Institutional Responses on Strengthened Intellectual Property Rights in Agriculture and Needs' Assessment on Intellectual Property Management of Public Research Institutions in Asian Developing Countries

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Abstract

Intellectual property rights (IPRs) are being introduced or strengthened in developing countries as a result of international agreements such as the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO). This study conducted a web-based survey to gain perspective on the impact of IPRs to public research institutions in developing countries and how these institutions have responded to IPR developments. Specifically, this survey collected information from research directors (n=43) of public research organizations in India, Malaysia, Philippines,

Thailand, and Vietnam. Overall, this study strongly indicates that research administrators in the five countries are positive towards IPRs and the implementation of measures to build their institutional IPR management capacities. They have also started to build their IPR structures and procedures by setting up IP policies and offices, but strengthening is needed, particularly in the area of technology commercialization. This research serves as a reference for international institutions interested in and/or evaluating capacity programs allowing them to craft projects that can better foster the importance of IP management to these and similar institutes in the developing world.

Keywords: commercialization, developing countries, IPR, IP management, technology transfer, public sector, capacity building, public agricultural research

Introduction

Public research universities are the main source for new technologies and innovations in developing countries. As intellectual property rights (IPRs) are expanded to include the agricultural sector, universities must adapt by taking on new roles and challenges to drive the implementation of new agricultural models in these societies. IPRs are rights over IP conferred by law, and form part of a nation's policy to encourage invention, innovation, and dissemination of technology for economic development. IPRs is a broad term used to cover patents, trademarks, plant breeders' rights, copyright, trade secrets and other types of rights that the law gives for the protection of investment in creative effort and knowledge creation.

A lively debate has emerged in the academic literature about possible implications of IPRs to public agricultural research. Such implications of IPRs, in general, can be divided into three themes: access of proprietary technologies, conduct of R&D, and dissemination of research results. With IP protection becoming a norm for public research institutions, it is also an open issue as to how many agricultural innovations will be available in the public domain, and how many will be patented and available for a fee (Maredia, Oehmke, & Byerlee, 2004). Sociologists of science, who use the tools of humanities and social sciences to study science and technology as a social activity, find this as a violation of scientific cultural norms because, to them, scientific progress is linked with an ideal of free and open dissemination of scientific information. Expansion of IPRs will restrict free circulation of ideas and will adversely affect and/or impede dissemination of new technologies and innovations and exchange of information among scientists, an important aspect of scientific research.

Hence, under this changing environment for IPR protection, agricultural research organizations in developing countries need to analyze efficient and effective ways of acquisition of new technologies or products. Access to new technologies and modern scientific methods covered by IPRs would require them to negotiate deals and execute formal licensing agreements (Maredia, Erbisch, Ives, & Fischer, 1999; Van Wijk & Komen, 1993). For institutions with budget constraints, these developments mean that they need to seek assistance for a freedom to operate (FTO) – the ability to practice or use an innovation or proprietary technologies royalty-free for research. Graff, Cullen, Bradford, Zilberman, &

Bennett (2003) and Heller & Eisenberg (1998) claimed that these IPR-related mechanisms are additional transaction costs and serve as a barrier for these institutions that can stifle further scientific progress, since without agreement of waiver of IPRs, research delays could occur.

Likewise, the increased push for IPR protection for publicly funded research means that research institutions also need to investigate the possibility of their own organizations developing the means of protection and commercialization of their technologies and products (Salazar, Falconi, Komen, & Cohen, 2000). Public sector institutions in developed countries, especially US universities, have increased their patenting and commercialization of their research outputs, especially in modern agricultural biotechnology (Heisey, King, & Rubenstein, 2005). For Thursby & Thursby (2002), these shift research agenda of these institutions while Aghion, Bloom, Griffith, & Howitt (2002) claimed that IPRs can limit the process of cumulative scientific discovery. As Davis, Larsen, & Lotz (2000) claimed, the freedom to choose research subjects by public sector scientists may come under pressure whenever institutions "behave like firms." Institutions are encouraged or even forced to produce patentable research results that are commercially viable, discouraging non-patentable research.

