



The Philippine Agricultural Innovation System at a Glance¹

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INTRODUCTION

‘Innovation is the specific instrument of entrepreneurship. The act that endows resources with a new capacity to create wealth’ – Peter Drucker

Innovation is one of the twelve pillars of the Global Competitiveness Index (GCI) which requires an environment that is conducive to innovative activity and supported by both the public and the private sectors (Schwab 2016). Innovative economies must design and develop cutting-edge products and processes to maintain a competitive edge and move toward even higher value-added activities. Apparently, the innovative countries were also the world’s most competitive economies. The latest Global Competitiveness Report (2016-2017) stated that Switzerland, Singapore and the United States remain the three world’s most competitive economies based on the overall GCI. These countries also ranked high under the Innovation and Sophistication Sub-index with Switzerland ranking first, second is the United States, while Singapore ranked 12th. The report pointed out that updated business practices and investment in innovation are now as important as infrastructure, skills, and efficient markets.

Currently, the Philippines’ GCI ranking is down by 10 notches from 47th among 140 economies in 2015 to 57th among 138 economies. This ends a decade of rank improvement from 73rd in 2005 to 47th in 2015. Looking at the 12th pillar of innovation, the country’s standing dipped by 14 notches to 62nd, with all of the seven components down: capacity for innovation (41st from 33rd ; quality for scientific research institutions (72nd from 69th); company spending on R&D (44th from 36th); university-industry collaboration in R&D (61st from 55th); government procurement of advanced technology products (74th from 59th); availability of scientists and engineers (78th from 67th); and Patent Cooperation Treaty (PCT) application per million population (86th from 85th).

GCI ranking is somehow a reflection of the performance of the country’s innovation system. An innovation system is a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into

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economic use, together with the institutions and policies that affect their behavior and performance (World Bank 2012).

This paper describes, in general, the agricultural innovation system (AIS) and identify its essential elements. It identifies policies that contribute and influences development of AIS in the Philippines.

THE AGRICULTURAL INNOVATION SYSTEM

Agricultural innovation typically arises through dynamic interaction among the multitude of actors involved in growing, processing, packaging, distributing, and consuming or otherwise using agricultural products. For innovation to occur, interactions among these diverse stakeholders need to be open and to draw upon the most appropriate available knowledge. Aside from a strong capacity in R&D, the ability to innovate is often related to collective action, coordination, the exchange of knowledge among diverse actors, the incentives and resources available to form partnerships and develop businesses and conditions that make it possible for farmers or entrepreneurs to use the innovations (World Bank 2012).

