outright, but no examples of that were found within this study. Universities that regularly engage in licensing will have standard agreements and policies. The agreements will set conditions for use, establish royalty structures (royalty-free agreements are also possible) and cover issues such as who owns the rights to any follow-on developments.

Companies will want to know if the licensing agreement is **exclusive or non-exclusive**. The options available will depend on local law and institutional policies. Companies will generally prefer exclusive licenses as this gives them a competitive advantage and safeguards their investment. However, this may not always be in the best interest of the research institution – for example if the company fails to commercialize the product within a reasonable amount of time or has a very limited geographical reach. Some will address this issue by specifying that the exclusive license is only for certain geographies or a specific timeframe. PICS has pursued the path of granting non-exclusive licenses. It does so with the intention of only granting one distribution license per country, but the non-exclusive arrangement gives PICS the ability to grant additional licenses if the first licensee is not able to achieve the desired results for sales or geographic reach.

CGIAR Centers are different because the results of their research are in the public domain as per institutional policy. However, there are still intellectual property issues to consider. Arrangements for planting material in particular can be complex. Varieties are normally released through national agricultural research institutions, which have their own policies on intellectual property. None of the companies

interviewed saw the public domain nature of the CGIAR's work as a drawback. However, most of the companies working with CGIAR Centers were doing so for planting material. It is common for seed companies to sell at least some varieties that are in the public domain as few small- or medium-sized companies have the resources to conduct their own breeding work for an entire product line.

It should be noted that under certain circumstances CGIAR Centers can enter into exclusive license agreements that are time bound and geographically specific. This option is not widely known or used though one notable example (outside the Partnering for Innovation framework) involves certain tropical forage grasses developed by the International Center for Tropical Agriculture (CIAT). The research institution has licensing agreements with companies such as Grupo Papalotla (a seed company based in Mexico) and Dow AgroSciences to commercialize these hybrids and cultivars. The financial terms of these agreements have not been publicly disclosed.[7]

The company's intellectual property and how it will be protected

Depending on the role the researcher will play, **the company may have concerns about its own intellectual property**. The literature points to the potential to lose confidential information as one of the main drawbacks for company involvement in knowledge transfer or commercialization with the public sector.[8] If the researcher is playing a consulting role, for example, or has required quality testing as a part of the licensing agreement, he/she may be exposed to proprietary information that forms an important part of the company's competitive advantage. The company may ask the research institution to sign a nondisclosure agreement or similar instrument to protect this information.

The implications for the researcher's ability to continue research and publication on this topic

It is important to have a clear discussion and agreement about the researcher's continued research and writing about a product transferred under a company's intellectual property. These issues must be considered at the start to avoid future conflict. The researcher and the company need to **understand the implications for future work** on the same topic. Can the researcher continue to conduct research on the same topic? If the researcher develops an improvement to the innovation, does the company automatically have the rights or first right of refusal? If the company develops an improvement to the innovation, who owns that? Is the researcher free to publish about his/her work with the company? These are all questions to address early on.

It should be noted that despite the best efforts to protect intellectual property, there is the risk that counterfeit products will be developed, or in the case of public domain research, that lower quality "copycat" products will emerge. Such products can undermine profitability and the reputation of the company's product. Although this was not an issue identified by Partnering for Innovation partners, it has sometimes been an issue in other projects.

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[7] Dow AgroSciences and CIAT (2011). Press Release. "Dow AgroSciences, International Center for Tropical Agriculture (CIAT) Enter into Research and Distribution Agreement: Grass Hybrids to Help Improve Livestock Productivity and Strengthen Global Food Security." And Dow AgroSciences (2010) Press Release. "Dow AgroSciences, Papalotla Enter into Tropical Grass Seed Agreement: Brachiaria to Help Latin America Ranchers Improve Livestock Productivity"

[8] Veuglers, R. (2013), "Industry science cooperation", *Workshop Presentation on Financing Knowledge Transfer in Europe*, Bologna, 11 June 2013; De Fuentes and Dutrenit (2012), "Best channels of academia-industry interaction for long-term benefit", *Research Policy,* Vol. 41, pp. 1666-1682. As adapted and extended in OECD (2013), "Policies to enhance the transfer and commercialization of public research" in Commercialising Public Research: New Trends and Strategies, OECD Publishing.

Success Factor #3: Ensure quality control.

One of the risks in commercialization is that the company will not produce a quality product. **A poor-quality product can pose a reputational risk to the research institution, and if the research institution owns the intellectual property, it can also pose a financial risk by lowering the value of the brand.** A problem with the company's processes can be misinterpreted as a problem with the innovation itself – either by consumers (farmers) or other companies that might otherwise be interested. This can result in the failure of a product to take off and make it more difficult for the research institution to pursue alternative options for commercialization. For some types of products, there could also be health and safety issues, and with smallholder farmer customers in particular, ethical concerns about encouraging the investment of limited resources on an ineffective or low-quality product. The company will have similar concerns on its side – as producing a low-quality product will not result in repeat customers and the company must comply with applicable regulations – thus creating opportunity for collaboration.

In Zambia, Good Nature Agro Products (Good Nature) and the International Institute of Tropical Agriculture (IITA) are partnering to commercialize improved cowpea and soy seed. Together with the Zambian Agricultural Research Institute (ZARI), they developed licensing agreements to arrange for the successful commercialization of the seeds. The due diligence required for ensuring clear licensing and roles/responsibilities can be time consuming, but ultimately builds an effective foundation for successful commercialization of seeds that benefits smallholder farmer productivity.

In Kenya, it took three years for the University of Nairobi and MEA, a Kenyan fertilizer company producing the rhizobium inoculant BIOFIX, to reach an agreement for commercialization. This process included developing a new approach to commercialization for the university – one that involved licensing the technology to another company instead of producing in-house. Ultimately, the parties agreed to a contractual arrangement whereby the university granted MEA an exclusive license to produce and sell BIOFIX in Kenya and a number of other countries in eastern and southern Africa. In return, MEA pays the university a royalty on net sales. The agreement also establishes the University of Nairobi as the supplier of the cultures for producing the inoculant, and commits the university to providing support on quality control and related staff training.

Case Studies 1 and 4 detail the above partnerships.

Quality issues will arise during the commercialization process

It is easier to control quality when producing a product in small quantities in a highly-controlled research or laboratory setting than producing on a large, commercial scale. As such, the researcher will need to develop realistic expectations for an acceptable level of quality when producing at commercial volumes.

When transferring the technology to a company, the research institution should seriously consider building in a certain level of quality training and assurance. This would include training company staff on quality control and testing, advising on solutions to quality issues, and perhaps periodic quality testing/inspection to identify issues and develop solutions. This is particularly important in the early years when the company is still working out how to produce the product, building internal staff capacity, and making frequent adjustments to the production process. As noted in the intellectual property discussion, companies are likely to want a nondisclosure agreement if the research institution is to play a role in this process. Different companies will have different abilities to build this capacity in-house.

When a research institution owns the intellectual property and is a licensor, it can include quality training, testing, and maintenance of a minimum standard as a condition in the licensing agreement. These services can be paid for either through the royalty payment structure or on a fee-for-service basis. In this case, failure to comply with minimal quality standards could lead to termination of the licensing agreement, and the company would lose the ability to continue producing and profiting from the product. Over time, this should become less of a concern as the company builds its internal capacity to manage quality control processes and seeks to maintain its brand image.