Public research institutions in developing countries have evolved in a world without IPRs. Hence, it is important to understand how they have responded and adapted to this new environment while maintaining continuity of service to their stakeholders. This paper discusses IPRs as they relate specifically to biotechnology and genetically modified organisms being used as tools to achieve sustainable improvement of crop productivity. This study uses the definition of biotechnology as covering the application of tissue culture, immunological techniques, molecular genetics, and recombinant DNA techniques in all facets of agricultural production and agro-industry.

Focusing in five countries in developing Asia, this study aims to provide such information and add insights to the state-of-the-art in the IP challenges confronting public research institutions. Realizing that the development of innovative capabilities and institutional policies depends on a strong and sustained commitment from the authorities, this study targeted institutional heads and research administrators of public research organizations doing agricultural biotechnology in India, Malaysia, Philippines, Thailand, and Vietnam. The respondents were asked about their perceptions of the concept of IPRs and the implications of IPRs on public agricultural research, and the current capability and priority needs in handling IP issues. This research can serve as reference for international institutions interested in developing action plans and/or capacity programs on IP management. This may also enable a subsequent step towards an analytical framework to investigate institutional capacity for IP management in the public agricultural institutions in developing countries.

Methodology

The focus of this research was on public agricultural research institutions in five countries in Asia: India, Malaysia, Philippines, Thailand, and Vietnam. The scope includes universities and research institutions conducting agricultural biotechnology in these five

countries. This list of institutions was obtained from the Food and Agriculture Organization (FAO)-Biotech (FAO-BioDec) database (FAO, 2005), which contains baseline information on state-of-the-art crop biotechnology products and techniques that are either in use or in the pipeline in developing countries. Names and contact information of the respondents were obtained from their respective institutional websites and were included in the circulation list. The project was reviewed and approved by Institutional Review Board at Washington State University (WSU-IRB # 10650 Activity #002).

A web-based survey format was constructed to determine current perceptions, status, and needs assessment of the different public research institutions on IPRs. This was chosen for several reasons. Samples included personnel working in Asia's public universities and research institutions with active and up-to-date websites. These institutions tend to have high-speed Internet access, minimizing difficulty in accessing a web-based survey. Web-based surveys also reduced time to completion, direct branching, and reduce overall survey costs if no significant programming is required (Schonlau, Fricker, & Elliott, 2002).

To ensure that these surveys were clear and concise, the questionnaire was pre-tested to improve the clarity of questions and instruction, and determine the understandability and validity of the contents. The pre-test group included members of the National Partners' Initiative (NPI) of the Central Advisory Service on Intellectual Property (CAS-IP). NPI is a community of IP practitioners based in developing and emerging economies working together to support partnerships in relation to IP and technology transfer management between the Consultative Group on International Agricultural Research (CGIAR) centers and National Agricultural Research Systems (NARS). Comments received from this group were used to refine the survey instrument. None of the data collected in the pre-test were used in the final research analysis.

The online survey instrument and the resulting hosted web site was designed and managed by WSU-SESRC. Selected faculty and staff from WSU then tested the final web-based survey questionnaire and validated the survey process. The survey was designed in such a way that respondents could review and change their responses. Response to the survey was completely voluntary, and it was expected that some of the respondents would skip some of the questions. Undesirable access to survey pages was controlled through firewalls set up by the SESRC server. Randomly generated personal access codes assigned to respondents also controlled access to the survey. Respondents entered their unique access code at the survey homepage to gain access to the survey itself. Once a survey was completed, the used access code became invalid and further access to the survey using that code was denied. The SAS statistical package was used to analyze the survey data. Descriptive statistics such as mean, frequency, and percentage were primarily employed in the interpretation and comparison of data among groups. Decision rules were set for interpreting numeric data to draw final conclusions. For those items where one category received 40% or more with the other three categories receiving 25% or less of the responses, this occurrence was called "a clear majority." A response pattern was "without a clear majority" when all four categories received 25% or less of the responses.

The survey questionnaire consisted of 27 questions split into three sections. Section A, technology transfer capabilities, collected information on capabilities, including experiences of institutions with IP management and technology transfer. Section B, IP protection to agricultural biotechnology management, collected information on the attitudes of institutional heads and research managers on the features of IPRs and the implications to their scientists, institutions, and public agricultural research. Section C, background information collected demographic data. All three sections included multiple-choice questions, Likert-scaled responses, and open-ended questions.