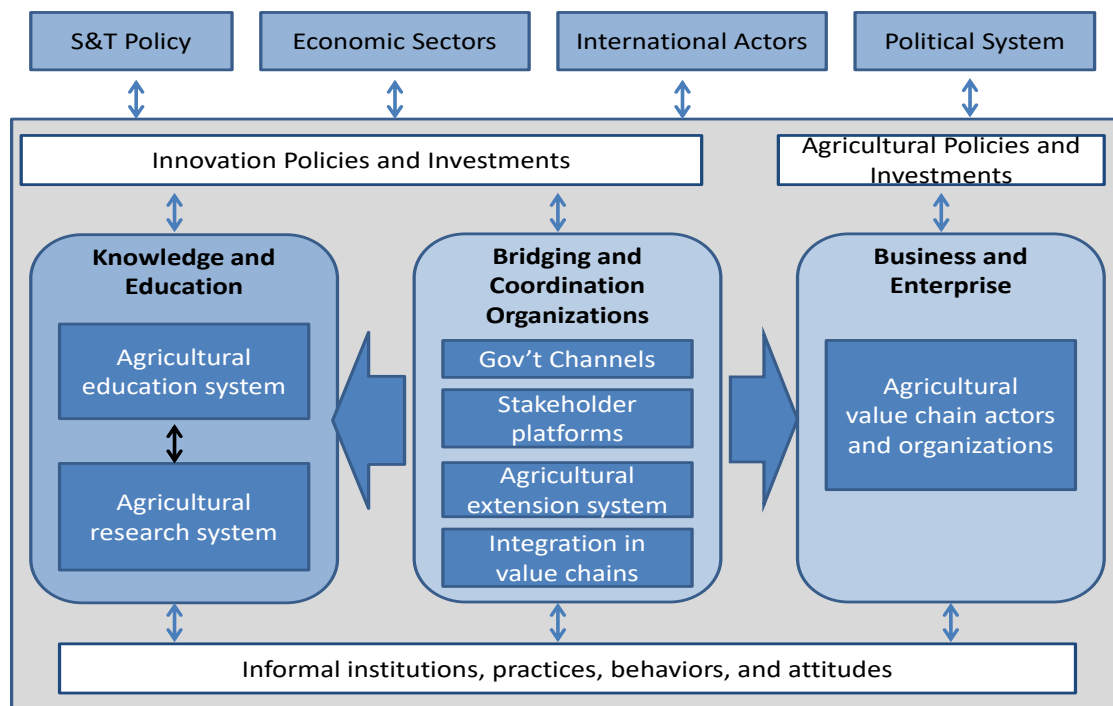
Research, education, and extension are usually not sufficient to bring knowledge, technologies, and services to farmers and entrepreneurs and to get them to innovate. Innovation requires a much more interactive, dynamic, and ultimately flexible process in which the actors deal simultaneously with many conditions and complementary activities that go beyond the traditional domains of R&D and extension. These conditions and complementary interventions have not been consistently addressed to date; new, additional ways and means of doing so are needed (World Bank 2012).

An AIS approach looks at the multiple conditions and relationships that promote innovation in agriculture. It may offer a more flexible means of dealing with the varied conditions and contexts in which innovation must occur. Figure 1 presents a conceptual framework for an AIS modified from Spielman and Birner (2008).

The essential elements of an innovation system include a) knowledge and education domain, b) business and enterprise domain, and c) bridging institutions that link the two domains. The knowledge and education domain is represented at the left-hand side of the Framework and is composed of the agricultural research and education systems. The business and enterprise domain is shown on the right-hand side and comprises the set of value chain actors and activities that both use outputs from the knowledge and education domain, and innovate independently. Between these domains are the bridging institutions such as extension services, political channels, and stakeholder platforms that facilitate the transfer of knowledge and information between the domains (Spielman and Birner, 2008).

The framework also includes reference to the frame conditions that foster or impede innovation, including public policies on innovation and agriculture; informal institutions that establish the rules, norms, and cultural attributes of a society; and the behavior, practices, and attitudes that condition the ways in which individuals and organizations within each domain act and interact.

Implicit throughout the system are farmers who are considered as consumers and producers of knowledge and information, as producers and consumers of agricultural goods and services, as bridging institutions between various components, and as value chain actors. Beyond the borders of the system are essential influencing factors such as linkages to other sectors of the economy (manufacturing and services); general science and technology policy; international actors, sources of knowledge, and markets; and the political system.



Source: modified from Spielman and Birner, 2008

Fig. 1. A conceptual framework of an agricultural innovation system

THE PHILIPPINE INNOVATION SYSTEM

Development of the Philippine innovation system: A brief history

Philippine science and technology (S&T) has a long history, dating back to the early American colonial period during which the Bureau of Science was created focused only on agriculture, health and food processing (Cororaton 2003). Through the creation of the University of the Philippines System and the various S&T-related agencies and laboratories, the Bureau effectively became the training ground for Filipino scientists. In 1946, the Bureau was reorganized into an Institute of Science, under the Office of the President of the Philippines. Major shifts in the 1950s and 1960s focused on S&T institutional capacity building through the establishment of infrastructure-support facilities like new research agencies and manpower development. In response to the need for S&T to generate products and processes that were supposed to have greater beneficial impact on the country, focus was re-directed toward applied research in the 1970s. Furthermore, in the 1980s, research utilization was given stronger emphasis. This led to the creation of the National Science and Technology Authority (NSTA) in 1982 and this reorganization resulted into the creation of the S&T Council System which became responsible for the sectoral formulation of policy and strategies for its specific field and allocation of funds. In 1986, the NSTA was reorganized into what is now called the Department of Science and Technology (DOST) by virtue of Executive Order 128. The DOST, headed by a Cabinet Secretary, was mandated to provide central direction, leadership and coordination of scientific and technological efforts and ensure that the results therefrom are geared and utilized in areas of maximum economic and social benefits for the people.

