SCIENCE, TECHNOLOGY, RESEARCH AND INNOVATION FOR DEVELOPMENT (STRIDE)

Agribusiness Innovation Ecosystem Assessment

May 2017
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### Abbreviations

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<th>Full Form</th>
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<tr>
<td>ATI</td>
<td>Agricultural Training Institute</td>
</tr>
<tr>
<td>BPI</td>
<td>Bureau of Plant Industry</td>
</tr>
<tr>
<td>DA</td>
<td>Department of Agriculture</td>
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<tr>
<td>DA-BAR</td>
<td>Department of Agriculture-Bureau of Agricultural Research</td>
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<tr>
<td>DOST</td>
<td>Department of Science and Technology</td>
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<tr>
<td>DTI</td>
<td>Department of Trade and Industry</td>
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<tr>
<td>FDA</td>
<td>Food and Drug Administration</td>
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<tr>
<td>FPA</td>
<td>Fertilizer and Pesticide Authority</td>
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<tr>
<td>IP</td>
<td>intellectual property</td>
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<td>ISP</td>
<td>industry strategic plan</td>
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<tr>
<td>ITDI</td>
<td>Industrial Technology Development Institute</td>
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<tr>
<td>KTTO</td>
<td>Knowledge and Technology Transfer Office</td>
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<tr>
<td>LGU</td>
<td>Local Government Unit</td>
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<tr>
<td>NGO</td>
<td>nongovernmental organization</td>
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<tr>
<td>NMRDC</td>
<td>National Mango Research and Development Council</td>
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<tr>
<td>PCAARRD</td>
<td>Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development</td>
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<tr>
<td>PCIEERD</td>
<td>Philippine Council for Industry, Energy, and Emerging Technology</td>
</tr>
<tr>
<td>PhilMech</td>
<td>Philippines Center for Post-Harvest Development and Mechanization</td>
</tr>
<tr>
<td>PhP</td>
<td>Philippine pesos</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>research and development</td>
</tr>
<tr>
<td>SMEs</td>
<td>small and medium enterprises</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
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<tr>
<td>STRIDE</td>
<td>Science, Technology, Research and Innovation for Development</td>
</tr>
<tr>
<td>SUCs</td>
<td>state universities and colleges</td>
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<tr>
<td>TOT</td>
<td>training of trainers</td>
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<tr>
<td>TTPD</td>
<td>Technology Transfer and Promotion Division</td>
</tr>
<tr>
<td>UPLB</td>
<td>University of the Philippines-Los Baños</td>
</tr>
<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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</table>
Introduction

The Science, Technology, Research and Innovation for Development (STRIDE) program aims to strengthen the capacity of Philippine universities to conduct science and technology research aligned with the growth needs of the private sector. The 5-year United States Agency for International Development (USAID)-funded program, implemented by RTI International, aims to drive inclusive growth by improving universities’ research, policy, and management capacities and engagement with the private sector. STRIDE works closely with universities and industries to create a network of researchers, entrepreneurs, and investors who innovate and turn ideas into products and companies. To do this, we encourage industries to become active stakeholders in university research, assist universities to become market-driven providers, and build institutional structures to support and sustain this system. The program helps universities develop applied research capabilities and technical curricula and build a professional workforce with world-class technology. As a result, the program team hopes that more Philippine graduates will be equipped to participate in the global economy as employees, researchers, and entrepreneurs within the Philippines.

Agribusiness is a priority sector for the STRIDE program. Thirty percent of the Philippine workforce is engaged in agriculture (World Bank, 2016), and with average farm sizes below 2 hectares, agriculture is intrinsically linked to poverty and is, therefore, vital for inclusive growth (Lowder, Skoet, & Singh, 2014). In this context, innovation within the sector can have transformational impacts on productivity, income, and employment. For example, a mango disease-management technology could increase yields for the 2.5 million smallholder farmers engaged in mango production and increase sales for input providers, traders, and processors. However, simply inventing the technology will not achieve this. In agriculture, more than in any other sector, the complex dynamics of the innovation ecosystem can facilitate or impede the generation, dissemination, and adoption of such innovations.

An agricultural innovation is a new technology or
practice that can be adopted by a producer or agribusiness to “upgrade,” or improve, operations, typically resulting in greater yields, higher quality products, cost savings, or improved sustainability. The agriculture sector is continuously innovating and upgrading to adapt to the changing environment and market conditions and improve competitiveness. An innovation ecosystem includes all the actors involved in research and innovation and in the policies and social norms that affect actors’ behaviors in the ecosystem (Figure 1). The ecosystem approach looks at the interlinkages and interactions among actors in the innovation economy and the importance of the incentives they encounter in the pursuit of innovation (Wessner, 2005). A well-developed innovation ecosystem links the interests of individual actors with the ecosystem in transforming ideas into useful products and services. Further, a healthy innovation ecosystem channels some of the profits from the private sector into research and innovation, resulting in innovative commercial products that grow the economy. When this succeeds, it creates a virtuous cycle of more research and innovation and more innovation-driven profits in the economy, per the STRIDE Innovation Ecosystem Assessment of 2014 (RTI, 2014). This sector-neutral report assessed the six factors in the Philippine innovation ecosystem, in terms of supply, demand and the enabling environment, as shown in Figure 2.

![Figure 2. 2014 STRIDE Innovation Ecosystem Scorecard](image)

The 2014 assessment also led to four key findings, which are summarized below:

1. One-size-fits-all overly complicated procurement laws slow the procurement of research equipment, diminishing research and innovation productivity.
2. Research grants do not compensate universities for researchers’ time, leading to competition with researchers’ teaching responsibilities.

3. Universities have unrealistic expectations for patent revenue, which discourages industry partnerships.

4. Mutual mistrust and misunderstanding between university and industry strains collaboration.

These issues were validated by key players within the innovation ecosystem and have been targeted by STRIDE and its partners since the report was released.

The 2014 report assessed factors common across all sectors. However, while the cross-sectoral findings have general relevance, there are sectoral factors that do not emerge from the original study. To explore one of the key sectors more deeply, STRIDE initiated a follow-up agriculture-specific assessment. The innovation ecosystem for agriculture functions in ways that are unique in comparison to other sectors. Because agriculture is intrinsically linked to poverty and food security, dominant institutions were founded on and maintain the ethos that agricultural innovations are public goods, developed for the benefit of the farmer. Through this paper, we explore the implications of this ethos on the diffusion and commercialization of innovation. Further differentiating the sector, the Government of the Philippines is heavily involved in both the funding of agricultural research and the transfer of technologies, and users of agricultural technologies are dispersed, which impedes the diffusion of information.

The purpose of this report is to assess the innovation ecosystem, specifically for agribusiness in the Philippines. It aims to inform STRIDE and its stakeholders about the various actors in the agribusiness innovation ecosystem and how they are connected and identify strengths, weaknesses, and opportunities for interventions to improve its overall functioning. The report does not present the opinions of the researchers but rather compiles the perspectives of various stakeholders within the ecosystem. Within agriculture, the assessment focused on three specific value chains—cacao, coffee, and mango—as representative examples for the sector writ large. Many of the elements of the innovation ecosystem, such as government extension and research funding entities, are common to all crops; thus, the findings are generalizable.

The structure of the report outlines five stages on the pathway from innovation to agricultural growth (Figure 3). We adapt the framework used in the 2014 assessment to delineate this pathway. In each stage, we analyze the key actors, relationships, and critical factors that foster successful innovation.
Figure 3. Innovation to Growth Pathway

**STAGES**

1. Innovators identify a need and ideate potential solution
   - Government priorities
   - Academic-business linkage
   - Private company

2. Innovation is generated and tested
   - By academic
   - By entrepreneur
   - By government
   - By private R&D

3. Innovation is transitioned out of research
   - Commercial Pathways
     - Licensing
     - Spinoffs
     - Startups
   - Social Pathways
     - Government
     - NGOs
     - Universities

4. Innovation is introduced, sold, or given to users
   - Via extension
   - Via direct sales
   - Via info sharing
   - By academic

5. Innovation used to upgrade operations
   - Of growers
   - Of input companies
   - Of processors
   - Of manufacturers

**Critical Factors**

- ✓ Communication of agribusiness needs for innovation
- ✓ Relationship between private sector and research community
- ✓ Research funding available and accessible
- ✓ Strong research capacity and bandwidth
- ✓ IP policies and support
- ✓ Connection to investors
- ✓ Startup support services
- ✓ Transparent processes
- ✓ Incentives
- ✓ Validation of market need
- ✓ Funding available and accessible for social pathways
- ✓ Knowledge sharing
- ✓ Training
- ✓ Incentives

- ✓ Innovation is practical and cost-effective for users
- ✓ Users understand how to use innovation
- ✓ Users can access finance if upfront investment is required

**Inclusive growth**
Rapid Assessment Methodology and Crop Overviews

The STRIDE team developed a custom methodology to enable a deep dive into the innovation ecosystem while ensuring that the assessment was conducted in a timely and efficient manner. Given the robust and diverse agribusiness sector, two core elements to this approach include the following: (1) developing a framework and resulting question “guide” rather than employing a fixed survey, and (2) selecting value chains that could be representative of the ecosystem.

INTERVIEW APPROACH

The assessment team used a question guide based on the conceptual framework to ensure that key topics were covered while allowing for interviews to reveal unanticipated, relevant, and interesting information about the agricultural innovation ecosystem. Additionally, this strategy allowed interviews to be conversational, encouraging respondent candor. This open-ended approach to data collection was necessary because the assessment is a process of learning about the innovation ecosystem and how stakeholders view its functioning.