There can be some practical issues with the above technical assistance or quality inspection arrangements, however, if the research institution is not located near the company or has a large number of licensees to manage. When the research is in the public domain and no licensing agreement is used, as is often the case with the CGIAR Centers, requiring quality control measures is even more difficult. A company can simply commercialize the products as it deems best – and while the research institution can offer their services for quality control or training, it has little leverage to require that the company uses those services when the research is in the public domain. Ultimately the company will decide if it wants this service and when it is no longer necessary. However, in some cases, regulatory compliance may require some ongoing interaction with the research institution; for example, some countries require that planting material is certified as authentic and meets certain standards.

Different regulations apply to a company producing a product for sale than to a research institution producing a product for research purposes

Regulations help ensure that public health and/or safety concerns in regards to products and their uses. Depending on the country and the nature of the product, the research institution may play a role in regulatory approval processes. For planting material, countries normally have a set process for the release of varietals. Typically, this process is handled by the plant breeder's research institution, but in some circumstances, it may be the responsibility of the company that is commercializing it. If the product is completely new, it is possible that the appropriate regulations do not yet exist or are not fully formed. In these cases, the company and regulatory authority may call on the research institution to provide supporting information to address public health and safety requirements.

Success Factor #4: Recognize that research is just one part of R&D. The development aspect also takes considerable time and resources.

The development process includes a number of interrelated components that can be iterative, that are usually a part of a company's intellectual property, and that take time. These factors can make the development process, beyond the research institution's original innovations, very expensive. The process is not linear and involves a number of feedback loops, and a lot of trial and error[9]. Researchers and donors will benefit from appreciating the cost and complexity of commercializing publicly-funded research for a mass market.

Companies invest significant resources and take risks to develop products resulting from publicly-funded research

Even if a researcher or donor does not understand the development process, or have the purview to witness it directly, the development process takes significant investment on the company's part. It is also risky – the product could fail, and the company's investment would fail to pay off. **It can take years to get a product right and competitors could enter the market in the meantime.**[10] The seasonal nature of agriculture presents some additional challenges that can lengthen the timeframe. For example, if farmers normally plant seeds at a certain time of year, but the seed company's new equipment arrives just after that period, the company will have to wait until the next season to test market their new product. Then, if they want to make changes to the product or the marketing strategy, they will have to wait until the season after that to retest.

Companies must balance sale price with their investments to successfully cover development costs (and eventually earn profit)

To be commercially successful, the company needs to be able to bring the product to market at a price that is profitable for the company and that the customer is willing to pay. Smallholder farmers tend to be more risk-averse and more price-sensitive than larger, commercial farm customers.[11] With smallholder farmers in particular, this can necessitate several cycles of development processes to arrive at a price that is low enough for the smallholder to afford but still profitable for the company – raising development costs for the company even more. For example, since marketing costs could be high, the company looks for ways to lower the costs of production or distribution. As new production technology becomes available, this offers opportunities to lower costs. Although it was not mentioned as a factor in Partnering for Innovation partnerships, government subsidies for agricultural inputs can be a positive or negative factor depending on how they are structured. If the company's product is being subsidized, it can lower the price for the farmer without requiring the company to find ways to reduce its costs. However, if alternative or competing products are being subsidized, it can create a significant challenge as the company would have to be able to produce and sell at a very low price in order to compete. Linking with broader agricultural development programs can help to lower marketing costs by providing access to smallholder farmers who already have training and a basic knowledge of the value of a product such as improved seeds

[9] The specifics of what is involved will vary by the company and with the product, though the process can be generally understood to include: (re)developing the product; determining a feasible business model; designing the mass production process; establishing the production facility; building the supply chain; determining the distribution channels and related logistics; researching the market; developing and implementing a marketing strategy; and understanding and complying with regulations.

[10] Although it was not raised as a concern by those interviewed for this study, this could also include competition from counterfeit products that undermine trust in the product category.

[11] USAID (2015). Literature Review: Scaling Agricultural Technologies & Innovation Diffusion.

or fertilizer. Another technique is to link to other companies that are involved in the same value chain. For example, a seed or input supply company can work with a company that is buying the farmers' crop.

Companies face challenges in balancing the development of a supply chain, the product itself, and marketing

Universal Industries and its work to develop processed food products made using orange-fleshed sweet potatoes sourced from smallholder farmers is one such example. As the product is being developed and introduced, the company needs to carefully balance building an adequate (but not excessive) supply of ingredients, experimenting with creating new products (which may require adjustments in ingredients needed), and marketing the product (building demand, but not faster than the company can meet it). Raw material supply must be coordinated with demand growth in order to avoid either gluts or shortages of the product. Similarly, market forecasting, stocking, and inventory management also require careful balancing.

Companies have varying abilities to address all of the development issues in-house

Some have large R&D departments that are capable of doing much of this work entirely on their own. Others have more limited capacity and may draw on the expertise of the research institution or other external experts to provide assistance. Within the context of Partnering for Innovation partnerships, research institutions often play a role in training smallholder farmers who are suppliers or potential customers. This is sometimes done directly or by training the company's staff to carry out this work. Other common areas for research institutions' involvement are mass production (advising on design and/or assisting with related quality testing) and regulatory compliance (assisting with the process, providing data to regulators). Mass production (producing the product at a commercial scale) is often the most expensive aspect of the development process as it usually requires investment in a facility, equipment, and workers.[12]

Universal Industries Limited (Universal) worked with the International Potato Center (CIP) to identify orange-fleshed sweet potato varieties suited to Universal's product development needs. Originally, the varieties were developed with farmers' household consumption in mind. Identifying and producing the suitable varieties for food processing is a requisite step that must be considered as a part of the supply chain and product development processes.

Some of the orange-fleshed sweet potato varieties were not viable for use in Universal's recipes, and thus the company needed to work with CIP to identify a subset of its varieties for commercial use.

See Case Study 2 for the full story about the product development required to bring the research to market in the Universal-CIP partnership.

[12] Siminov A.P. (1998). "The Main Problems in Commercialization of Scientific Research Results" in Technology Commercialization: Russian Challenges, American Lessons. National Academy Press.

Success Factor #5: View the smallholder farmer as a customer.

Understanding the smallholder farmer as a customer for a product is different from interacting with the smallholder farmer as a participant in a research study or end user of a product. When researchers work with farmers to conduct research and test innovations, they are focused on proving the concept and testing if the idea works. In other words, the focus is generally on assessing the innovation and its ability to address a particular development challenge with farmers as participants in and/or beneficiaries of the research. **For commercialization to be successful, however, a shift in thinking is required.**

Understanding the customer

For the product to sell, a company needs to understand smallholder farmer needs and wants, and convince the customer that the product addresses those needs and wants better than alternatives. The customer will not buy the product simply because it is there or because the researcher has shown that it remedies the research question he/she set out to answer. While the researcher may incorporate some aspects of this thinking into his/her research, there is a definite shift in thinking during the commercialization process with the company seeing the farmer primarily as a customer[13]. Research institutions that work directly with farmers often have valuable insights that can assist companies in understanding their customer and developing their marketing strategies. For example, researchers likely have data on the extent of the particular disease or pest problem they are studying, or how many farmers are growing a particular crop. They may also have information on marketing challenges that the company is likely to face – such as what farmers will see as the alternatives to buying the product.

Universal Industry's vitamin A-fortified "Beta Crisps" are sold in national grocery retailers in Malawi.