The Philippine Agricultural Innovation System (AIS)

Based on the AIS framework, the attributes of the Philippine AIS were described according to the three domains: a) knowledge and education domain, b) business and enterprise domain, and c) bridging institutions that link the two domains.

Knowledge and education domain

Agricultural education system

Higher education prepares a country to be globally competitive as they supply skilled human capital. The Commission on Higher Education (CHED) reported that there were 2,374 higher education institutions in the Philippines consisting of 112 main state universities and colleges (SUCs) and 451 satellite campuses, 98 local universities and colleges, 14 other government higher education institutions (HEIs) and 1,699 private colleges and universities (CHED, 2014). The report also revealed a total of 11 Centers of Excellence (COEs) and 13 Centers of Development (CODs) in the fields of agriculture, agricultural engineering, fisheries and veterinary medicine. In the forestry discipline, there are three COEs. The total enrolment in these fields significantly increased from 59,745 in 2010 to 96,164 in 2014.

The National Agriculture and Fisheries Education System (NAFES) was established by virtue of Republic Act (RA) 8435 otherwise known as the Agriculture and Fisheries Modernization Act of 1997. The CHED and the Department of Agriculture (DA) are mandated to establish the system, with funding sourced from the Higher Education Development Fund of CHED. NAFES was implemented through the national universities and colleges of agriculture and fisheries and the provincial institutes of agriculture and fisheries (Vitriolo 2013).

Agricultural research system

The Philippines had a total of 19,151 R&D personnel in 2011. This represented an increase of 15% from previous level in 2009 survey. Looking at sectoral level, 8,874 (46%) of the R&D personnel were from private industry, 6,602 (34%) represented the higher education sector from both public (4,881) and private (1,721) higher education institutions, 3,548 (19%) from the government while only 127 or 1% came from private non-profit institutions. Within the higher education sector alone, almost three-fourths or 74% were employed in public HEIs or SUCs (Estella, 2013). Overall, there were 156 researchers per million population in 2011. It was not specified, however, how many agricultural researchers were available per million population.

In 2011, of the total number of R&D personnel (10,277) in the three sectors - government, higher education and private non-profit institutions, 24% or 2,480 worked as researchers in the field of agricultural science. Of this number, 36% or 1,283 worked in the government, 25% worked in the public (1,145 or 23%) and private HEIs (41 or 2%), while 9% or 11 researchers were in private non-profit organizations (Estella, 2013).

In recent years, the government has recognized the need for investments in R&D. Realizing R&D importance in the development of the agriculture sector, PCAARRD and Department of Agriculture-Bureau of Agricultural Research (DA-BAR), two of the country's top institutions for agricultural researches, have received significant increase in budget allocation from 2010 to 2013. On average, the budget appropriation for PCAARRD and DA-BAR significantly increased at a rate of 41% and 53% annually, respectively, during the same period. For PCAARRD, the dramatic increase in budget allocation was able to augment its

budget for R&D and technology delivery services, from 57.77% in 2010 to 65.30% in 2012. On the other hand, DA-BAR was able to augment funding for the national programs on rice, corn, high value commercial crops and promotion and development of organic agriculture (Aquino *et al.*, 2014).

Agricultural R&D is not the sole purview of public organizations. R&D expenditures for agricultural production and technology in 2002-2011 show that public investment (government and public HEIs) comprised about 88%, on average, and the rest came from the private sector, i.e., private business firms and private HEIs (Aquino *et al.*, 2014). For public R&D, public HEIs contribute almost 43% of total, on average to agricultural R&D.