VALUE CHAIN SELECTION

Whereas many ecosystem functions are common across all agricultural value chains, we selected three specific value chains to allow for a more in-depth assessment of supply and demand actors. STRIDE focused on cacao, coffee, and mango—smallholder-dominated crops with growing markets, but that require adoption of technologies and innovations to meet market potential. We did not target crops produced primarily on plantations by multinational companies, such as bananas and pineapples, these companies are expected to source their new technology internationally. Likewise, spices and other niche crops were eliminated because of their modest economic significance. Cacao, coffee, and mango are included in the Department of Agriculture’s (DA’s) High Value Crops Development Program and face growing domestic and international demand. The selection process was conducted in
consultation with several Philippine agricultural experts. In Figure 4, we provide a high-level overview of each value chain and the types of innovation used at each stage of production.

INTERVIEWEE IDENTIFICATION

The assessment team conducted over 65 interviews in the agribusiness innovation ecosystem over the course of five months in 2016. Our objective was to conduct interviews with representatives of each ecosystem function and for each value chain. We identified interviewees through background research and previously conducted value chain studies, STRIDE project and personal contacts, and the “snowball” method (referrals from interviewees). A full list of interviewees is included in the appendix.¹

¹ We do recognize that some bias may exist among those actors who are willing to be interviewed. For example, companies that are more protective about their innovations tend to be less willing to share their practices and contribute to this report. We try to incorporate this into our findings and triangulate through interviews with industry representatives, such as the chamber of commerce, who can speak on behalf of such organizations.
Figure 4. Overview of the Crops Addressed in This Paper: Mango, Cacao, and Coffee

<table>
<thead>
<tr>
<th>Crops</th>
<th>Productivity</th>
<th>Income</th>
<th>Key Challenges</th>
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</thead>
</table>
| Mango     | 900,000 MT   | $66 million | - Mango production is input-intensive.  
- Fertilizer and pesticide use is common, but under-adopted due to cost.  
- Seedlings available from private nurseries and the DA.  
- Disease and pest management  
  Flower induction |
| Cacao     | 5,400 MT     | $230 million | - Seedlings produced and distributed by large cacao buyers, also by private nurseries.  
- Old, low-productivity trees and low application of fertilizer and pesticide constrain yields.  
- Vascular streak dieback disease  
- Integrated Pest Management  
  Nutrient management |
| Coffee    | 75,000 MT    | $83 million | - Limited access to new planting materials; most seeds sourced from existing trees.  
- Low fertilizer use.  
- Commonly intercropped; low density of trees per hectare.  
- Varietal adaptability by region  
  Micro-propagation for planting materials |

**Inputs and Growing**
- Mango production is input-intensive.
- Fertilizer and pesticide use is common, but under-adopted due to cost.
- Seedlings available from private nurseries and the DA.
- Disease and pest management.
  Flower induction.

**Harvest and Post-Harvest**
- Mangoes are harvested manually or with rudimentary picking equipment.
- Lack of training in sorting and packing can cause substantial post-harvest loss or damage to fruit.
- Improved packaging.
  Picking equipment.
  Storage chamber.

**Processing**
- Vapor heat treatment, hot water treatment, and/or waxing to meet export requirements for fresh mangoes.
- Lower quality mangoes are dried or processed into juice, jams, or puree, producing large amounts of waste.
- Waste management.
  Mango Liqueur.

**Recent or in-demand Innovations**
- Data sources: FAOSTAT, UN Comtrade.
Innovation-to-Growth Pathway

This section assesses the innovation ecosystem at each of the five stages of the pathway, highlighting key findings from our interviews. For each stage, we assess the relationships, actors, and policy factors that affect innovation.

1. IDENTIFICATION OF NEED

The first critical stage in the innovation-to-growth pathway is the identification of a need for innovation. For agriculture, in this stage, private sector actors, such as farmers, agro-input companies, or processors, identify challenges or inefficiencies in their operations that could be improved or made more competitive with an innovation. The most important element of this stage is that innovators (including researchers) can accurately identify these needs. Thus, strong relationships between research and industry are crucial. In this section, we discuss the primary ways through which innovators gain insight into agribusiness needs.

### Table 1. Government Bodies Quick Reference

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<tr>
<th>GOVERNMENT AGENCY</th>
<th>RELEVANT SUB-AGENCIES</th>
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| DOST               | Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD)  
|                    | Philippine Council for Industry, Energy, and Emerging Technology (PCIEERD)  
| DA                 | Bureau of Plant Industry (BPI)  
|                    | DA-BAR  
|                    | Agricultural Training Institute (ATI)  
|                    | Philippines Center for Post-Harvest Development and Mechanization (PhilMech)  
| DTI                | |

In the Philippines, the government (with stakeholder input) assumes the primary role of identifying needs for agricultural innovation and communicating those needs to university researchers. The government offers substantial funding through various sources—primarily the Department of Science and Technology (DOST) and DA—that can be accessed by university and public sector researchers to conduct research and generate innovations. (Table 1 provides a quick reference to government bodies; Table 2 a guide to research prioritization processes.) The DOST develops programs aligned with national R&D priority areas and submits budget requests to fund them. DOST funding priorities also align with the industry roadmaps developed by the Department of Trade and Industry (DTI). Thus, in some cases, there is a direct demand for R&D from a specific industry association. In the past, the DOST accepted unsolicited proposals. Now, it identifies
needs for research and only funds proposals that adhere to those specific demands; however, per some interviewees, this change has not been fully realized across all DOST arms. The DA-Bureau of Agricultural Research (DA-BAR) is also a substantial source of public funding for agricultural innovation.

<table>
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<th>AGENCY</th>
<th>RESEARCH PRIORITIZATION AND ALIGNMENT WITH INDUSTRY NEED</th>
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<tr>
<td>PCAARRD</td>
<td>• Develops an industry strategic plan (ISP) for each priority commodity (including mango, coffee, and cacao).&lt;br&gt;• The ISP process includes a stakeholder meeting to ensure that the plan addresses private sector needs.&lt;br&gt;• Productivity levels for each crop are benchmarked against other countries, and gaps to achieving productivity are identified.&lt;br&gt;• Once the ISP is established and validated, researchers submit proposals for research to address specific needs.&lt;br&gt;• The proposal evaluation process includes validation of the local market demand for the innovation.</td>
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<tr>
<td>DA-BAR</td>
<td>• Research priorities align with DA-BAR’s 6-year strategy based on the political cycle.&lt;br&gt;• The priorities are informed by a consultative process with a broad range of stakeholders. However, some interviewees noted that farmers are underrepresented in the consultative process and that, sometimes, the events are conducted in English, which some farmers do not speak.&lt;br&gt;• Research proposals are accepted on a rolling basis in alignment with strategic directives.&lt;br&gt;• A second stage of proposal review is conducted with industry, and the proposals are evaluated based on the potential for dissemination of the research findings.</td>
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Both DA and DOST employ multi-stage proposal evaluation processes and incorporate mechanisms to ensure the industry applicability of the research. However, several interviewees from the private sector perceived funded research to be impractical or not useful to industry. One respondent noted that researchers are not required to identify any real market demand before receiving funding; although the DOST invites the private sector to evaluate proposals, these outside reviewers are not providing funding and are, therefore, less critical in their evaluations. One DA representative told the research team, “All research should have an application—that is our weakness. Researchers are confined by the four corners of a room. But research should be for the needs of the people, not for education purposes.” One university-based interviewee suggested that obtaining in-kind commitments from private sector counterparts at the proposal stage would improve viability: “It shows that someone actually wants to sell the product.” Some projects and funders already do this, but it is not the norm.

The public-sector research prioritization and funding process, which is described above, is one method of identifying and communicating needs.
for agricultural innovation. Another modality is direct linkages between industry and academe. If students and university researchers have direct connections to farmers or companies, they can more seamlessly identify needs for innovation. However, our research uncovered very few instances of direct academe-business linkages. Indeed, only a handful of one-off instances in which, because of a researcher’s own network or experience, s/he was aware of a need for innovation were identified. Students in non-agricultural fields (notably, engineers) who come from farming families may be aware of relevant challenges and have a desire to develop solutions. However, it was noted that, particularly for engineers and chemists, if students do not have a personal connection to agriculture, it is unlikely that they will become aware of the needs for innovation in this sector through their education. One notable exception is Nestlé, which engages with universities and undergraduate students to innovate on issues related to coffee, nutrition, and the environment.

Faculty researchers may be able to build relationships by consulting for private companies; however, most such consulting opportunities arise through existing relationships. Administrative barriers prevent universities from capitalizing on faculty consulting arrangements and institutionalizing relationships with industry, as discussed further in Section 5.

Private agribusinesses rarely draw on the expertise of Philippine universities for R&D. Large-scale, commercial growers can more easily collaborate with international researchers through their affiliations with large international buyers. One such company mentioned that research with Philippine universities is often driven by the interests of the researchers, rather than market demand. Additionally, they noted that they do not perceive university research as useful and, therefore, do not actively pursue it, although researchers sometimes approach them about collaborations. One agribusiness representative described how a university approached their company to ask for a co-investment in the development of a local enzyme. However, the business projected that the product would never be profitable, and thus, declined the collaboration. This example underscores the need for market validation in the first stage of innovation. One interviewee did note that a large, multi-national fruit company had commissioned some specific research related to fertilizer from the University of the Philippines-Los Baños (UPLB.)