Commercial strategies focus on segmenting customers given their unique contexts

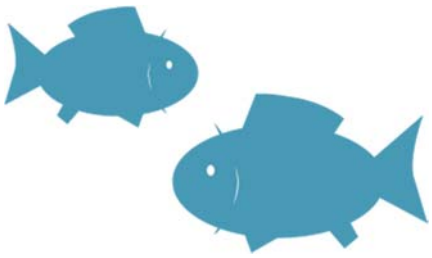
The company's marketing strategy will include information on customer profile, market research, and agricultural cycles.[14] It will look at potential sales growth areas and opportunities to aggregate demand. Partnering for Innovation has published a number of guides and tools on marketing to smallholder farmers that can be helpful to companies in this process. However, **companies often require a fair amount of trial and error to arrive at an effective approach for their particular market.** To market to smallholder farmers, companies normally have to use more hands-on marketing strategies with greater interpersonal contact, demo plots, and training in order to demonstrate the value of the product. It is common for companies to offer free samples or discounts as a way of persuading potential customers to try the product. This is a widely-used marketing technique and can be seen in both developed and developing markets for a variety of products. Sometimes companies also have to address other issues,

[13] While researchers can also think about the farmer as a customer during their research, there are some limitations. For example, assessing cost effectiveness and willingness to pay is difficult given that costs of production for research purposes are different from those for commercial purposes. It is also important to note that research that is commercialized does not always start out with that objective, and research may involve other aspects such as good agricultural practices.
[14] USAID (2015). Literature Review: Scaling Agricultural Technologies & Innovation Diffusion.

such as access to finance, to gain customers. As a result, marketing to smallholder farmers is generally more expensive with longer time horizons than marketing to larger customers.

Understanding customers is particularly important in developing country contexts because of the length of time it takes to achieve sales among smallholder farmers. Marketing products in developing countries also takes longer to be successful. Once a product in on the market in the US or Europe, it typically takes about six years to take off with a significant uptick in sales.[15] In middle income countries, such as Brazil and India, it takes about nine and 12 years, respectively.[16] Presumably it takes just as long, if not longer, in developing country contexts.

Establishing customer feedback loops



An important part of the development process is gathering continuous feedback from different customer segments. Partly for this reason, companies will sometimes choose to test market at least some of the product directly (rather than through a distributor) in order to have greater direct contact with customers. Companies often make adjustments to the product based on customer feedback. For example, MEA changed the packaging design for BIOFIX after customers noted that the packaging for two different products was too similar. Chi Farms started selling slightly larger juvenile catfish to farmers to improve survival rates, and companies producing StrigAway changed their production techniques after farmers noted low germination rates.

Chi Farms (Chi) is working with Partnering for Innovation to expand its capacity to produce high quality inputs for smallholder fish farmers in Nigeria. Based on its experience, the company noted that larger-scale fish feed customers normally base their purchasing decisions on price and availability. With other products available on the market, smallholder farmers value a positive relationship with Chi and rely on the company for technical assistance and training. Before buying inputs, farmers need to see the benefits of the product in action. The company has offered tours of its aquaculture operations and is temporarily offering smallholders the opportunity to buy at wholesale prices. The company also addressed financing issues to enable farmers to purchase its products and initiated a buy-back scheme to assure farmers of a market for their fish.

[15] USAID (2015). Literature Review: Scaling Agricultural Technologies & Innovation Diffusion.
[16] Ibid.

Success Factor #6: Understand the motivation, and the responsibilities, of the researcher.

All of the researchers interviewed for this study noted that they feel personal satisfaction beyond professional success when their research is commercialized for use among smallholder farmers. Many noted the improvements that they had seen in the lives of smallholder farmers as the result of their research. Similarly, the literature points to the main benefits for research institutions of engaging in knowledge transfer or commercialization are the opportunity to share information, develop new ideas, and access more resources. According to the same study, the drawbacks are limitations on publications, distraction from core work, and limited professional incentives.[17]

However, although all of the research institutions involved in this study have policies in place to encourage commercialization (or at least public private partnerships), and many have offices to support it, **most of the researchers interviewed felt that the bulk of the work fell to them.** Understanding their motivations can help researchers, their institutions, the companies they work with, and donors to design research processes that result in smoother commercialization.

Researchers manage the relationship with the company

While technology transfer offices can be helpful in navigating legal issues and providing general advice for working with commercial partners, the researcher ultimately "champions" and then manages the commercial relationship with a company. In the case of US universities, while technology transfer offices do offer a wide range of services, their company relationships and market knowledge tend to be more focused on the US, and more specifically, the state in which they are located rather than in developing countries where smallholder farmer research is carried out. Therefore, even more impetus falls on researchers to connect their potential products with a commercial partner for production and sales to smallholder markets.

Similarly, on the company side, having a champion who advocates for the idea and sticks with it through the challenges is important. This necessitates a commitment from the company's management to dedicate the necessary financial, time, and staff resources.

This does imply some risk if one of the highly motivated individuals – the researcher or the company representative – leaves the organization or moves into a new role. Several researchers mentioned the important role that a mentor had played in shaping their interest in commercialization, and noted the need to instill this thinking in others.

[17] Veuglers, R. (2013), "Industry science cooperation", *Workshop Presentation on Financing Knowledge Transfer in Europe*, Bologna, [11] June 2013; De Fuentes and Dutrenit (2012), "Best channels of academia-industry interaction for long-term benefit", *Research Policy,* Vol. 41, pp. 1666-1682. As adapted and extended in OECD (2013), "Policies to enhance the transfer and commercialization of public research" in Commercialising Public Research: New Trends and Strategies, OECD Publishing.

Research institutions and universities have varying incentives for researchers to engage in commercial partnerships

Some researchers mentioned that their university considers patents and commercialization as part of their performance evaluation or tenure consideration process, and offers recognitions and awards based on this. At other institutions, unless it was a requirement of a specific project, time spent on commercialization was seen as a distraction from core responsibilities to conduct research, publish papers, manage projects, etc.

Universities that license technology and receive royalty payments use these funds first to cover associated costs and then direct funds back to the researcher's department to support additional research or educational activities. In some cases, the inventor also receives a percentage of the royalty payments as personal income. However, none of the researchers interviewed noted this as a major source of financing or as a factor in their interest in commercialization.

In Zambia, Good Nature Agro Products produces seed varieties that were originally developed by the breeding program at the International Institute of Tropical Agriculture (IITA), a publicly-funded research center in the CGIAR system.

Success Factor #7: Value relationships and networking.

Of the Partnering for Innovation cases studied, all of the companies learned about the research innovation through **interpersonal communication.** This is further supported by the literature, which notes that, with the exception of pharmaceuticals, interpersonal communication (both conferences and informal exchanges) is the most common way that companies learn about research, with publications also playing a role.[18] This is reflective of current practice, and has some clear limitations.

Informal versus formal relationships in connecting researchers and commercial entities

In most cases, within the context of Partnering for Innovation, the company and the research institution had an existing relationship – whether formal or informal – prior to the start of the commercialization process. Formal relationships include working together on past projects (directly or indirectly) and company participation on advisory panels or stakeholder groups led by research institutions. Informal relationships include personal ties between former colleagues, or companies hiring graduates of a university. When available, entities such as accelerators, like business incubators or centers for innovation, can play a valuable role in connecting researchers and companies, and helping to bridge the gap between the language of science and the language of business. However, these entities tend to be focused on a specific geographic area, and may also have more specific functional areas of focus – targeting a few research areas/industries. Such entities are common at universities in the US and other OECD countries, but less common elsewhere.