Business and enterprise domain

As noted in the AIS framework (Figure 1), the agricultural value chains represent the business domain in the agricultural innovation system. An agricultural value chain describes the full range of activities required to bring agricultural goods or services through different phases of production, delivery to final consumers, and final disposal after use, and it incorporates a range of activities within each phase, including both input supply and output marketing systems (Kaplinsky and Morris, 2001 as cited by Spielman and Birner, 2008).

The major actors along the agricultural value chain include input suppliers, agricultural producers/farmers, processing sector, distribution/wholesale/retail, and the consumer base. The agricultural sector's contribution to GDP has decreased from 14% in 2000 to 10% in 2015 (Table 1) while employment was recorded at 29% of the total labor force of 38,742,000 persons in 2015 (Table 2).

The country's manufacturing sector comprises of a number of agri-based industries. In 2015, the food sector was the highest contributor, at 34% (P603,249 Million), to the total manufacturing value added of P1,760,988 million (Figure 2) (Philippine Statistics Authority, 2016).

Table 1. Gross domestic product (GDP) by major sector, 2000 and 2015.

Sector	2000		2015	
	Value*	%	Value*	%
Agriculture	500,111	14	719,748	10
Industry	1,233,773	34	2,535,796	33
Services	1,846,830	52	4,338,225	57
Total	3,580,714	100	7,593,769	100

*At constant 2000 prices, in million pesos

Sources: Philippine Statistics Authority (PSA) National Accounts

<http://www.nscb.gov.ph/sna/default.asp>

<http://industry.gov.ph/>

Table 2. Philippine employment by sector, 2010-2015.

Particulars	2010	2011	2012	2013	2014	2015
Percentage distribution of employed persons (%)*						
Agriculture	33	33	32	31	30	29
Industry	15	15	15	16	16	16
Services	52	52	53	53	54	55
Total employed persons (in thousands)	36,035	37,192	37,600	38,118	38,651	38,742

* Based on PSA Labor Force Survey

Sources: PSA Labor Force Survey <http://WEB0.psa.gov.ph/statistics/survey/labor-force>
<http://industry.gov.ph/employment-by-sector/>