Additionally, mutual mistrust permeates industry-academe relationships, and bureaucratic hurdles and IP concerns can dissuade collaboration, reiterating the findings from STRIDE’s 2014 study. One interviewee noted that a company was planning to commission a public university to develop enzymes; however, 6 months into the negotiations, the paperwork had still not reached the university approver. In some cases, private sector interviewees demonstrated an interest in leveraging
university expertise but could not identify the appropriate experts or were unaware of specific capacities for innovation. Further, private agribusinesses mentioned lacking real incentives to collaborate with universities.

In one notable exception to this finding, the agro-input company La Filipina Uly Gronga recently donated facilities to Central Luzon State University and UPLB for research on hogs and animal feed nutrition content. This donation was partly intended to achieve corporate social responsibility, but the company also expects that these facilities will positively impact the training and recruiting of graduates and the provision of research and testing services for their feeds. We did not encounter anything similar in our selected crop value chains.

Industry associations or sector-specific research centers may be more likely to connect with universities than independent companies. One private university reported working directly with the national coffee research center to identify research needs and solutions in the sector. Similarly, the cacao industry association in Mindanao is partnering with the University of Southern Mindanao on clonal improvements for pest and disease resistance.

Another form of university-private sector linkage that can facilitate the identification of needs for innovation is agricultural extension. Universities are responsible for extension, and some faculty are mandated to divide their time between teaching, research, and extension. This occurs to varying degrees across faculty and universities, and the incentives for extension are weaker than those for research and teaching, although faculty can receive honoraria for extension. Universities in agricultural production areas, such as Davao, are naturally more involved in farmer extension than those closer to Manila. Interviewees at UPLB indicated that faculty participate in extension but only when doing so is part of their research projects.

Needs can also be identified within the private sector or by individual entrepreneurs. This section has focused largely on how university researchers identify needs for agricultural innovations because they are disconnected from industry. Within private companies, this process is much easier; one (multinational) input company described using its distributors to conduct local market research to inform new product development. Similarly, a local input distributor, which sells primarily to plantations, reported being approached directly by the plantation when a new product is needed and then sourcing it locally or abroad. Some private sector actors communicate R&D needs directly to the

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3 Farmer training and technology demonstration. Agricultural extension is discussed in depth in Section 3D.
4 In between research and publication of this report, the Commission on Higher Education issued an order which may change these mandates.
government agencies that can help address them—mainly the DA and DOST. Private companies can contract DOST agencies to conduct research directly or submit a request to the DA for publicly funded research. The following section includes a discussion of PhilMech, Industrial Technology Development Institute (ITDI), and private sector R&D.

### 2. GENERATION AND TESTING OF INNOVATIONS

Once a need for innovation has been identified and communicated to innovators, the innovation must be generated and tested. In this section, we discuss the primary ways through which agricultural innovations are generated in the Philippines and the critical factors—namely, funding and research capacity—that enable innovation at this stage.

### UNIVERSITY RESEARCH

Most agricultural research and innovation in the Philippines occurs in universities and is led by individual faculty members. As discussed in the previous section, Philippine universities primarily access agricultural research funding from PCAARRD and DA-BAR, which had research budgets of approximately 650 million and 1.2 billion Philippine Pesos (PhP), respectively, in 2015. PCIEERD and the Commission on Higher Education also offer funding for agriculture and food processing.\(^5\)

Whereas the DOST releases specific calls for proposals with fixed budget ceilings and application deadlines, DA-BAR has an open funding window. DA-BAR is viewed by some researchers to have less cumbersome and time-consuming proposal requirements and to be far quicker at dispersing funding than DOST. According to one source, funding from DOST may take as long as a year to be disbursed, and funding amounts can change.

Access to funding varies by university and researcher. Faculty with strong reputations at relatively prestigious schools closer to the Manila area can access research funds and are sometimes approached directly by funders for targeted research. In fact, interviewees perceived that 50–70 percent of PCAARRD funding goes to UPLB.\(^6\) In contrast, DA-BAR funding is more geographically dispersed, although nearly one third goes to UPLB. PCAARRD solicitations are announced and bid through their regional research consortia (described in more detail in Section D), but not all

[5] As of 2008, the Philippines’ agricultural research intensity ratio (share of spending on research to agricultural gross domestic product was in line with those of Indonesia, Bangladesh, and Thailand but behind those of Malaysia, China, and India (ASTI 2013). More recent benchmarking data were not available at the time of this study.

[6] Researchers could not acquire an accurate figure from PCAARRD, but PCAARRD interviewees estimated that the percentage was lower.

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**Finding**

**Government funding is perceived to be concentrated at UPLB and other large universities close to Manila.**

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Finding
National funding favors experienced researchers.

Government funding favors experienced researchers because it is heavily dependent on the track records of both the university and the researcher. Therefore, it can be difficult for young researchers to access funds, particularly at lesser-known universities. Some universities recognize this issue and try to pair junior and senior researchers on projects, and some funding opportunities target junior faculty specifically. National funding is also difficult for first-time researchers and universities to access because locating the solicitations and guidelines can be challenging. One researcher at a private university reported being interested in national funding but completely unaware of where or how to locate such funding opportunities, even after conducting web searches on funders’ websites. The authors of this report searched online and found that funding guideline documentation is available on the PCIEERD and DA-BAR websites, but it is scattered across multiple documents and unclear whether it is up-to-date. We were unable to locate research funding guidelines on PCAARRD’s website.

Some researchers are apprehensive about submitting proposals online for fear of losing ownership of their research idea. That is, there is a perception that lesser-known researchers’ good ideas may be redirected to researchers with whom the funding agency is more familiar. Regardless of its veracity, this perception can discourage new researchers who lack a personal connection with the funding agency from submitting proposals.

Channeling funding to universities and researchers with strong reputations reduces the risk to funders and may, to some extent, be attributable to those universities’ objectively stronger scientific capabilities. However, for agriculture, more than any other sector, these advantages must be balanced against the relevance of the research and extension advantages of universities based in key agricultural production areas, especially Mindanao. Universities that are far from Manila and have stronger connections to farmers may have better insight regarding practical and marketable innovations and be better positioned to disseminate impactful applied agricultural research. However, these universities may also have more difficulty accessing research funding (despite active efforts from PCAARRD and DA-BAR to reach regional universities).

One potential constraint to accessing funding is proposal writing capacity, although this issue is not unique to agriculture. A wide range of proposal writing abilities exists among researchers and is not correlated with research quality, as noted by interviewees and observed by STRIDE. However, most universities do not provide proposal development or editing services. STRIDE observed that research offices do not function as proposal gateways for faculty. Furthermore, some researchers may be...
intimidated by the requirements involved in applying for and administrating research funding and be discouraged from applying. Some interviewees indicated that these capacities constitute a weakness among researchers who are not familiar with the relevant policies and regulations.

Though very few private universities have agriculture programs, private universities often have more efficient and less cumbersome fund management and human resource and procurement systems and regulations. Thus, private universities can be more competitive on some proposals. Partnerships between private and state universities where the private university is the primary applicant, allowing the partnership to take advantage of its lower overhead, are rare. UPLB and other universities have set up private foundation to bypass cumbersome university regulations and procure and manage research more efficiently. The foundation is only intended to manage applied research.

Human research capacity is perceived as strong, even in universities outside metro Manila. However, student enrollment in agricultural disciplines is declining, and some concerns about the future supply of research are emerging. Despite strong capacity, the bandwidth for research is a constraint. The 2014 assessment found that financial competition between universities’ teaching and research objectives because of the inability of government research grants to compensate faculty for research time (effectively de-loading) creates a disincentive for faculty research. Our research validated this misalignment of incentives in the universities we interviewed. Faculty state that they cannot give adequate time to research (and extension) because of heavy teaching loads. Standard teaching loads vary between nine and 18 credits, and some interviewees perceived the teaching loads to be higher in more rural and resource-strapped state universities. Thus, teaching requirements further constrain the supply of applied agricultural research.

There is some flexibility in allocating teaching and research workloads for high-performing faculty at state schools, but this flexibility is not commonly utilized because resource constraints mean that teaching loads must be maintained. Private universities are more flexible with teaching loads. Additionally, research facilities and equipment are lacking at more rural universities. Some sharing of research facilities between universities exists and is encouraged by funding agencies. In the absence of this funder mandate, universities appear to be reluctant to share facilities because the researchers managing the equipment are held responsible if it breaks.

7 Declining enrollment in agricultural programs in the Philippines is documented extensively in Briones and Carlos (2013), so we do not focus on this issue, despite its importance for generating innovations.
Norms around research collaboration and competition were described with mixed opinions. Many interviewees noted difficulty in encouraging collaboration among researchers, particularly across disciplines. Some faculty believe they will advance more quickly if they keep to themselves, whereas others simply lack the time, incentives, or personal connections necessary to join projects. Younger faculty tend to be more likely to collaborate, shared facilities can foster collaboration, and some funding from the DOST is contingent on collaboration.

Collaboration across multiple universities is also a factor. Collaboration outside of personal networks is constrained by the limited information on faculty research expertise that is available online. The DOST has programs, including the regional consortia model, that are designed to incorporate state universities and colleges (SUCs) into its research projects and, like UPLB, did not indicate the existence of any divide or competition between them. However, in Mindanao, universities reported a north-south cultural divide and a lack of trust that prevents collaboration beyond that mandated by PCAARRD. A lack of collaboration was also noted between the various government agencies involved in agricultural research and technology transfer and between universities and the government. “Turfing” considerations were described as a barrier to collaboration.