Across the cases in this study, it was the research institution that informed the company of the opportunity, rather than the company contacting the research institution. In communicating with the company, it is helpful if the researcher has some basic information on the potential market. For example, some statistics on the extent of the problem that the innovation is addressing, number of farmers producing the crop, advantages over current solutions, affordability, etc.[19]. Ultimately, the company will conduct its own market research, but this information is helpful to spark interest and start a conversation.

Context matters for developing and nurturing partnerships between research and commercial entities

In some countries/sectors it is easier to identify potential private sector partners than others. For example, in Malawi, Universal Industries is well-known as a major food company that makes potato-based products. From the International Potato Center's perspective, it was an obvious company to approach for its work on Irish potatoes and later sweet potatoes. For PICS Global, it has at times been more difficult, as potential manufacturers or distributors of its bags are not necessarily household names, and in some countries, there are few trade shows or other networking events at which they are present. PICS Global works with its local business consultants and conducts its own research to identify potential business partners and

[18] Litan RE, Mitchell L, Reedy EJ. (2017) Commercializing University Innovations: A Better Way. AEI-Brookings Joint Center for Regulatory Studies. Related Publication 07-16. May 2017.

[19] More and more researchers are integrating market assessments into their studies, which can help development knowledge that helps facilitate private partnerships to commercialize publicly-funded research. For an example of the type of market information helpful for "making the case" for a company to invest in product development for a mass market, see J. Anderson, C. Marita; D. Musiime; M. Thiam (2017). "National Survey and Segmentation of Smallholder Households in Nigeria." CGAP blog: http://www.cgap.org/publications/national-survey-and-segmentation-smallholder-households-nigeria. See also CGAP (2016). Segmentation Tool Kit: http://www.cgap.org/publications/customer-segmentation-toolkit.

conduct personalized outreach. It should be noted that the business model used for commercialization has some implications for the likelihood of success and level of involvement required by the research institution. Generally speaking, larger companies will have greater capacity to solve problems and control quality on their own, while smaller companies will require greater assistance during the technology transfer process. In deciding which company to work with, the research institution should consider the company's capacity to produce and sell a quality product, and weigh that against the research institution's ability to provide the required level of technical assistance.

The relationship can be tested as the commercialization process gets underway

As discussed in the first three success factors above, setting the stage for a commercialization relationship that includes researchers and commercial entities is very important. It is because when these aspects are not properly thought through, it can lead to tensions or misunderstandings later – thus testing the relationship as the work moves forward. For example, if the company views the research institution as the supplier of a particular good or service in the near-term while the research institution sees potential for a long-term partnership, the expectations may lead to disappointment by both parties.

Additionally, for researchers, their studies can often become their "life's work." While they are happy that a company sees the value of their work and that it will ultimately benefit smallholder farmers, it can also be difficult to let go of something that has been the focus of their career. The researcher is giving up control and watching as someone else does things differently. Several researchers interviewed spoke about the challenges of letting go and the need to remind themselves of the end goal. This can also test the "health" of the relationships with a private sector partner for getting the research innovation market ready.

Success Factor #8: Involve the private sector in research early on.

Involving the private sector early on builds a collaborative relationship between research institution and company, and produces research that is more readily commercialized as it responds to particular challenges or needs. Research institutions, particularly those with a "research for development" objective, often focus on the farmer as the main stakeholder or constituent. While farmer perspectives are of great value and are an essential part of agricultural research, they are different from food and agricultural companies' perspectives.

Many of the researchers interviewed for this study noted that they wished they had involved the private sector earlier, and this sentiment was echoed by a USAID Bureau for Food Security survey of US universities leading Feed the Future Innovation Labs[20]:

Donors drive researchers to connect their work with "scaling" that work, including through commercial means, to smallholder farmers

All of the CGIAR Centers interviewed mentioned that private sector partnerships and/or value chain approaches are now expected by donors. While US public universities often have collaborative relationships with the private sector, these tend to be either large US/multinational companies or companies based in the state where the university is located. In the context of the Feed the Future Innovation Labs, they have noted the importance of engaging with host country companies that have the capacity to reach that country's smallholder market. There are different forms that private sector involvement can take, both formal and informal. At a higher level, advisory boards or stakeholder groups can provide a forum for companies to share their perspectives on the bigger picture issues that they see and provide input on the strategic direction of research. At a more technical level, they can provide feedback on the direction of the market and feasibility. Engagement can be a relatively low-cost, informal exchange of ideas, or a more formally funded contract or collaborative research program.

Breeding is an area that particularly benefits from early commercial feedback

Typically, breeders will focus on farmers and what traits they find desirable such as yield, resistance to pests and diseases, and suitability to local growing conditions. However, unless the farmer is producing for household consumption only, there are other perspectives to consider. Consumers will have expectations for taste, physical appearance, and cooking properties. Companies will consider aspects such as shelf-life and physical attributes that impact transportation, storage, and processing. They normally also have insights into consumer preferences as a result of their market research and experience. Ultimately, the breeder needs to balance these perspectives. Case Study 2 (on orange-fleshed sweet potatoes) highlights the role and importance of company feedback in breeding programs.

[20] The Feed the Future Innovation Labs, of which there are 25 listed as of this writing, each create a theory of change that includes an "impact pathway" for how their research will ultimately affect people and livelihoods. See CIP (2011). "Participatory Impact Pathways": https://cipotato.org/impacts/participatory-impact-pathways/.

Lessons Learned and Future Considerations

In addition to the success factors, there are four broader lessons learned from the experience of researchers and company representatives interviewed for this study. These are cross-cutting themes that are touched on with the context of the individual success factors, and lead to recommendations for future consideration.

Lessons Learned

- **Companies should play the leading role in commercialization.** Research institutions or other organizations play supporting roles, but companies need to take the lead when the innovation passes from the research phase to the development phase. Companies have the expertise to plan, budget, and finance this work and know what is realistic for their company to achieve. It can be tempting for research institutions and other organizations to lead the design in the context of pursuing donor funding, but they lack the companies' experience and expertise and can design processes and timeframes that are unrealistic. Ultimately, it is the company that will decide whether or not the product is commercially viable.

- **Donor and/or host government funding plays an important role in commercialization to benefit smallholder farmers.** This support can be direct or indirect. In terms of direct support, this public funding plays a role in the hand-off between the research institution and company (particularly when the innovation is in the public domain) and/or in financing parts of the company's development work (supply chain, mass production, marketing, etc.) needed to produce the product at a price the smallholder farmer can afford.

  In terms of indirect support, broader agricultural development programs that include training, technical assistance, and other services to smallholder farmers provide a vehicle for companies to work with a smallholder supply chain or smallholder customer base that already has a certain level of knowledge and can be more easily reached. For example, it will be easier to sell certain varieties of seed to farmers who already recognize the advantages of buying improved seed in general. In this way, the program is helping to build demand for the product and linking farmers to suppliers. Additionally, host country governments play an important role on the policy and regulatory front. A well-resourced and efficient regulatory process facilitates commercialization while protecting consumer interests, while an under-resourced or inefficient process creates bottlenecks and inhibits commercialization.

- **There is often a communication barrier between researchers and company representatives.** Researchers and businesses bring different perspectives, motivations, and objectives. While they can, and do, come together around common issues, they often struggle to effectively communicate with each other and understand the other's perspective. Research is often driven by intellectual curiosity and the pursuit of knowledge, while business is market-driven. Academic freedom allows researchers to pursue their preferred course of research and work on long-term horizons; companies need to focus on the most practical course of action and work on shorter time horizons.[21] The involvement of a third party (such as a donor, NGO, consultant in a

[21] Aghion, Philippe et al. (2010). "The Public and Private Sectors in the Process of Innovation: Theory and Evidence from the Mouse Genetics Revolution." American Economic Review 100.2 (2010):153-158.

project context, or incubator) or an internal expert (such a professor from the university's business school or a company's research department) who understands both perspectives can be helpful to bridge the gap.