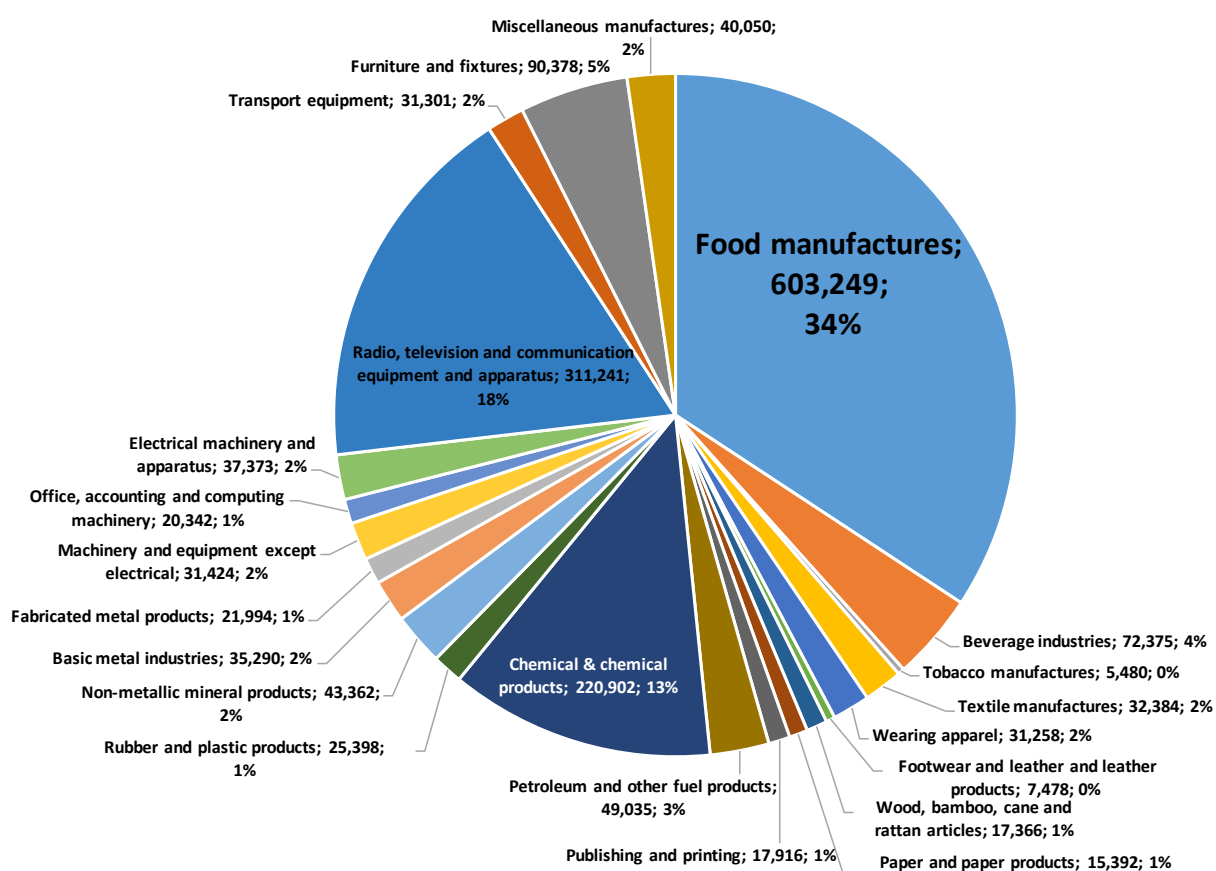


Fig. 2. Philippine Manufacturing Value Added, in million Php, 2015 (based on constant 2000 prices) (Source: Philippine Statistical Authority)

Bridging and coordinating institutions domain

Government channels

The governance of the Philippine AIS is mainly instituted to the three main bridging institutions: Department of Agriculture (DA), Department of Science and Technology (DOST) and Department of Environment and Natural Resources (DENR).

The DA is the delegated agency responsible for promoting agricultural development in the Philippines. It has a network of 48 organizations: Office of the Secretary (nine offices and

services equivalent to directorates), 22 attached agencies, nine bureaus and 16 regional field units (RFUs), including in the Autonomous Region in Muslim Mindanao (ARMM) (Mercader, 2014).

The DOST is envisioned to be a reservoir of scientific and technological know-how providing world-class solutions that empower Filipinos to attain higher productivity and better quality of life. The Department is now composed of three sectoral planning councils; seven research and development institutes; seven S&T service institutes rendering science and technology-related services; two collegial bodies with mandated functions of assistance, recognition, advisory and establishment of international linkages; and 16 Regional Offices headed by a Regional Director and 79 Provincial S&T Centers (PSTCs) manned by PSTC Officers. The three sectoral planning councils include: 1) the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development or PCAARRD; 2) the Philippine Council for Health Research and Development or PCHRD; and 3) the Philippine Council for Industry, Energy and Emerging Technology Research and Development or PCIEERD.

PCAARRD operates mainly through SUCs by offering scholarship grants for graduate degrees and helping universities develop facilities for research in agriculture. The Council also has the capacity to execute large-scale national programs through the mobilization of R&D consortia across the country (Briones and Carlos, 2013).

For the forestry and environment sector, the DENR has as its research agency the Ecosystems Research and Development Service (ERDS) mandated to provide technological support to the regional development thrusts of the DENR.

Agricultural Extension System

The agricultural extension system in the Philippines is public sector driven, but some NGOs and private agri-business companies also play a significant role. The growth and development of agricultural extension in the Philippines has always been associated with government reorganization. It had undergone dramatic changes at different regimes. In 1991, the Local Government Code mandated the devolution of the agricultural extension services to Local Government Units (LGUs). Extension service, which is a basic requirement to effect societal change especially among the disadvantaged sector is now the responsibility of LGUs. More recently, some research and development institutions were mandated to do extension work such as the Philippine Rice Research Institute, the Bureau of Post-Harvest Research and Extension, and the Philippine Carabao Center (Tenorio and Aganon 2006).