PRIVATE SECTOR R&D

Large multinational companies involved in agricultural production tend to source R&D from their international headquarters and then test it under Philippine agronomic conditions. Some large buyers that invest in their producers (or plantations for other crops) have their own research and demonstration farms to develop agronomic best practices for their farmers. We encountered limited private sector-led domestic R&D on inputs, with most conventional inputs being imported to or assembled in the Philippines from imported components. For agro-inputs, it is believed that the Philippines will never reach the economies of scale necessary to compete with imports on price. As mentioned in the previous section, the private sector rarely engages universities in R&D efforts, except for using exports for the field trials required for product registration.

Chemical fertilizer and pesticide manufacturers are often part of multinational corporations or designated registrants of their products in the Philippines. For multinationals, R&D is conducted internally but not locally. For example, one large chemical company explained that new molecules (for pesticides) are developed at global R&D headquarters and subsequently cascaded to the Philippines for field trials in local environments. This is common practice among similar companies because it is more efficient to conduct R&D at centralized facilities in
countries with more advanced R&D capacities. The company that made this observation does, however, have a team in the Philippines to identify local market demand for new technologies and communicate the demand to its headquarters.

Seedling nurseries are the primary source of new coffee, cacao, and mango trees. The primary innovation of interest to these actors is likely new varieties or new strains of popular varieties. However, most nurseries are not active in R&D. Indeed, many nurseries are based in other countries, and it can be difficult to source planting materials suitable for specific Philippine localities. For example, one Mindanao cacao seedling provider interviewed conducts its own R&D on both cacao varietal breeding and cost-effective fertilizer mixing.

Small and medium food processors and manufacturers develop new products largely based on taste through trial and error and internet research. In the case of chocolate, some have gone abroad to European trainings or hired foreign consultants to learn how to make quality chocolate. Most innovation is aimed at reaching international quality levels for chocolate and coffee. Large companies have product design teams and develop new products based on market research and food lab experiments. One major food company considers its own product design team and facilities complemented by international consultants to be superior to Philippine universities’ and researchers’ capacities. Several small and medium enterprises (SMEs) aware of the services offered by the DA and DOST leverage government R&D support. However, this primarily occurs on the post-harvest and manufacturing sides; we did not encounter an example of input companies leveraging government research.

**STARTUPS AND ENTREPRENEURS**

Independent entrepreneurs may also generate and test new technology solutions for agriculture with the intention of transitioning them into startup companies. However, this is not currently a significant source of agricultural innovation in the Philippines. One startup accelerator noted that only approximately four percent of the applications they receive are for startups in the agri-food sector. They further noted that agriculture startups tended to be student run. One possible explanation for the lack of agri-food startups is the focus on information technology, computer programming and engineering; students in these disciplines are not exposed to the challenges in the food and agriculture sectors, except via family or personal connections. One interviewee suggested an “agri-hackathon,” which could expose programmers and developers to industry challenges and encourage collaboration and new projects in this space. The International Rice Research Institute sponsored a hackathon.
specifically for rice in 2013, which generated several promising innovations. However, whether any of these innovations have been scaled or commercialized remains unclear.

GOVERNMENT RESEARCH

Some innovations are generated and tested by government agencies. Except for higher priority rice and coconuts, government crop research is handled by the DA’s BPI. For example, BPI’s National Mango Research and Development Council (NMRDC) on Guimaras conducts mango research. In general, BPI’s role in research has decreased as its regulatory responsibility has expanded. BPI provides a modest 2.5 million PhP (US $48K) annually for research and competes with universities for DA-BAR and PCAARRD funding.

Other government research agencies include the ITDI, an R&D institute that is part of DOST, and PhilMech, which is funded through the DA. ITDI conducts research on food processing and manufacturing primarily in alignment with DOST industry roadmap priorities. Approximately 20–30 percent of ITDI research is contracted directly by SMEs that do not have in-house R&D capabilities. ITDI has the highest quality equipment for food processing research, and thus, sometimes, universities rent its facilities for specific projects. Additionally, through the Food Innovation Centers project, ITDI is helping establish regional facilities for food processing research based at SUCs. One interviewee indicated that the private sector is more likely to engage ITDI for research than universities because universities lack the necessary equipment.

PhilMech develops new post-harvest technologies for DA priority commodities. The intended beneficiaries of PhilMech R&D are smallholder farmers and small-scale processors and manufacturers who cannot afford to invest in their own R&D. Private companies can submit requests to the DA but do not contract specific assignments with ITDI. If private requests align with DA priorities and funding is available, PhilMech will respond. PhilMech technologies are developed with the goal of becoming a “public good” and are not licensed to individual companies.

3. TRANSITION PATHWAYS

Different pathways exist through which an innovation can be transitioned out of the R&D stage and into use. This process is frequently referred to as technology transfer or technology transition. These pathways are described below using two categories: social pathways,  

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8 The Philippine Coconut Authority and PhilRice conduct research.
which are often sponsored by the public sector, and traditional commercial pathways. Because of the importance and smallholder nature of agriculture in the Philippines, social pathways are more critical than they are for other sectors.

No clear criteria or decision point exists for whether a given technology should follow a commercial or social pathway. In fact, this lack was cited as an issue that constrains the commercialization of technologies. The pathway followed often depends on the source of funding; typically, DA-funded projects are public goods. However, ambiguity and, often, discord arises between the pro-commercialization mentality of the research funder and the ethos of agricultural universities that technologies are developed to help farmers and, therefore, should not be exploited to earn a profit. Additionally, some technologies sit squarely in the gray area between social and commercial. These technologies, such as the fertilizers sold by agricultural universities, are owned by the university, manufactured at limited scales, and sold at below-market prices to walk-in customers. Because no one stands to earn anything from their sale, limited promotion occurs.

SOCIAL PATHWAYS

In this section, we refer to new technologies (e.g., seeds, fertilizers, and materials) as well as research relating to agricultural practices (e.g., integrated pest management or optimal varieties for a given region) generated by university researchers with public support. Both are considered innovations. For these innovations to enter the public agricultural extension system (discussed in section D), universities and funding agencies must “transfer” them. This transfer occurs differently depending on the agency funding the research and the nature of the innovation. The transfer of physical technologies, such as fertilizers, requires manufacturing and distribution, whereas research-informed practices can be promoted through information sharing and training.

Finding

There is no clear system for identifying mature research ready for dissemination or transfer.

For DA-BAR research performed by universities and government bodies, DA-BAR passes technologies on to the ATI after the grantee’s research and demonstration have been approved. DA-BAR leads this process; ATI does not seek out innovations to disseminate or have a formal procedure for soliciting them from universities or other sources. Formally, PCAARRD-funded research should be approved by PCAARRD’s central Technology Transfer and Promotion Division (TTPD) before being disseminated. However, the process for identifying mature research that is ready for dissemination is ad hoc. Several annual events are held at which PCAARRD-funded researchers are invited to share their research findings. TTPD has identified this as a challenge and is currently more
Mechanical Mango Harvester with Riser

Team: Dr. Roger Montepio, University of Southeastern Philippines

Identification of Need
Traditional harvesting method can break mango stems and causes brown stains on the fruits’ skin, making them impossible to export and therefore significantly decreasing their market value.

Generate and Test Innovation

Funding:
• Two-year Philippine Council of Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD) grant to develop post-harvest mango technologies
• Funding was delayed by administrative issues

Research:
• Developed a modification of the traditional stick-and-basket mango picker
• Design was based on an Australian model with knife blades on the basket to cut the mango stem
• Research team made additional improvements, including adding a trigger mechanism that cuts stems without pulling

Testing:
• New harvester reduced staining by nearly 80%, but increased harvesting time

Transition out of Research: “Social”/University Pathway

Funding: PCAARRD has approved dissemination, but approval was not granted in time for the team to apply for commercialization funding.

Startup support services: The team of agricultural engineers has little experience in market planning and assessing commercial viability and will rely on the Department of Trade and Industry for support.

Intellectual Property: The patent application for the picker is currently pending.

Introduce Innovation to Users

• Planned commercialization and distribution through the university farm store
• Will sell to farmers and local government units for distribution
• Feedback on the picker from local mango industry stakeholders is positive, but picker is viewed as “stuck” because industry has been aware of it for several years but it is not yet widely available
• Several prototypes have been sold to farmers who were involving in the testing

CHALLENGES AND LESSONS LEARNED

✓ Difficult to find a fabricator capable of making blades that maintain a sharp edge.
✓ Considerable delays due to waiting for funding and faculty availability for research.
✓ The research team does not yet have a concrete backup plan to fund commercialization if it is not granted PCAARRD follow-up funding. One possibility may be funding from the University’s research and extension division. Another is a former student who is now a fabricator and has expressed some interest. The team is interested in identifying potential investors, but does not know how.
proactive about tracking completed research and identifying technologies for transfer.

No permanent formal mechanism exists through which university researchers can inform the DA or PCAARRD of mature research or new technologies that are ready to be shared with users. Instead, this process depends on the researcher’s connections and entrepreneurialism. One researcher reported that he submits a letter describing his technology signed by his department head to the appropriate person in the DA. Some universities have or are developing Knowledge and Technology Transfer Offices (KTTOs) that can support this transition both to government agencies and externally.