- **Commercialization is an ongoing process that requires a long-term view.** It is not a short-term project, although short-term project funding can play a role in advancing specific aspects. It takes years to get it right – eight to ten years was common for partners examined in this study. As new mass production or marketing technologies become available, or the market changes, companies will revisit their processes. To stay competitive and grow, companies need to be continually improving upon existing products, developing new ones, and/or pursuing new markets.

Future Considerations for Donors and Leaders of Research Institutions

- **Develop systematized structures and procedures to engage with the private sector on research early and at a strategic level as part of the R&D process.** Companies should provide input into strategic priorities for both basic and applied research – even if there is no immediate potential for commercialization of results. This should be done at both the donor and research institution level. Such engagement can take the form of more formal, standing advisory boards or less formal, ad hoc stakeholder convenings for input on the design of specific programs. Such structures are already common practice in research targeting the US agricultural sector. Trade associations or other industry groups can assist in convening the companies and/or representing the consensus view. Keep in mind that different companies within the same industry will often have different views. The perspective of a large, multinational company with diverse business offerings will be different than that of a company that focuses on one country or a specialized product line.

- **Ensure that donor funding allows for co-creation and co-development.** Donors that plan to support research with the intention of commercialization and/or to support commercialization directly, should engage with companies during the design phase. Ultimately, commercialization needs to be company-led, and companies can provide valuable input on realistic timeframes and processes, key challenges, and the most impactful use of donor funds. Co-creation and co-development processes that allow for early, direct engagement between donors, research institutions, and companies should be utilized whenever possible. If the intention is to support commercialization directly, the company should play the leading role in managing the project.

- **Strengthen linkages between research institutions, companies, and broader agricultural development programs with complementary interests.** As noted earlier in this report, such programs provide a vehicle for companies to more easily reach a potential smallholder customer or supplier base with the innovations they are commercializing. Research institutions can benefit from the opportunity to engage directly with farmers on their research, and farmers can benefit from access to the latest research information. Donors and host governments have an important role to play in facilitating such linkages.

- **Support the development and use of intermediaries to bridge the gap between researchers and businesses.** These intermediaries help to facilitate partnerships, address communication barriers, and work out mutually agreeable terms on roles, intellectual property, and compensation. Such intermediaries can take several forms. It is common for US (and many OECD countries) universities to have entities such as accelerators, incubators, science parks, etc.

that serve this purpose, but they tend to have the greatest expertise on local or national (rather than international) opportunities. Donors should consider supporting the development of similar entities that would be affiliated with CGIAR Centers and/or Feed the Future Innovation Labs, for example. In the case of the Feed the Future Innovation Labs, such an entity could complement the lead universities' centers with country- and sector-specific expertise. Alternatively, intermediaries can be independent third parties with no direct role in the commercialization process. Partnering for Innovation has played this role, as has the British Council (see Case Study 1 on BIOFIX).

- **Design programs that recognize the financial and time horizon realities of commercialization.** When supporting research for which commercialization is the desired outcome, donors should build in funding support for technical assistance and the costs associated with initiating this process on the research institution's side – and recognize the time required to achieve the desired result. It cannot be assumed that promising innovations will be commercialized without further effort to engage with companies. When donors are supporting commercialization more directly (such as support for aspects of the company's product development processes), it is important to understand the bigger picture and how shorter-term project funding will fit into a broader, longer-term process. Project design should consider the trial-and-error nature of commercialization and be flexible to accommodate the unexpected.

This report is intended to provide a starting point for researchers at publicly-funded research institutions to think about commercialization and engage with company partners. Based on the experience of Partnering for Innovation, the report identifies success factors around the themes of defining the relationship with the company, understanding the company's value and perspective, and appreciating the human element. Commercialization is an important pathway for ensuring that smallholder farmers ultimately benefit from publicly-funded agricultural research.

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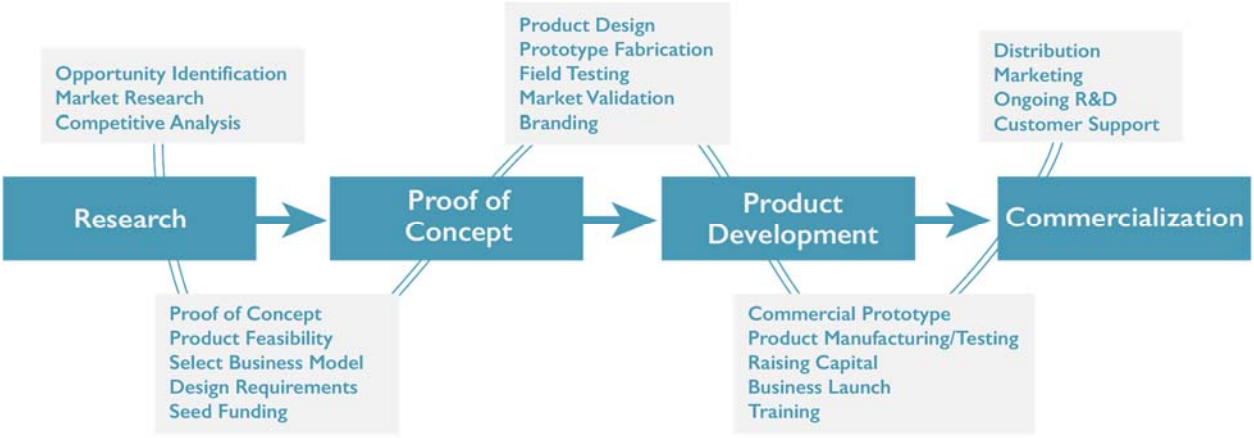
Appendix 1: Commercialization Steps, Definitions

The below graphic is a general overview of a basic research to commercialization process for the purposes of contextualizing the handoff between research by a research institution and a separate, usually business, entity for commercialization, as demonstrated by the cases studied for this report. **It is not intended to be an exhaustive explanation of the processes of research to commercialization.** Details of any research to commercialization process vary on a case-by-case basis and are often highly iterative, and not necessarily in order from left to right as in the below graphic. For example, if one entity is researching, developing, and commercializing products it could be that multiple products are developed from any round of research at any given time. **More information can be found in business cases and textbooks, and individual steps often have dedicated research in and of themselves.**

The diagram below represents the general experience of Partnering for Innovation, as do the definitions that follow. The blue boxes denote major phases of the process and the white boxes are an illustrative list of activities undertaken by the commercializing entity.



Research:

- *Opportunity Identification*: Identifying a potential research question to shed insight or even solve an agricultural development challenge with a product, service, or technology innovation.
- *Market Research*: Answering research questions about market trends and consumer preferences.
- *Competitive Analysis*: Identifying potential "competitors" to researching agricultural challenges or developing products to solve them.
- *Proof of Concept*: To provide verification that an initial concept, method, approach, product, service, etc. will eventually be put into practice or use.
- *Product Feasibility*: To assess whether a proposed concept, method, approach, product, service, etc. will be practically realizable.
- *Select Business Model*: Planning for what type of business model will best create value, sales, and profit for a new product or service; usually based on market research.
- *Design Requirements*: Documentation of the minimum physical and functional needs of the basic product/service design to perform its purpose.