Results and Discussion

Through a web-based survey, information was collected on how research administrators view the concept, importance, and implications of IPRs to public agricultural research. The survey was designed to determine the current capability, as well as capacity needs of their respective institutions in handling IP issues, especially those related to modern agricultural biotechnology. Ninety-one institutions (90% of 101) conducting agricultural biotechnology and their institutional heads or research administrators were selected for the survey. Of these 91, 36 institutional heads (39.56%) responded to the survey, with seven partially completing the form, resulting in a total response rate of 47%.

Profile of Respondents

As shown in Table 1, agricultural biotechnology R&D in the five countries is predominantly administered by male professionals (72.2%). This finding is expected, since the majority of government and agriculture personnel in India, Malaysia, Philippines, Thailand, and Vietnam are males (UNESCO, 2010). Most respondents were aged 51-60 (52.8%), and a majority (75%) held a Doctor of Philosophy degree. The high number of PhDs is also not surprising, especially in India, since many developing countries invest in training and higher education to increase a nation's position as a knowledge economy. These research administrators led an institution size of more than 200-1000 employees (52.8%). Most of the respondents (30.6%) came from institutions in India and the Philippines.

Perception and Awareness on IPRs and their Developments

Respondents were asked to evaluate, on the 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), the different features of IPRs. Most of the respondents strongly agreed that IPRs give owners exclusive rights to control the users of the property (20 of 35, 57.14%); give owners the exclusive rights to sell, lease or transfer the property right (18 of 35, 51.43%); clearly define the geographic and time scope of the property (18 of 35, 51.43%); allow public access to the property under strict professional scientific guidelines (16 of 35, 45.71%); clearly define relative rights of individual innovator/inventor and institution, agency, organization (24 of 35, 68.57%); and provide income/incentives to innovators or inventors (24 of 35, 68.57%) (Table 2). To them, IPRs can be a

Table 1: Socio-Demographic Characteristics of the Respondents

Characteristics		Frequency	Percent	N
Gender	Male	26	72.2	36
	Female	10	27.8	
Age	Less than 30	2	5.6	36
	31-40	4	11.1	
	41-50	11	30.6	
	51-60	19	52.8	
Position in the institution	Professor	4	11.8	34
	Associate Professor	4	11.8	
	Assistant Professor	1	2.9	
	Director	13	38.2	
	Senior Research Scientist	7	20.6	
	Other	5	14.7	
Highest level of education	Bachelor (BA/BS)	3	8.3	36
	Master (MA/MS)	5	13.9	
	Doctor (Phd/EdD/DSc)	27	75.0	
	Others	1	2.8	
Number of staff supervised	None	5	13.9	36
	1-5	5	13.9	
	6-10	6	16.7	
	11-19	7	19.4	
	20 or more	13	36.1	
Size of institution	Less than 200 employees	7	19.4	36
	200 - 999 employees	19	52.8	
	1,000 - 4,999 employees	9	25.0	
	5,000 - 9,999 employees	1	2.8	
Country	India	11	30.6	36
	Malaysia	2	5.6	
	Philippines	11	30.6	
	Thailand	4	11.1	
	Vietnam	8	22.2	

source of additional income, and the key important feature of IPRs is providing incentives to innovators or inventors. Six survey respondents reported that IPRs as incentives can specifically help inventors remain in their own countries and develop new technologies. One institutional head explained that incentives from the government are few or nonexistent, resulting in the

Table 2: Respondents' Perceptions on the Features of IPR

Features of IPRs	Frequency (Percent)					
	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Do Not Know	Total
Give owners the exclusive rights to control the users of the property	4 (11.4)	4 (11.4)	6 (17.1)	20 (57.1)	1 (2.9)	35 (100)
Give owners the exclusive rights to sell, lease or transfer the property right	2 (5.7)	6 (17.1)	9 (25.7)	18 (51.4)	-	35 (100)
Clearly defines the geographic and time scope of the property	2 (5.9)	6 (2.9)	9 (44.1)	18 (47.1)	-	35 (100)
Allow public access to the property under strict professional scientific guidelines	1 (2.9)	5 (14.3)	16 (45.7)	13 (37.1)	-	35 (100)
Clearly defines relative rights of individual innovator or inventor and institution, agency, organization	1 (2.9)	2 (5.7)	8 (22.9)	24 (68.6)	-	35 (100)
Provide income/incentives to innovators or inventors	2 (5.7)	1 (2.9)	5 (14.3)	26 (74.3)	-	35 (100)
Analysis: Most of the respondents positively responded on the different features of IPR.						

flight of best researchers to foreign lands. Higazi (2005) highlighted the importance of incentive policies to reverse "human capital flight" or the "brain-drain" phenomenon.