Both PCAARRD and DA-BAR require that technologies advance beyond the development phase and be pilot tested before they are considered eligible for the dissemination or technology transfer support they offer. However, several interviewees noted difficulty in accessing funding for pilot-stage testing. Additionally, some indicated that researchers developing technologies do not want to pilot test or to hand it off for technology transfer support, instead preferring to continue iterating on the development of the technology itself.

In some cases, the transition starts via a social pathway and becomes commercial after a market is generated. For example, the biofertilizer developed by UPLB for smallholders will be manufactured by the university, and the government will purchase and distribute it to farmers. Doing so could help to popularize a technology and demonstrate its marketability, and thus, down the line, a private actor may license the technology and start producing it for sale.

Other social pathways can include NGO actors, foundations, and international donors seeking to support smallholder access to technology. Based on our interviews, none of these actors are significant sources of technology transition in the Philippines.

COMMERCIAL PATHWAYS

Commercial pathways are channels through which innovators (academe, entrepreneurs, private companies, or the government) transition newly developed technologies from the R&D stage so that they may be sold to users. Whereas social pathways include knowledge transfer, commercial pathways are generally specific to technologies that can be sold rather than research on agricultural practices. Commercial pathways include technology licensing, spinoff companies, and startups. For a private

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*Finding*

Some research is stalled at the testing phase, due to unavailability of second-phase funding.
company conducting in-house R&D for new product development, no separate pathway is needed, although some steps, such as patents or new product registration, are often required.

Technologies developed via university research can be commercialized if the university acquires IP rights to the technology and either licenses it to an outside company or establishes a spinoff company to which the IP is transferred. In our interviews, we encountered very few university-developed agricultural innovations that had been successfully commercialized. However, a notable shift has occurred in universities’ and funders’ desires to commercialize technologies: Many interviewees described new or conception-stage programs and policies to support commercialization. These initiatives are all based on the common understanding that universities lack the capacity for commercialization.

Some interviewees identified a need for training scientists in entrepreneurship and IP processes; others thought that because being an entrepreneur is outside the traditional skillset and job description for researchers, universities should hire additional marketing staff or establish commercialization centers to manage this process. One university biologist told us, “The university won’t allow me to make my app available or demo the technology until I get a patent. But I don’t understand the patent paperwork, or which parts of the research are patentable. The process has been very time consuming.” Momentum exists within universities to provide support to researchers around IP and patents. In addition to implementing IP policies, universities are training staff and faculty on patent searching and conducting seminars to introduce faculty to IP because “it is not naturally part of their mindset.” Many universities now host a branch of the Innovation and Technology Support Office, under the auspices of the Intellectual Property Office of the Philippines (IPOPHL).

Another example of emerging support for commercialization is UPLB’s newly developed “One Biotech” concept. This is planned to be a company within UPLB that is responsible for commercializing all technologies developed through UP biotech; thus, the faculty would not be tasked with the marketing side (although they will retain equity). Implementing this concept would also shorten the licensing process. Currently, 36 technologies that have been deemed relevant for the agriculture sector and market ready are “lined up.” One Biotech, like other initiatives to support commercialization, remains in the planning phase. Indeed, although the situation is changing, an overreliance on faculty entrepreneurship for technology commercialization still seems to persist.

Most interviewees mentioned that it remains difficult to set up a spinoff from a university. A researcher must go all the way up through the president and chancellor to obtain permission for commercialization.

Finding

Universities and funders demonstrate substantial momentum and commitment toward improving technology commercialization.
which is a disincentive for innovation. It is similarly difficult to license a technology to private agribusinesses; several interviewees noted that agribusinesses are often discouraged by the slow speed and bureaucracy of universities. Part of the delay or hesitance could be related to a lack of understanding of the various options for commercialization. One DA representative told us, “Private companies want to buy innovations from the university—the problem is the process itself. Universities are weak at identifying business opportunities.” Industry mistrust is also a factor at this stage. One interviewee noted an example of a large input company interested in purchasing the rights to a university-developed fertilizer; however, the inventor did not trust the company, and thus, the sale did not go through. We heard substantial frustration from businesses who had tried to license agricultural technologies from a university but failed: “UPLB does record breaking stuff. But their mandate is to give technologies away for free—they make it very hard for the private sector to get involved. It’s faster to source technologies from abroad than to try to get them from UPLB.”

Further, we noted very little information flow from universities to industry—that is, when researchers publish research or develop a new technology, it is very unlikely that industry will know about it. Universities rarely have communications or media strategies designed to inform agribusinesses about new developments. Additionally, conferences are typically siloed: Academic conferences and industry events exist, but they rarely overlap. As one industry association put it, “We’d like to stay abreast of new research, but it seems like scientists just produce research and shelve it.” One-off examples of businesses staying connected to universities usually originated through alumni or were the result of individuals who were particularly dedicated to supporting the universities or sourcing products locally. This is another phase in which direct linkages between business and universities would strengthen the ecosystem. Newspapers, a major source of agricultural technology information, could be an appropriate channel for this.

Our research also explored how the private sector can transition new technologies from the R&D phase to market. One frequently cited frustration was the process of registering and/or certifying new agricultural inputs, particularly pesticides. Approximately 5 years are required to register a new product. This is primarily because new pesticides must undergo field trials locally with an accredited external evaluator, and companies must work through the Fertilizer and Pesticide Authority (FPA). The trial itself is not the bottleneck; rather, the FPA lacks manpower, succession plans, automated systems, and incentives. One interviewee also noted that the FPA must hire subject matter experts, usually retired scientists, to review permit applications, but these experts are poorly compensated and have no incentive to move quickly. For
INNOVATION BRIEF

Green Enviro Management System (GEMS)

Team: Dr. Evelyn Taboada, Dean of the School of Engineering and Professor of Chemical Engineering at the University of San Carlos (USC)

1 Identification of Need
University prioritized research that solved local problems. In Cebu, a major issue is the large volume of discarded mango seeds and skins that contributes to urban waste management problems.

2 Generate and Test Innovation
Funding:
- Dr. Taboada received seed funding from USC to begin research on high-value products that can be generated from mango waste.

Facilities:
- USC also invested in a gas chromatography mass spectrometry instrument to identify the different substances within mango waste, recognizing that the expensive equipment could be used for multiple projects in the future.

Research:
- Mango flour, which is gluten free and more nutritious than wheat flour, was identified as an opportunity for value addition. Because mango flour has a tart taste, Dr. Taboada’s team has have created mixtures with other flours, including cassava and coconut. They also produced mango tea, briquettes, and animal feed.

3 Transition Out of Research: Commercial Pathway
Intellectual Property:
- Filed patent applications through USC’s information service technology office
- Incorporated the business; USC retained a share of the company

Investment:
- Identified potential investors through personal/university network, which existed due to frequent collaborations with industry
- Chose one of several interested investors to finance the construction of a factory

4 Introduce Innovation to Users
Identified primary buyer (City of Johannesburg), which wants to buy as much mango flour as GEMS can produce. Currently looking for additional buyers to expand consumer base.

5 Innovation Used to Upgrade Operations
The City of Johannesburg uses the mango flour as part of a baking skills development program. GEMS continues to innovate, testing different mango flour mixes and recipes.

CHALLENGES AND LESSONS LEARNED

Dr. Taboada is unusual among scientists; she holds a master’s degree in intellectual property law and is innately entrepreneurial, a rare combination of capacities. The early success of GEMS is not likely to be replicated exactly without her. Instead, support services should be available so scientists are not required to be experts in intellectual property law, entrepreneurialism, and factory design for their innovations to be commercialized. USC is well-connected to industry, which eased the process of finding investors. This is also rare. Dr. Taboada attributes this to the university’s streamlined bureaucracy, which makes private-sector engagement much less cumbersome and time consuming than for public universities. Additionally, because of its religious affiliation, the university takes its extension and community engagement mandate very seriously and therefore has a lot of experience engaging the private sector.
companies introducing generic or different brands of approved active ingredients rather than new molecules, the registration process has fewer bottlenecks but is still expensive and can deter new market entrants and discourage innovation. The process for fertilizer approvals is also faster. One input dealer noted that the process can be expedited via back channeling. Additionally, interviewees from the private sector mentioned that the Philippines has not updated its agrochemical laws, which prevents some new, organic products from being used in the country. The legislation contains outdated language and “there is no momentum in the FPA” to make any changes.\(^\text{10}\) One agrochemical company noted that the annual process and costs of certifying a product organic are prohibitive and cannot be recouped by charging a premium. Indeed, it is much cheaper to register a synthetic product.

New food product development is constrained by Food and Drug Administration (FDA) requirements for registering new products, which are, like those of the FPA, viewed as anachronistic and slow. Interviewees indicated that registration requirements are all in paper copy rather than online and that new product registration reportedly takes upwards of 6 months, much longer than the 2 weeks required in Thailand. However, the FDA has recently upgraded to electronic registration for all new products classified as low risk and has plans to expand this feature to all products by the end of the year. The FDA estimates that e-registration has reduced the total time required from 114 days to 53 days.

Independent entrepreneurs and innovators who have developed new technologies and seek to commercialize them via launching a startup company are unlikely to have transition support provided by a university or large company. Several incubator and accelerator programs support the Filipino startup community, although we encountered none focused specifically on food and agriculture. Across all sectors, there is a need for startup services, including basic accounting and legal support, but without access to a formal incubation or acceleration program, startups have a difficult time finding these services. University researchers with DOST funding may receive support like the services offered by incubators: The DOST offers training on pitching and business plan development, holds pitching days with angels and venture capitalists, and supports product registration. In some cases, the DOST supports the establishment of incubators within universities; for example, the University of San Carlos is applying to become an incubator for engineering in food, energy, and waste, and UPLB a biotechnology incubator.