- *Seed Funding*: Identify and secure funding for limited production or manufacture of a new product or service, usually to test its market readiness and to make adjustments based on market response.

Proof of Concept:

- *Product Design*: Designing initial product models.
- *Prototype Fabrication*: Manufacturing initial product models.
- *Field Testing*: Testing initial product models in real-life situations with potential customers.
- *Market Validation*: Verifying, through field testing, that the initial product model is viable for mass market sales. Sometimes includes adjusting or reconfiguring product design.
- *Branding*: Assigning a particular name to the product for marketing and sales purposes.

Product Development:

- *Commercial Prototype*: The final product/service prototype that matches all requirements including for branding.
- *Product Manufacturing/Testing:* Testing and finalizing the product/service for mass market distribution and sales.
- *Raising Capital*: Identifying and increasing funds for covering manufacturing and other costs related to products and services.
- *Business Launch*: Formal designation of an operational product line or business.
- *Training*: The process of teaching the workforce to understand and sell products/services.

Commercial Distribution:

- *Distribution*: Developing and maintaining commercial distribution channels, or modes, for delivering products and services to end consumers.
- *Marketing*: Strategies and channels for raising awareness and interests from potential customers about products and services.
- *Ongoing R&D*: Ongoing research and improvements to products and services to improve sales and profit.
- *Customer Support*: The provision of information and knowledge to customers on the use of the product or service.

Appendix 2:
Partnering for Innovation Case Studies of Commercializing Publicly-Funded Research

Case Study 1: BIOFIX in Kenya

Developing Sustainable Partnerships

INTRODUCTION

BIOFIX is a rhizobium inoculant for use with leguminous crops that naturally increases the plants' capacity for nitrogen fixation. It serves as a lower cost, organic product that can be used as an alternative to nitrogen fertilizer. BIOFIX is marketed to smallholder farmers in Kenya and other countries in East and Southern Africa. BIOFIX was originally developed by researchers at the University of Nairobi and is currently produced and sold by MEA Ltd., a Kenyan fertilizer company. This case study focuses on the development of the partnership between MEA and the University of Nairobi including some of the initial challenges faced in beginning production for domestic and international markets.

KEY TAKEAWAYS FOR SUCCESS

- Clearly define the role of the research institution and an appropriate funding mechanism.
- Address intellectual property from the beginning.
- Donor funding can mitigate start-up costs while refining mass production techniques.

THE PATH TO COMMERCIALIZATION

Researchers at the University of Nairobi, a public university chartered in 1970, first developed BIOFIX in the early 1980s as the result of previous efforts to collect valuable microorganisms and the desire to develop alternatives to imported, more expensive inorganic fertilizers. This was one of the university's first innovations with commercial potential, and it decided to produce and market the product in-house based on the idea that this would maximize the financial benefit for the university. However, the university had limited capacity to do so. Efforts were made to introduce the product to farmers through trade fairs, exhibitions, and other means, but without a nationwide distribution network, farmers could only purchase the product by going to Nairobi and buying it on campus. As a result, the impact of this first commercialization attempt was limited in terms of distribution, market penetration, and financial returns.

In 2003, the British Council approached the University of Nairobi about participating in its Africa Knowledge Transfer Partnership initiative, which sought to build stronger connections between universities and the private sector. BIOFIX was one of the promising technologies identified for this initiative. The British Council organized some networking events to bring together researchers from the university with private companies. MEA was one of the companies in attendance and showed interest in BIOFIX as a complementary product to an existing line of products.

It took three years for the University of Nairobi and MEA to reach an agreement for commercialization. This process included the development of a new approach to commercialization for the university – one that involved licensing the technology to another company instead of production in-house. Ultimately, the parties agreed to a contractual arrangement whereby the University of Nairobi granted MEA an exclusive license to produce and sell the product within Kenya and a number of other countries in East and Southern Africa. In return, MEA pays the university a royalty on net sales. The agreement also establishes the

University of Nairobi as the supplier of the cultures for producing the inoculant, and commits the university to provide support on quality control and related staff training. This licensing and royalty arrangement allows for sustainable funding for the ongoing involvement of the university.

ADDRESSING CHALLENGES

- **Adjusting to Mass Production**: Following the signing of the licensing agreement, MEA established a laboratory and production facility to produce BIOFIX on a commercial scale. After beginning production in the new facility, several issues became apparent: 1) the production capacity was insufficient to meet demand; 2) the layout was not efficient, requiring workers to move back and forth between different areas; 3) this movement was creating quality control problems by increasing the risk of contamination. Funding from Partnering for Innovation helped MEA to invest in new production technology that is more efficient and produces at higher capacity. This upgrading also provided the opportunity to reconsider the layout of the facility to reduce quality control risks. The University of Nairobi provides training on quality control to MEA staff and also conducts periodic quality inspections.

- **Developing Regulations for Export:** The product already had the proper regulatory approvals for production and distribution within Kenya, but policies and procedures for certifying a biofertilizer for export did not exist. MEA, with support from the University of Nairobi, worked with the Kenya Plant Health Inspectorate Services (KEPHIS) to develop the appropriate regulations, accreditation, and inspection processes to certify the product for export. This process started in 2009 and was only completed in 2015. The importer obtains an import permit from its country's government and KEPHIS then approves the shipment of BIOFIX for export and issues a phytosanitary certificate.

LESSONS LEARNED

- **Know when to seek partnerships with others.** Working with a private sector partner allows for the successful commercialization and wider spread of a technology. The researchers noted the great personal satisfaction that they felt in knowing that their research was having a positive impact on smallholder farmers. This would not have been achievable had they continued to produce in-house. The researchers also noted that the university now encourages collaboration across departments, which represents positive institutional change that fosters interdisciplinary collaboration – an important ingredient for fast partnership identification and benefits.

- **It takes commitment.** Successful commercialization takes a long time and requires considerable upfront financial investment in equipment, personnel, and marketing. There is a certain amount of trial and error involved, and it requires a commitment from management to continue to support the process and work through any issues. Having a champion, both within the company and the research institution, is important to persevering through setbacks and challenges.

Case Study 2: Orange Fleshed Sweet Potato in Malawi

What Comes First – The Supply Chain or the Market?

INTRODUCTION

Universal Industries Limited (Universal) is manufacturing and selling a number of products made with orange-fleshed sweet potato. The varieties of sweet potato were developed by the International Potato Center (CIP – a CGIAR Center), and Malawi's Department of Agricultural Research Services (DARS). These sweet potato varieties are high in beta carotene, which becomes vitamin A when metabolized, and are grown by smallholder farmers. Products are marketed to retail customers and other food businesses. This case focuses on product development required to bring the research to market.

KEY TAKEAWAYS FOR SUCCESS

- Involve the private sector in research.
- There are multiple levels of "customers" to consider in agriculture – farmers, processors, companies, manufacturers, retail, and consumers.
- Recognize the complexity of developing a supply chain, product line, and market simultaneously.

THE PATH TO COMMERCIALIZATION

In Malawi, sweet potato is traditionally grown by smallholder farmers for household consumption. From 2009, CIP and DARS started implementing projects that bred and released several varieties of orange-fleshed sweet potato and supported farmers in improved production techniques. CIP found that farmers were reluctant to invest in improved planting material and other inputs when producing for their own consumption, and that simply following improved practices led to a surplus in production (relative to household needs). CIP decided to seek out a private sector partner to provide a market for the surplus crop.