Most of the respondents (83.4-88.9%) are aware of the three most discussed IPR-related international treaties and conventions: World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights (WTO-TRIPS); the Convention on Biological Diversity (CBD); and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) (Table 3). They also claimed that their institutional IP policies comply with these international treaties.

Implications of IPRs to Public Research Institutions and Public Agricultural Research

These questions aim to reveal common perceptions of respondents regarding the benefits and risks of IP to public research institutions and to public agricultural research in general. As cited by one of the survey participants, many universities receive governmental funds to support R&D and generate new technologies. Such technologies are then freely accessible to the public. The use of IPR's has been criticized as privatizing knowledge and restricting public access to publicly funded research. A majority of the respondents (50-76.5%), however, did not share this same perspective as they agreed on the positive influence of IPRs on agriculture and agricultural research. As presented in Table 4, they strongly agreed that IPRs do not constrain or reduce the flow of technology transfer among national agricultural research systems (51.56%). Respondents further stated that IPR regulations do

Table 3:
Awareness of Respondents on International Laws on IP and Agricultural Biotechnology

International Treaties	Response	Frequency	Percent	N
1. The Trade-Related Aspects of Intellectual Property Rights (TRIPS)	Well Informed	15	41.7	36
	Somewhat Informed	17	47.2	
	Not Sure/Not Aware	4	11.1	
2. Convention on Biological Diversity	Well Informed	16	43.2	37
	Somewhat Informed	17	45.9	
	Not Sure/Not Aware	4	10.8	
3. The International Treaty on Plant Genetic Resources for Food and Agriculture	Well Informed	15	41.7	36
	Somewhat Informed	15	41.7	
	Not Sure/Not Aware	6	16.7	
Analysis: Most of the respondents (83.4-88.9%) are aware on these international treaties. They also claimed that their institutional IP policies comply with these international treaties.				

not delay the research process or result in research stoppage (57.5%), and do not promote competition, but rather enhance collaboration with the private sector (55.9%). Respondents also agreed that IPRs:

1. foster creativity and stimulate invention and new innovations by scientists (76.5%);
2. help increase agricultural production (50%);
3. promote and disseminate use of new knowledge and technologies (50%);
4. promote domestic and foreign investments in biological innovations(55.9%);
5. serve as incentives/reward mechanism for scientists/researchers (67.6%);
6. foster public-private sector collaboration (50%);
7. provide additional budget for institution (52.9%);
8. influence institutional policy to generate more agricultural biotechnologies and products (50%); and
9. result in more focused R&D, increased institutional productivity, and credibility (60.0%).

Current Capacity and Capability-Building Needs of Institutions on IP Management and Technology Transfer

A majority of the respondents (70%) indicated that their institutions possess an office that manages the identification, promotion, and commercialization of intellectual property (Table 5). These offices provide a one-stop shop to advance the development of each institution's technologies, inventions, and discoveries, facilitate patent protection, and foster strategic collaborations with industry through licensing, sponsored research, and new venture agreements. The Philippine Rice Research Institute, a rice R&D institution located in the Philippines, has an IP Management Office that evaluates technologies for protection,

Table 4:
Perception of Respondents on the Impacts of IPR to the Agriculture and Agricultural Research