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\(^{10}\) We conducted one interview with an administrative officer at the FPA who did not comment on these findings. Higher-level officials at the FPA explicitly declined to participate in our study.
One critical factor for the success of startups (and, in most cases, that of university spinoffs) is the availability of investors, including angels and venture capitalists, which is generally perceived to be adequate in the Philippines. However, interviewees repeatedly noted that investors (and other startup services) are more accessible in Metro Manila and that for agriculture startups, which are more likely to come from outside of Manila, this can be a challenge, as described in the innovation brief below.

Further, Filipino investors tend to be less tech-savvy and “startup minded” than the angel investors in the global technology community. They are more traditional investors and are less accustomed to the high-risk nature and idea of investing in teams. For tech, there is a need to educate investors and wean them from this traditional mindset; however, for agriculture and food, this represents an opportunity. Even high-tech agricultural innovations, such as apps and sensors, can be understood by investors because they support the production of food, which is a familiar and relatively stable market. One respondent thought that agri-food startups would be more tangible and, therefore, attractive to the Filipino investors than software or more digitized or social network-based ideas.

However, startups may still encounter difficulties in finding the right investors. Several investor networks exist in metro Manila that entrepreneurs can tap into if they are aware of them. One interviewee noted that in Cebu, no good investor network is in place, so although growing interest in food is emerging among investors, it remains difficult for innovators to find well-aligned investors and vice versa without a personal connection. Incubation and acceleration services, which typically help startups connect with investors at early stages, mostly support information technology startups.

One option for financing agribusinesses is impact investors. The Philippines lags other countries, such as India, in the impact investing space, but some are available in Manila. Impact investors typically fund established businesses rather than idea-stage startups. Additionally, it is difficult for them to connect with agribusinesses located in the provinces, and vice versa.
CloudFarm Remote Sensors

Davao City-based startup launched by recent engineering graduates of the University of Southeastern Philippines (USEP)

Identification of Need

- Students were interested because of family connections to farming.
- Through consultation with commercial-scale farmers, they identified a need and decided to design a remote heat stress analyzer. Similar technologies are available overseas, but don’t function well in remote areas in the Philippines.

Generate and Test Innovation

Funding:

- Ideaspaces’s annual startup accelerator competition selected CloudFarm as one of 10 startups to be awarded support in the form of office space, legal advice, a scholarship to the Asian Institute of Management, and approximately US$60,000 in startup capital.

Research:

- CloudFarm expanded the remote sensing units to monitor for moisture in the soil and air, light, pH balance, and nutrient content, allowing farmers to respond quickly to changing agronomic conditions and track trends over time. The solar-powered sensor uploads data to an android-based application. It covers a range of one to two hectares, but the team is working to expand it using low-cost satellite sensors.

Testing:

- CloudFarm has manufactured and tested prototypes using a local manufacturer and has been satisfied with the quality. They have tested the technology with the Bureau of Plant Industry (BPI) and have done farm trials on USEP’s Mabini campus. The tests at BPI showed that the remote sensing unit increases yields in a greenhouse by 6%, but CloudFarm expects this to be significantly higher on farms where agronomic parameters are more variable. Additional tests are planned.

Transition Out of Research: Commercial Pathway

- CloudFarm has registered as a business and has a patent pending on the sensor technology. Because Ideaspaces provided a patent attorney, the patent application process has been relatively simple for CloudFarm.
- Currently CloudFarm lacks the capital necessary to reach commercial scale. Its most likely source of scale-up funding is the Department of Science and Technology open window for funding for commercialization. It has also had some interest from one angel investor, one input company, and the Bureau of Agricultural Statistics, but no investment has materialized. They are not aware of angel investors in Davao.

CHALLENGES AND LESSONS LEARNED

- Startup incubator and accelerator services provide valuable support for innovation, but lack of next-phase capital remains a challenge, particularly outside Manila.
- Market research is essential early in the innovation process. CloudFarm is uncertain about the domestic market size for such a high-tech agriculture product. Even relatively wealthier farmers are not easily convinced of the sensor’s benefits relative to costs. Because of this, CloudFarm is exploring developing a lower cost alternative.
4. INNOVATION INTRODUCED TO USERS

Once an innovation has been successfully transitioned from the R&D phase and is ready for use, it must be introduced to the users for whom it was developed. This introduction can occur via private sector promotion, publication and information sharing, or agricultural extension. This stage is particularly complex in the agriculture sector because of the heavy involvement of public agricultural extension services and the wide dispersion of Filipino farmers.

The agricultural extension system is the process through which trained agricultural extension agents provide training and demonstration to farmers on agricultural technologies, practices, and agricultural enterprise management. The specific services delivered by an extension agent vary widely by region and agent and may also include commercialization or distribution of technologies at a local level. Our objective is not to thoroughly assess the Philippines’ agricultural extension system. Rather, in this section, we provide a brief introduction to how agricultural extension fits within the greater innovation ecosystem, highlighting insights elicited from our interviews.

In the Philippines, a complex web of actors and relationships exists in agricultural extension (Figure 5).

Figure 5. Technology Transfer Actors in the Agricultural Extension System
Philippine devolution in 1991 assigned responsibility for agricultural extension to Local Government Units (LGUs). LGUs implement extension at provincial and municipal levels and are supported at national and regional levels by the DA but are primarily funded with local taxes. Within the DA, the ATI is responsible for delivering trainings of trainers (TOTs) to LGU extension staff, who then deliver training to farmers; however, the LGUs are not actually accountable to the ATI. ATI also provides some program funding to LGUs, which covers logistics and other non-salary costs. Other agencies, including the DTI and Department of Agrarian Reform, also conduct some extension activities. This multiplicity of players involved in extension was cited as causing confusion when transitioning technologies into the extension system.

LGU agricultural extension services are generally recognized as weak because of devolution, as documented in several publications (Ocenar, Brillantes, Cuthbertson, & Tumanut, 2004; Saz, 2007) and reflected in our interviews. One challenge is the lack of operational and travel funding, which prevents extension agents from leaving the office. More importantly, devolution has isolated agricultural extension offices, weakening their connections to national research systems (Saliot, 2006.)

Some prominent modalities for cascading agricultural research and technologies to farmers are outlined in Table 3. In theory, these modalities also serve to identify farmer-developed innovations and needs for research, although we encountered little evidence that this occurs.

### Table 3. Extension Modalities in the Philippines

<table>
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<tr>
<th>Modalities</th>
<th>Details</th>
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<tr>
<td>**Farmer Scientist Training Program/Science &amp;</td>
<td>• Farmer scientists nominated by LGUs and local universities receive inputs and training on new innovations.</td>
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<tr>
<td>Technology-based Farms**</td>
<td>• Farmer scientists demonstrate new technologies to other farmers but do not distribute or sell them; other farmers must ask the DA or LGUs how to obtain the technology, which may or may not be available.</td>
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<td></td>
<td>• This program was developed by PCAARRD and transferred to the DA.</td>
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<td></td>
<td>• One interviewee indicated this program is being scaled back, and another stated that it has evolved into community-based demonstration farms.</td>
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<tr>
<td><strong>Farmer Information and Technology Service</strong></td>
<td>• These centers are in municipal agricultural offices in village centers.</td>
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<tr>
<td>(FITS) centers</td>
<td>• They house information, manuals, and computers for farmer use.</td>
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<tr>
<td></td>
<td>• Over 800 exist across the Philippines.</td>
</tr>
<tr>
<td><strong>PCAARRD Regional Consortia</strong></td>
<td>• Fourteen regional consortia exist and include SUCs, LGU, and NGO collaborators.</td>
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<tr>
<td></td>
<td>• They serve as a mechanism to conduct and disseminate research at the regional level.</td>
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Finding: The complexity of the agricultural extension system impedes the transfer of new technologies and research.
Research pertaining to practices rather than technologies is approved by PCAARRD for public sector dissemination and then disseminated at the regional level through LGU consortia members. Most respondents indicated that it is generally uncommon for the private sector to access research results from universities or government agencies. One mango grower noted that the NMRDC had conducted an expensive study on mango strains, but even if farmers were aware of the research, they cannot access it without traveling to Guimaras.

In the private sector, because strong incentives to introduce their technology to users exist, the process tends to be more successful. Large companies have existing distribution networks for selling seedlings, fertilizers, and pesticides, and thus, when a new product is available, introducing it via that network is generally a seamless process. Some companies may opt to work through the public extension system to introduce their technologies to farmers. In some cases, PCAARRD pursues extension and commercialization simultaneously; introducing technologies through extension can generate traction and build a market for a product, making its commercialization more attractive to private companies.
5. INNOVATION USED TO UPGRADE OPERATIONS

The final requirement for an innovation to have impact is that it must be used by farmers or private agribusinesses to upgrade operations. Simply introducing it is not sufficient. In this section, we provide an overview of the main actors in the ecosystem that use innovations. Noting that these actors feed directly back into the first phase—identifying a need for innovation—we also discuss the types of innovations each actor demands.