There are five major players of agricultural extension systems in the Philippines. These are:

a) bureau and attached agencies of the Department of Agriculture; b) the local government units of the Department of Interior and Local Government; c) the state colleges and universities of the Commission of Higher Education; d) some non-governmental organization; and e) some private agri-business companies (Tenorio and Aganon 2006).

PCAARRD et al. (2015) produced a two-volume book on the Compendium of Extension and Technology Transfer Modalities in Agriculture, Fisheries and Natural Resources in the Philippines. The book documented a total of 215 extension interventions from institutions active in supporting and implementing agricultural extension interventions. DA's Agricultural Training Institute (ATI) has been providing extension services since 1987 through its 16 centers spread across the country, with some 303 extension staff in 2009.

PCAARRD implemented the Techno Gabay Program (TGP) which integrated a number of projects and services through its four main components: (1) Farmers Information and Technology Services; (2) Farmers Scientist Bureau; (3) Information, Education and

Communication (IEC); and (4) Information Communication and Technology (ICT). PCAARRD signed an agreement in 2008 with CHED to mandate SUCs to adopt the TGP. In 2013, the overall implementation of the TGP has been transferred to the DA-ATI through Executive Order 801.

External Environment

An agricultural innovation system is also influenced by the actors, organizations, institutions, and policies that are outside the boundaries of the innovation system. Equally important are the S&T policies, linkages to other sectors of the economy, international actors and the political system.

The Philippine AIS is also influenced by linkages with international actors promoting cross-country supply of agricultural innovation. To name a few, the country's designated department and agencies has at least initiated linkages with the following international actors: Malaysian Agricultural Research and Development Institute (MARDI); Pakistan Agricultural Research Council (PARC); Indonesian Agency for Agricultural Research and Development (IAARD); Japan International Research Center for Agricultural Sciences (JIRCAS); International Technical Cooperation Center–Rural Development Administration (ITCC-RDA, South Korea); Bioversity International; International Livestock Research Institute (ILRI); International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); International Maize and Wheat Improvement Center (CIMMYT); Australian Centre for International Agricultural Research (ACIAR); Food and Fertilizer Technology Center (FFTC); Center of International Agricultural Research Cooperation for Development (CIRAD, France); International Rice Research Institute (IRRI); Food and Agriculture Organization of the United Nations (FAO); Japan International Cooperating Agency (JICA); International Potato Center (CIP); and Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

The Philippines joined the World Intellectual Property Organization (WIPO) in 1980, and has been a party to various international treaties and conventions on intellectual property including World Trade Organization-Agreement on Trade Related Aspects of Intellectual Property Rights (WTO-TRIPS). The following are pertinent laws in the Philippines governing intellectual property and fostering innovation:

- Republic Act (RA) 7459 or the “*Inventors and Invention Incentives Act of the Philippines*”
An act providing incentives to Filipino investors and expanding the functions of the Technology Application and Promotion Institute, appropriating fund therefore and for other purposes. Pursuant to this national policy, the Government shall provide a program to set up a climate conducive to invention and innovation, give encouragement and support to inventors who are creative and resourceful, as well as imbued with a deep sense of nationalism, and maximize the capability and productivity of inventors through incentives and other forms of assistance and support.
- Republic Act 8293 or the “*Intellectual Property Code of the Philippines*”
An Act prescribing the Intellectual Property Code and establishing the Intellectual Property Office, providing for its powers and functions, and for other purposes. Pursuant to this national policy, the State shall promote the diffusion of knowledge and information for the promotion of national development and progress and the common good. The policy shall streamline administrative procedures of registering patents, trademarks and copyright to liberalize the registration on the transfer of technology, and to enhance the enforcement of intellectual property rights in the Philippines.