CIP generally takes a value chain approach to its projects and often includes some form of public-private partnership in its activities. As an already established processor of Irish potato in Malawi, Universal was a natural partner for CIP to approach. As such, CIP had a relationship with Universal from a project related to Irish potatoes, and they decided to approach Universal about this opportunity with sweet potato. At the time, Universal was looking to expand its line of healthy/nutritious products, and saw the high vitamin A content as a positive factor.

CIP agreed to support the development of the supply chain by building the capacity of nurseries to produce the improved planting material and providing training to farmers on production, quality control and storage. CIP provided some support to Universal from its food science and technology experts on issues related to processing. The sweet potato varieties are in the public domain. Although Universal is currently the only processing company in Malawi working with orange-fleshed sweet potato, the arrangement is not exclusive.

ADDRESSING CHALLENGES

- **Selecting and promoting varieties that meet processing needs.** The original CIP-DARS breeding and selection program was designed with farmers in mind as both the producers and

consumers of the crop. However, when sweet potato is used in food processing, other factors come into consideration depending on the specific product. Factors such as fiber and dry matter content become important as they impact the manufacturing process, and factors such as color and taste are important for consumer appeal. As Universal worked to develop new consumer products using sweet potato, they realized that certain varieties worked better than others for each product, and that some varieties were not suitable at all. They fed this information back to CIP to ensure that CIP would focus on promoting varieties to farmers that Universal was willing to buy. CIP now seeks to incorporate such feedback earlier in the breeding process prior to release.

- **Developing a supply chain.** Although there was a surplus of sweet potato production relative to household consumption, the supply was still limited relative to the minimum requirements for commercial-level processing. In order to develop and market a line of processed sweet potato products, Universal would need a reliable, quality supply at an appropriate volume. To further complicate matters, Universal would need different quantities of a number of different varieties. Furthermore, sweet potato production is highly seasonal and only available at certain times of the year. CIP helped to build up production and address quality and storage issues, and over time Universal was able to develop buying relationships and engage with farmers more directly. Maintaining reliable, consistent volumes has been a challenge. In some years, production is inadequate and in others it exceeds demand. Currently, the supply chain is based on smallholder farmers, but this could change in the future if demand continues to increase and larger, more commercial farming operations choose to enter the market. Such farms would have an advantage in their ability to invest in irrigation and other systems that could extend the production season.

- **Building the market.** In Malawi, sweet potato is generally seen as a staple food for the rural poor. In trying to develop and market processed products to the broader population, Universal had to overcome that perception. It was important that the first product launched be of high quality and broad appeal, and sweet potato crisps were developed as an initial consumer product. However, the company sees potential in selling sweet potato-based alternatives to bakery businesses. Bakeries must first make the decision to invest in experimenting with adjustments to their recipes. These customers also must be assured of the reliability of supply – that they will be able to buy the product when they need it, at the volumes they need, and to a consistent quality standard.

LESSONS LEARNED

- **Involve the private sector in research as soon as possible**. Farmers are a key component of an agricultural value chain and their needs are important, but if their crop is ultimately being sold to a company, the company's needs also merit consideration. A company will buy only when the product meets its standards and delivery expectations.

- **The private sector needs to lead commercialization.** New product development takes considerable time and investment from companies, and ultimately must meet business objectives to be successful and sustainable.

Case Study 3: Seed Production in Malawi

Commercialization as a Continuous Process

INTRODUCTION

Good Nature Agro Products (Good Nature) is a company in Zambia that produces seed through a network of smallholder outgrowers and markets seed to smallholder farmers. They are producing varieties of cowpea and soya that were originally developed by the breeding program at the International Institute of Tropical Agriculture (IITA), a publicly funded research center in the CGIAR.

This case study highlights challenges in the supply chain and market development processes, and the potential for longer-term collaboration with public research institutions.

KEY TAKEAWAYS FOR SUCCESS

- Address intellectual property issues from the beginning.
- Value relationships and networking.
- Involve the private sector in research.
- Commercialization is an ongoing process that requires a long-term view.

THE PATH TO COMMERCIALIZATION

Good Nature was actively seeking new sources of quality foundation seed. The company was aware that the varieties it was producing were originally developed by IITA, and it was familiar with IITA's work with farmers on agronomic practices from previous interactions through another USAID project. Ultimately, Good Nature decided to work with IITA as a source of foundation seed for improved varieties of cowpea and soya, and as a provider of technical assistance.

IITA developed the improved varieties jointly with the Zambian Agricultural Research Institute (ZARI), and as such within Zambia the intellectual property rights and naming rights are with ZARI. Good Nature obtains the foundation seed directly from IITA, and has a licensing agreement with ZARI and pays it royalties. The license is for a five-year period with royalties calculated as 2.5 percent of gross sales. As these particular varieties were already released, the arrangement with ZARI is not exclusive.

In addition to supplying the foundation seed, IITA also provides training to Good Nature staff who are responsible for seed inspection and extension services (with a focus on integrated soil fertility management and participatory variety selection). IITA also advises on best practices for Good Nature's foundation farm and the scaling out of soybean and cowpea varieties through demonstration plots.

ADDRESSING CHALLENGES

- **Developing a cost-effective supply chain.** Originally, the foundation farm was labor-intensive and therefore relatively costly to operate. Investment in farm equipment such as a tractor and adoption of improved practices helped to increase efficiency. Good Nature is a social enterprise that focuses on smallholder farmers as both suppliers and customers. At the beginning, building a smallholder-based supply chain requires investment in staff training and intensive outreach and training for

outgrowers, which Good Nature provides through an internal extension service. There is a great deal of variability in the production capacity of different outgrowers. Partnering for Innovation is supporting the expansion of Good Nature's private extension service, but the model is designed to be self-sustaining in the long-run.[22]

- **Competing in the marketplace.** Good Nature conducted its own market research and identified varieties of cowpea and soya that would appeal to its target market – both the farmers who would buy the seed and the end users who would buy the farmers' crop. Cowpea production in Zambia is currently relatively low, but Good Nature believes that there is an opportunity for growth and is promoting its production. The soya sector is sizeable and the seed market is competitive, although Good Nature believes it has some advantages in the varieties it offers and the packaging required to appeal to smallholder demand. Developing linkages with donor or government programs is a helpful vehicle to expose more farmers to the benefits of using improved, purchased legume seed (as opposed to saving their own) at the appropriate intervals. The company also looks for existing distributors with a wide reach and geographical presence. Partnering for Innovation is assisting with the marketing strategy to reach smallholder farmers.

- **Future research and product development.** To stay competitive, Good Nature would like to offer some unique products that are exclusive to the company. With a better understanding of the practical and legal aspects of the breeding and commercialization process in Zambia, Good Nature is now well-positioned to play a more active role. Based on its market research and direct experience with farmers (as suppliers and customers), it can provide feedback to IITA on desirable and undesirable traits to incorporate into the breeding process. It can then partner with IITA and ZARI to pay for the field testing and other processes legally required for release, and then acquire an exclusive commercial license for those particular varieties.

LESSONS LEARNED

- **Commercialization is an ongoing process.** To stay competitive in the marketplace, companies need to continuously develop new products and/or improve on existing ones in order to maintain and expand their market share. Particularly in the seed business, public research institutions and their breeding programs play an important role in this process. Regular communication with the research institution on customer feedback and desired traits helps to ensure that new varieties will be developed to respond to market needs.

- **Strong relationships and partnerships are important from a business perspective.** Look for research/commercial partners with complementary skill sets and capabilities. Partnerships with research institutions complement companies' internal capacity for R&D and staff training. Developing relationships with agricultural development programs can more effectively expand market reach and help to grow the initial smallholder customer base. Similarly, commercial relationships with distributors and large buyers of farmers' crops helps to increase market reach and ensure that the product is meeting both the needs of the smallholder farmers and those of the buyers of their crops.