Food companies can also be users of innovation around processing, packaging, and waste related to agricultural products, although most innovation is conducted in-house. Large multinational food companies introduce new products in the Philippines based on local market research. These new products are developed through in-house R&D, which may happen abroad. One local company noted the need to source expertise and equipment from Europe to produce higher-quality chocolate in the Philippines because the equipment available locally is inadequate. In the coffee sector, similar dissatisfaction existed with local machinery, which is primarily made for Robusta only and breaks when used on larger beans. One industry association noted that its members would be unlikely to prioritize spending money on research, although they may be willing to invest in such technologies if they were available and could increase yields.

Large-scale farms are uncommon in the mango, cacao, and coffee value chains. Contract and managed farms run by large buyers may have their own agronomists, and at least one has its own research and demonstration farm that collaborates with a university on disease research. These farms are more active in the pursuit of innovation and are generally more likely to use new technologies and adopt research-based practices.

Smallholder farmers constitute most primary producers of cacao, coffee, and mango in the Philippines. These farmers usually have minimal capital to invest in new technologies and are, therefore, rarely active in the pursuit of innovation. Indeed, most use traditional practices. Smallholder adoption of known productivity-enhancing technologies that are already utilized by larger farmers is low. For example, only 35 and 45 percent of mango growers have adopted fertilizer and pruning practices, respectively, (Buguis, n.d.). The low technology adoption rates of smallholder farmers constitute a priority issue around the developing world and have been thoroughly researched. Low adoption does not necessarily imply low demand for better technologies. Instead, in most cases, low adoption can be explained by farmers’ constrained access to
information, finance, input or output markets, labor market inefficiencies, risk preferences and exposure, or land rights (Jack, 2013).

Therefore, as noted by many interviewees, the extension of existing and, in some cases, basic technologies is more important for smallholders than the development of new, more advanced innovations. Thus, many useful innovations have been developed but have failed to reach the final step(s) of the process or remain inaccessible to farmers because of high costs or poor distribution. In several interviews, Filipino farmers were described as traditional, risk averse, or even “emotional” and resistant to change and, therefore, slow to innovate or adopt innovations.

**Finding**
For smallholder farmers, access to existing, basic technologies is more important than the development of new, more advanced innovations.
Key Findings and Recommendations

This section discusses some of the key cross-cutting findings of the agribusiness innovation ecosystem assessment. Overall, the findings indicate both positive momentum and strong university capacity and government support for agricultural research and innovation. We reiterate that these findings represent stakeholder opinions of the agribusiness innovation ecosystem rather than an authoritative diagnostic. This report is intended to provoke discussion among interested stakeholders and provide the opportunity for open dialog. Below, we outline key findings and associated recommendations for fostering the development and diffusion of agricultural innovations that can lead to inclusive growth.

Universities and government research funders demonstrate substantial momentum for the adoption of pro-commercialization practices.

Many interviewees noted progress or indicators of momentum related to moving research and technologies “off the shelves” and into the hands of users. Heightened awareness of the importance of technology transfer exists, although it may not have fully permeated the ecosystem. At the DOST, this awareness is evidenced by the passage of new IP policies in 2015, which include a technology transfer protocol for universities receiving DOST funding. Additionally, the DOST is proactive in identifying technologies ready for spinoff and working with researchers to develop business plans and identify investors. As of March 2016, none of these technologies had successfully spun off; however, the effort is clearly indicative of momentum and interest in commercialization from one of the principal funders of agricultural research. The DOST is also working with LANDBANK to facilitate lower rates on startup loans and is active in requiring evidence of market demand for a technology before releasing research funds.

We also noted several university-led initiatives in the pipeline or planning phases to ramp up commercialization. These initiatives primarily occurred in the form of capacity building for university faculty staff in entrepreneurship and IP, the development of IP policies, and the provision of centralized support services through the university for marketing and legal support, including KTTOs. Several university actors mentioned that they are trying to increase exposure to industry.
These emergent policies—or, in some cases, early-stage ideas—are inchoate, and therefore, the research team could assess whether they are contributing positively to the ecosystem. However, they noted a strong awareness of the need for change and steps in the right direction.

**Recommendations:**

Funders and universities should seek comprehensive feedback on new programs and policies from stakeholders and strive to continuously adapt and improve them. Private sector input should be incorporated when possible. Initiatives aimed at improving commercialization should not rely too heavily on one solution—for example, faculty entrepreneurship or an IP policy—but should instead seek solutions from various ecosystem components.

The intrinsic mindset that agricultural innovations are public goods can ultimately hinder users’ abilities to access those innovations.

Public institutions involved in the generation of agricultural technologies are typically founded with a mission to promote agricultural productivity and help poor farmers. This is a worthy mission and has undoubtedly resulted in departments of agriculture and universities worldwide contributing to agricultural growth. However, this ethos and the underlying desire for social benefit can also constrain technology transfer.

We encountered this tension at every stage along the pathway. Some faculty avoid commercializing technologies because doing so conflicts with their mission. Most notably, in stage 3—already the most critical and complicated stage—whether a technology should be social or commercial must be determined, but no clear criteria or even authority to do so exists. Further, even if a technology is following the commercial pathway, myriad approval levels are present in public universities, and each one is an opportunity for a different university official to stop and ask, “Wait, doesn’t selling this to a company for profit conflict with our mission?” This can delay and complicate what is already a lengthy process.

Many technologies are classified as social and pushed out via the extension system or universities directly; this is often the best choice. However, because of the lack of incentives in the extension system, these technologies may not be disseminated as widely as commercialized ones.
**Recommendations:**

Universities and funding agencies should clarify who is responsible for classifying a technology as social or commercial and the criteria for classification. This should be done as early in the research process as possible and communicated widely. Universities should continue efforts toward “sensitizing” faculty toward commercialization, building entrepreneurialism, and communicating the message that, in many cases, technologies are more likely to reach farmers through the private sector.

The extension system suffers from several challenges, as previously discussed, and thus, incentives alone are unlikely to improve its performance. In any extension reform, however, incentives should be carefully considered; several recent experimental studies indicate their positive effects on farmer adoption of technologies and practices. Incentives do not necessarily have to be monetary; in fact, monitoring and farmer feedback are also effective mechanisms (Masset & Haddad, 2014; Jones & Kondylis, 2015).

**Weak relationships between academe and agribusiness hinder innovation.**

Academe-industry relationships throughout all five stages are vital in a functioning innovation ecosystem. When universities and agribusinesses are well connected, researchers understand industry’s needs for innovation and can produce marketable technologies, and industry is aware of university innovations, draws on university expertise, and can bring technologies to market when they are ready. Most respondents noted weak relationships between academe and the private sector—echoing a finding in the original innovation ecosystem study. Researchers rely on their primary sources of funding—PCAARRD and DA-BAR—to communicate with industry and set research priorities. Although this process functions, it deters the development of more direct relationships, limiting opportunities for two-way exchange.

- Limited information on university agricultural expertise, research and innovations is publicly accessible.

Private agribusinesses often cannot identify academic experts in technical areas that could add value their business. One manufacturer noted a technical issue regarding preservative application but did not know the individuals within a university that should be contacted about a solution. This is largely because of poor university websites that fail to detail the expertise and research accomplishments of their faculty, although variation in quality and the level of detail exist across different
universities and departments. Even at the department level, some programs do not provide information on their specialties and achievements. Further, universities often have poor internal information sharing.

We encountered no regular or systematized platforms for university-industry knowledge sharing or engagement around agriculture. Selected industry stakeholders are involved in setting the research agenda, but this involvement does not include any direct contact or relationship building between industry and academe. Universities also do not prioritize mainstream or industry-targeted dissemination of research. Faculty rely on academic publications to promote their work, which are not typically read by anyone outside of the specific field. Some universities are in the process of developing KTTOs (some with support from STRIDE), which can be used to address this disconnect, but we did not encounter any that are already doing so for agriculture. Similarly, funding agencies do not consistently publicize research they have funded that is ready for technology transfer online. Instead, such research seems to be published on an ad-hoc basis.

- Academic expertise is often perceived as not relevant to private agribusiness, and there is mutual mistrust between industry and academe.

STRIDE’s 2014 assessment found that widespread mutual distrust between universities and industry introduced friction into the ecosystem. Several interviewees validated this finding in the agriculture sector; some agribusinesses, even small companies who might benefit from local expertise, are reluctant to collaborate with university experts for fear that their secrets might be shared with competitors. Confusion about IP ownership also exists, with both sides being hesitant to embark on a joint research project because of concerns about who will have ownership of the product or patent. Private sector partners are often also deterred by the slow, bureaucratic processes within universities. Partly because of the above lack of information sharing, private agribusiness may assume that academic expertise is not relevant.

- University systems for faculty consulting arrangements do not facilitate institutional relationships.

Consulting assignments can serve to bolster university researchers’ connections to industry and understanding of industry needs while supplementing their salaries. Most interviewees on the university side were aware of at least some instances of faculty engaging in consulting work for agribusinesses. However, the consulting assignments are not usually made through the university, which is acceptable so long as the
consulting does not occur on university time. Formalizing consulting assignments through the university is viewed as unnecessarily bureaucratic and cumbersome and is, therefore, avoided. Consulting “side arrangements” are also an issue in LGU extension offices. One respondent noted some interest has developed in bringing consulting activities into the university fold.

Failure to keep track of consulting activities with the private sector represents a lost opportunity for universities to transform ad-hoc personal relationships with industry into institutional relationships that could lead to consulting opportunities for additional faculty and build a culture of trust and information sharing, which is currently lacking. In some cases, it may also constitute a lost opportunity for revenue capture. Furthermore, institutionalizing consulting agreements can protect universities from reputational risk, offering a mechanism for oversight and quality control.