- Republic Act 8439 or the “*Magna Carta for Scientists, Engineers, Researchers and other Science and Technology Personnel in the Government*”
An Act declaring the policy of the State to provide for a program of human resources development in science and technology to achieve and maintain the necessary reservoir of talent and manpower that will sustain its drive for total science and technology mastery. Pursuant to this national policy, the State shall establish, promote and support programs leading to the realization of this objective, such as science and engineering scholarship programs, improvement of the quality of science and engineering education, popularization of science culture, and provision of incentives for pursuing careers in science and technology.
- Republic Act 9150 or “*An Act for the Protection of Layout-Designs (Topographies) of Integrated Circuits, amending for the Purpose Certain Sections of RA 8293, otherwise known as the Intellectual Property Code of the Philippines and for other purposes*”
The Act amended Sections 112, 113, 114, 116, 117, 118, 119 and 120 under Chapter XIII of RA 8293. Chapter XIII refers to the industrial design and layout designs (topographies) of integrated circuits.
- Republic Act 9168 or the “*Philippine Plant Variety Protection Act of 2002*”
An Act providing protection to new plant varieties, establishing a National Plant Variety Protection Board and for other purposes. The State shall protect and secure the exclusive rights of breeders with respect to their new plant variety particularly when beneficial to the people. It also recognizes the indispensable role of the private sector, encouraging the participation of private enterprises and provides incentives to needed investments in the development of new plant varieties. While recognizing intellectual property rights in the field of agriculture, RA 9168 is still supportive of and not inconsistent with the State’s obligation to maintain a healthful ecology in accord with the rhythm and harmony of nature.
- Republic Act 10055 or the “*Philippine Technology Transfer Act of 2009*”
The Act aims to promote and facilitate the transfer, dissemination and effective use, management, and commercialization of IP, technology and knowledge resulting from research and development (R&D) funded by the government for the benefit of national economy and taxpayers. It was enacted to serve as the catalyst for increasing innovation and commercialization of technologies generated from government-funded R&D. The Act acknowledges that the successful transfer of government-funded R&D results depends on the proper management of intellectual property, development of capacity by R&D institutions (RDIs) to become competitive, and enhancing interaction and cooperation with the private sector through collaborative and contract research based on equitable, fair access, and mutual benefit for all involved actors.
- Republic Act 10372 or “*An Act Amending Certain Provisions of RA 8293, otherwise known as the Intellectual Property Code of the Philippines, and for other purposes*”
The Act amended certain provisions of the Intellectual Property Code of the Philippines. Among the amendments to the Intellectual Property Code are the following: establishment of the Bureau of Copyright and Other Related Rights within the Intellectual Property Office of the Philippines (IPOPHE); grant of specific enforcement functions to the Director General of IPOPHE and his deputies; implementation of technological protection measures and rights management information for copyrighted works disseminated through Internet; copyright limitations and exceptions for the benefit of visually-impaired persons; fair use exceptions to copyright; and clarifications on copyright infringements.

SUMMARY AND POLICY IMPLICATIONS

The Philippine agricultural innovation system (AIS) can be described as fragmented in the nature of governance structure. According to Zurn and Faude (2013), institutional fragmentation generates the problem of coordination and simultaneously creates the opportunity structure for its resolution: a world polity that is sufficiently coordinated to prevent enduring inter-institutional conflict and, at the same time pluralist enough to respect the diverging governance task. The challenge here is not to compete with each other but to complete each other. The legal aspects revealed that a number of pertinent laws have been crafted governing intellectual property since the Philippines joined the World Intellectual Property Organization (WIPO) in 1980. Hence, the policy environment now favors technology commercialization. However, there is a need for a more in-depth and comprehensive studies on how these policies are mainstreamed and implemented within the AIS. Taking stock of our innovation efforts in view of these policies fostering innovation is a good starting point to strategize future courses of actions. The Global Competitive Index report pointed out that updated business practices and investment in innovation are now as important as infrastructure, skills and efficient markets (Schwab 2016). Hence, it is imperative for a country to create the vision of a competitive agricultural innovation system.

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