[22] Further details on the sustainability design can be found online: www.goodnatureagro.com

Case Study 4: StrigAway in East Africa

The Role of Quality Control and Customer Feedback

INTRODUCTION

StrigAway is improved maize seed that is tolerant to the herbicide Imazapyr (a product produced by the chemical company BASF) and is coated with this herbicide to prevent infestation by the parasitic weed Striga. StrigAway is being commercialized by seven seed companies in Kenya, Tanzania, and Uganda with technical assistance provided by the African Agricultural Technology Foundation (AATF), a not-for-profit organization. This case study focuses on the importance of building quality assurance and risk management into the commercialization process, and of responding and adapting to customer feedback.

KEY TAKEAWAYS FOR SUCCESS

- Clearly define roles and responsibilities.
- Incentivize quality control.
- View the smallholder farmer as a customer.
- Recognize that research is just one part of R&D. The development aspect also takes considerable time and resources.

THE PATH TO COMMERCIALIZATION

In the late 1990s, BASF licensed an Imazapyr-resistant gene it had identified and patented to the International Maize and Wheat Improvement Center (CIMMYT) for use in its breeding program. The varieties developed by CIMMYT using the gene are in the public domain and available royalty-free, although the gene remains the intellectual property of BASF. To commercialize the product, a company obtains foundation seed from CIMMYT (royalty free) and purchases the herbicide from BASF or their appointed agents (at the market price). The commercializing company is then responsible for producing, coating, and marketing the seed.

In 2005, AATF was looking to develop projects to address the issue of Striga weed, which has a devastating impact on more than 1.4 million hectares of land where smallholder farmers grow maize, a key staple crop in East Africa. While scouting for new technologies that could be applied, AATF came across CIMMYT's work on herbicide-coated maize technology and approached the research institution for collaboration to bring the benefits of StrigAway maize to farmers. After AATF assessed the technology and market opportunity, the foundation signed on three seed companies to produce and distribute StrigAway. Over time, this grew to seven companies in three countries. Six companies already had a direct relationship with CIMMYT for other products but were referred to AATF for commercialization of StrigAway in order to benefit from technical assistance provided through AATF's expertise and project support. Two of the participating companies, NASECO in Uganda and Freshco in Kenya, began working with the project in 2014. At the beginning, the seed and herbicide were only approved for use in Kenya. BASF sought registration of the herbicide in Tanzania and Uganda, and AATF supported seed companies to pursue commercial release of the seed varieties, which required field trials and data collection. These approvals were obtained in 2013 and 2014, respectively.

ADDRESSING CHALLENGES

- **Significant investment required from companies.** Many of the companies involved in commercialization also produce and/or sell other seeds. For quality assurance and risk management, the companies need to invest in separate production and processing facilities as well as transportation systems. To minimize the risk of its herbicide-resistant gene escaping to other seed varieties, it is important that the StrigAway seed is stored separately to avoid seed mixture. And even more important, once the StrigAway seeds have been coated with herbicide, they must remain separate so that the other seeds are not contaminated and killed by the herbicide. This requires seed companies to make significant infrastructure investments in order to protect both the integrity of the StrigAway seed and that of their other products. Additionally, distributors and retailers (agrodealers and input supply shops) also need to take proper precautions with storage to keep StrigAway separate from other, non-treated products in their facilities.

  Similarly, seed companies must invest in staff training and capacity building to properly implement these quality control and risk mitigation measures. Staff must also be trained on proper application of the herbicide – how much to apply, when to apply it, and how long it can be stored. Failure to properly apply the herbicide can also result in quality issues and increase the risk of gene escapes. Participating companies vary in size and capacity, and as such, some found it easier to make these investments and develop their own solutions to problems encountered than others. One company noted that although this process was challenging, it made them better prepared to produce and sell similar types of products in the future.

- **Producing high-quality seed.** Production of quality seed is also a challenge for some companies. In some cases, this is a result of factors beyond their control such as weather conditions and the prevalence of diseases and pests; in other cases, it was due to limited supply of the early generation seed necessary for production. Initially, the varieties with the Imazapyr-resistant gene were only approved for release and commercial production in Kenya. Further, as with other maize seeds, certification is also required for quality checks and sale. Companies in Uganda and Tanzania faced delays in commercialization of StrigAway as the herbicide registration and variety release approvals were sought. One company, NASECO in Uganda, noted that there were newer hybrids already approved in Uganda that could be developed to contain the herbicide-resistant gene and took the initiative to do this.

- **Marketing and promoting the product effectively**. Smallholder farmers were not familiar with StrigAway or the general concept of herbicide-coated seed. Building the demand for StrigAway requires a concerted marketing effort to inform potential customers about its benefits and train customers on proper handling and use. StrigAway seed is sold at prevailing market competitive prices and allows farmers to produce maize where they could not before due to the noxious Striga weed. In collaboration with the seed companies, AATF is playing an important role in education in proper technology use and agronomic practices, demonstration, and marketing of the product. This facilitates long-term benefits when the partner companies directly assume this responsibility. As the main interface with the smallholder farmer customer, agro-supply shop staff play an important role in promoting the product at the point of sale. Following a Partnering for Innovation survey that showed

that these staff had limited knowledge of the product, AATF has been conducting greater training and outreach for them. While there are benefits (such as cost savings) to a common product promotion strategy, one of the challenges is syncing promotional efforts with product availability. Given the challenges that companies experienced with production, StrigAway was not always available for purchase when marketing campaigns were underway.

- **Educating the final customer.** Quality control and risk management extend to the final customer – the smallholder farmer – as well. Smallholder farmers in the region commonly intercrop maize alongside legumes. To minimize the risk of adversely impacting the legumes or other crops the farmer has, the farmer must adopt risk management practices such as not intercropping legumes, wearing gloves when working with StrigAway seed, or at a minimum washing hands afterwards. As with other improved maize seed, the farmer must buy new seed that is treated with Imazapyr each season. AATF StrigAway demonstration plots have been key in driving awareness among farmers, and ensuring that farmers are properly informed of the risk and management. However, this effort can be costly.

- **Adapting to customer feedback.** BASF, in partnership with AATF, worked with the seed companies to understand and address the quality control challenges they were facing – particularly in relation to application of the herbicide coating. Farmers had complained about low germination rates, which turned out to be the result of seed companies improperly applying the herbicide coating. BASF is now testing a new granular formulation and application method that will make proper application easier to achieve. NASECO also developed different packaging to reduce the risk of herbicide leaching out, and to clearly signal to farmers that this product is different from the seed they are accustomed to.

LESSONS LEARNED

- **Involve seed companies early when designing the commercialization strategy.** Although the companies involved had no prior experience with herbicide-coated maize seed, many do have broader experience with commercialization of other products. This gives them some expertise and insight into how to plan the commercialization process in general and anticipate challenges. Individual companies have varying capacities to conduct their own R&D and invest in the development of new products. This is an important consideration when selecting companies to partner with for commercialization.

- **Partner roles and responsibilities need to be clearly defined and strong communications channels maintained.** In a complex commercialization process that involves multiple institutions and/or companies, this is particularly important. Developing a product, adjusting production processes and volumes, and building a customer base require careful balancing that becomes more complex when different organizations are involved. Adding to these challenges, in this case, was the need for training and adoption of new practices at all levels – from company to customer.