These three factors contribute to the overall weakness of relationships between industry and academe. Thus, academe is disconnected from industry and farmer needs for innovation, and universities are developing fewer practical, relevant technologies. Private agribusinesses do not take advantage of the expertise available in Philippine universities, slowing the process of private sector innovation. Finally, weak relationships mean that universities are less connected to potential investors for agricultural technologies, hindering the process of commercialization and, ultimately, the potential for growth offered by such technologies. These factors serve to reinforce the weakness of these relationships.

**Recommendations:**

Universities need stronger platforms for engagement with industry, which could take the form of regular meetings or networking events, industry days, research showcases, internship programs, or any creative but systematized way to foster personal and institutional relationships with the private sector. These activities will have greater impacts on innovation if they expose researchers in non-agriculture fields (e.g., chemists, engineers, and computer scientists) to issues in agro-industry. As part of this engagement, universities should institutionalize consulting agreements, being careful not to bureaucratize them, which could deter faculty or businesses from engaging in such relationships. To reiterate the recommendation of the STRIDE 2014 report, stakeholders should develop revenue-sharing guidelines and protocols for university-industry partnerships to improve mutual trust.

University KTTOs or departmental offices should develop research communications or updates directed at industry and send them directly
to industry stakeholders electronically. The purpose of these communications should be to inform agribusinesses of who is doing what at the university in terms of new projects, new technologies, and technologies available for commercialization. In-person presentations are also recommended. The STRIDE program advocates many ways of building strong relationships intended to ease the flow of information. These include guest industry lectures, faculty ‘externships’ (or immersions) and ‘innovation workshops’.

Universities’ websites should detail the qualifications, expertise, and up-to-date research experience and output of faculty. Additionally, department and program websites should better illustrate their current research initiatives, mature research, and technology transfer achievements. These sites should be search optimized so they can be found directly by search using a few keywords.

Additionally, PCAARRD and DA-BAR should maintain technology “marketplace” pages on their websites, detailing tested technologies that have been tested and are ready to be transferred. (PCAARRD mentioned plans to launch something similar.) Rather than simply promoting research funders’ achievements, these sites should contain information useful for potential investors. Currently, people interested in new technologies must attend pitching events or visit the funders’ offices, which is a significant upfront time investment.

**Systematic constraints limit university supply of agricultural research and innovation.**

- Teaching loads are heaviest in rural universities where agriculture is more prominent.

Whereas in general, public universities’ standard teaching loads are reported to be nine credits per semester, in less well-resourced universities outside the Manila area, the requirement is approximately 18 credits per semester. This assessment confirmed the 2014 finding that even teaching nine credits constrains the bandwidth for innovation. Because these rural universities have an advantage in producing practical innovations and research to benefit farmers, this difference in teaching load requirement disproportionately affects the supply of farm-level innovations.

- Funding opportunities and guidelines are perceived by some as non-transparent.

Because rules, eligibility, and opportunities for funding are not perceived as transparent and publically available, researchers who are not
networked through their university, a consortium, or a personal connection or who are less experienced struggle to access funding. Some funding agencies post some opportunities and instructions online, but they are difficult to find, incomplete, and outdated. This perceived opacity can deter would-be innovators.

**Recommendations:**

To reiterate the recommendation from the 2014 assessment, research funders should permit faculty to use research grants funds to buy out or “de-load” their teaching obligations. The importance of this finding is amplified for agricultural research.

Agricultural research funders should update the solicitation sections of their websites to make them more complete and easier to navigate. All information about current funding opportunities and funding guidelines should be linked to from one page, and each page should be dated so that visitors know the information is current. These pages should be updated regularly. Funders could also try to promote their funding calls directly to less-connected universities or junior faculty through information sessions, webinars, or university visits.

**Opaque and inefficient public technology transfer and extension systems impede the diffusion of agricultural innovations.**

- Agricultural extension is de-prioritized by researchers and universities.

Extension is a valuable channel for universities to engage with farmers, build trust, understand the practical needs of agriculture, and disseminate research. Universities require their agriculture faculty to divide time among teaching, research, and extension. The teaching load is an inextricable requirement that can typically only be escaped through administrative duty. Research is modestly incentivized through honoraria from funders and university career advancement rewards for publications and patents. However, extension, while mandated, may be incentivized through honoraria but is rarely monitored or enforced. Extension is, therefore, left to researchers’ motivations and resourcefulness and the cultures of their departments. Additionally, researchers are said to often prefer obtaining follow-up research funding rather than dissemination funding, likely, at least in part, because the incentives for research output are greater.
Additional stages of grant funding are required for technology transition.

First-stage research grants fund basic research and prototype development. Researchers must apply for a second stage of funding to conduct efficacy trials or pilots. For research that does not involve product generation, grant funding rarely includes a budget for the dissemination of the research findings, so researchers must apply separately. This adds layers of potentially unrewarded effort and potential delays that disincentivize researchers from taking research to the technology transfer level.

Transfer from research to extension within government funders can be inefficient.

The ATI, which oversees extension at the national level, does not have a mechanism to identify and take over technologies from universities. Instead, it relies on the DA to pass along mature technologies. However, the DA may not always be aware of promising technologies that are ready for dissemination. PCAARRD’s TTPD tracks completed projects to identify mature research that is ready for transition, but the process is slow and involves many steps. The regional research consortia also serve as a mechanism for dissemination, but approval for follow-up funding to test a technology still requires the involvement of the PCAARRD central office.

The process for public technology transfer is opaque, which discourages researchers from pursuing it.

As described above, the path to technology transfer is complicated and depends on the source of funding and several different actors in the ecosystem. Some ambiguity exists regarding who is responsible for connecting the technology to the DA or agricultural extension. Researchers with mature innovations that are ready for dissemination often do not know how to deliver them into the extension system. This confusion itself dissuades researchers, who are not incentivized based on technology transfer, from pushing technologies over the finish line.

**Recommendations:**

Government-funded technology transfer offices (including the ATI) should be involved in research at an earlier stage so that they can identify, track, and take over research with promise for technology transfer. This would allow them to be proactive in responding to their mandate to transfer technology rather than reacting to research.
managers. Additionally, it would allow entrepreneurial researchers to communicate directly with people with the same motivation: to transfer the technology. Funding agencies (i.e., DA-BAR and PCAARRD) should communicate clear instructions and expectations for technology transfer when they release research grants.

Faculty at regional universities should have incentives that are tied to technology transfer, including extension activities. Because universities are resource constrained, these incentives should be structured not to reward time spent doing extension activities but rather on technology success. Therefore, in the case of extension, faculty should be encouraged to work with LGUs and the private sector to disseminate their innovations. These incentives should be aligned and shared with funding institutions. Furthermore, money for dissemination should be made more accessible. One possibility is to include funding in the original research grant and make its release contingent on meeting certain targets. Taken together, these steps—increasing incentives and decreasing barriers to extension—should reduce the supply of potentially good innovations stuck in the research phase.

**Lengthy processes for new agricultural product registrations slow and deter innovation.**

Pesticide (FPA) and new food product (FDA) registration times are significantly slower in the Philippines than in other countries in the region. Our interviewees estimated that 3–5 years are required to bring a new pesticide product to market; this is approximately 2 years longer than needed in neighboring Malaysia and Indonesia. This delay reduces the choices available to farmers and dis-incentivizes innovation among companies that are afraid they will not be a “first mover” with a new food product in the market. Part of this inefficiency is attributed to antiquated paper-based systems, and the FPA is said to be understaffed.

**Recommendation:**

Both the FPA and FDA should move towards online product registration systems following regional best practices and should invest in quality personnel with incentives aligned with expedition. Interviews with the FDA indicated that these improvements are already in progress for new food products. The FPA should consider updating its regulations, in line with globally accepted policies.
References


Appendix: List of Organizations Interviewed

- 1,000 Angels
- ACDI/VOCA
- Agricultural Training Institute
- Agrotiger
- Agspec Corporation
- Ateneo de Davao
- Atovi
- Australian Centre for International Agricultural Research
- Bureau of Plant Industry
- Cacao Dulce
- Cacao Industry Development Association of Mindanao
- Camiluz Enterprises
- Cavite State University
- Cebu Chamber of Commerce and Industry
- Center for Technology Transfer and Entrepreneurship (UPLB)
- CloudFarm Innovations
- Davao Provincial Agricultural Office
- COMPETE (USAID Project)
- Department of Agriculture
- Department of Agriculture-Bureau for Agricultural Research
- De La Salle University
- Department of Science and Technology
- Dow Chemical
- Department of Trade and Industry
- Farmtech Agriland Corp
- Food and Drug Administration
- Fertilizer and Pesticide Authority
- University of San Carlos
- Ideaspace
- ITDI
- Kennemer
- La Filipina Uy Gronco
- LGT Impact Ventures
- Mango Seedling Farm Corporation
- Mt Apo Coffee
- Naturale Wonders
- Nestle
- Nestle Tagum
- Oro Filipinas
- PCAARRD
- PCIEERD
- Philippine Coffee Board
- PhilMech
- Puentispina Farms
- Richfund International
- Samal Island Mango Marketing Cooperative
- Southern Philippines Fresh Fruit
- Splash
- Subasta Cooperative
- Southern Mindanao Agriculture and Resources Research and Development Consortium
- Universal Robina Corporation
- UPLB
- Urban Integrated Consultants
- University of Southeastern Philippines