Features of IPRs	Frequency (Percent)					
	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree	Do Not Know	Total
Foster creativity and stimulate invention and new innovations by scientists	1 (2.9)	1 (2.9)	5 (14.7)	26 (76.5)	1 (2.9)	34 (100)
Help increase agricultural production	2 (5.9)	2 (5.9)	11 (32.4)	17 (50.0)	2 (5.9)	34 (100)
Promote and disseminate use of new knowledge and technologies	2 (2.9)	2 (5.9)	12 (35.3)	17 (50.0)	2 (5.9)	34 (100)
Promote domestic and foreign investments in biological innovations	1 (2.9)	12 (35.3)	-	19 (55.9)	2 (5.9)	34 (100)
Serve as incentives or reward mechanism for scientists or researchers	1 (2.9)	12 (35.3)	-	23 (67.6)	2 (5.9)	34 (100)
Facilitate access of biotech IPs from other laboratories or countries	1 (2.9)	5 (14.7)	15 (44.1)	11 (32.4)	2 (5.9)	34 (100)
Increase costs of accessing research material or tools	1 (2.9)	2 (5.9)	14 (41.2)	16 (47.1)	1 (2.9)	34 (100)
Foster public-private sector collaboration	2 (5.9)	1 (2.9)	12 (35.3)	17 (50.0)	2 (5.9)	34 (100)
Source of additional budget for institution	1 (2.9)	2 (5.9)	11 (32.4)	18 (52.9)	2 (5.9)	34 (100)
Influence institutional policy to generate more agricultural biotechnologies and products	1 (2.9)	1 (2.9)	13 (38.2)	17 (50.0)	2 (5.9)	34 (100)
Result in more focused R&D, increased institutional productivity, and credibility	1 (2.9)	2 (5.7)	10 (28.6)	21 (60.0)	1 (2.9)	35 (100)
Distort and conflict with public mission of institution resulting in social disservice	9 (27.3)	6 (18.2)	11 (33.3)	6 (18.2)	1 (3.0)	33 (100)
Delay publication of research and has a negative effect on science	8 (23.5)	6 (17.6)	14 (41.2)	5 (14.7)	1 (2.9)	34 (100)
Require big investment (manpower, facilities, finances) for institutions	4 (11.8)	7 (20.6)	14 (41.2)	8 (23.5)	1 (2.9)	34 (100)
Promote competition rather than collaboration with the private sector	7 (20.6)	12 (35.3)	8 (23.5)	6 (17.6)	1 (2.9)	34 (100)
Divert resources to areas resulting only in IPRs; thus, inhibit or hamper exploration of fundamental long-term basic research questions	7 (20.0)	10 (28.6)	10 (28.6)	6 (17.1)	2 (5.7)	35 (100)
Delay the research process and often times result in stopping research	8 (24.2)	11 (33.3)	9 (27.3)	3 (9.1)	2 (6.1)	33 (100)
Constrain or reduce the flow of technology transfer among national agricultural research systems	8 (22.9)	10 (28.6)	5 (14.3)	10 (28.6)	2 (5.7)	35 (100)
IPR agreements are too legalistic for scientists to understand and comply	3 (8.8)	7 (20.6)	13 (38.2)	9 (26.5)	2 (5.9)	34 (100)
Prevent or serve as threats to future scientific investigation from IPR on previous research	7 (20.6)	9 (26.5)	9 (26.5)	7 (20.6)	2 (5.9)	34 (100)
Analysis: Majority of the respondents were positive on the impact of IPR to agriculture and agricultural research.						

facilitates patent prosecution, and handles commercialization agreements with the private sector. Other institutions in the Philippines with IP offices have similar administrative organization and functions.

Table 5: Current Capacity on IP Management and Technology Transfer

	Investments in IP management	Frequency	Percent	N
Office engaged in IP identification, protection, promotion and commercialization				
Identification	Yes	25	69.4	36
	No	10	27.8	
	Not Sure/Not Aware	1	2.8	
Protection	Yes	25	67.6	37
	No	12	32.4	
	Not Sure/Not Aware	0	0	
Promotion	Yes	25	65.8	38
	No	10	26.3	
	Not Sure/Not Aware	3	7.9	
Commercialization	Yes	25	65.8	38
	No	10	26.3	
	Not Sure/Not Aware	3	7.9	
Institutional IP policies and procedures	Yes, policies existing	28	73.7	38
	Yes, policies in discussion	2	5.3	
	No policies existing or planned	7	18.4	
	Not aware/don't know	1	2.6	
Number of staff working IP management unit	None	14	37.8	37
	1-3	9	24.3	
	4-5	9	24.3	
	More than 5	5	13.5	
Budget for IP management activities	None	17	45.9	37
	Less than $20,000	13	35.1	
	$20,000 - 24,999	1	2.7	
	$25,000 - 39,999	1	2.7	
	$40,000 - 44,999	1	2.7	
	$45,000 - 59,999	1	2.7	
	$60,000 - 79,999	2	5.4	
	$80,000 and above	1	2.7	
Analysis: Majority of the respondents (>70%) indicated that their institutions have offices that manage the identification, promotion and commercialization of intellectual property. It was interesting to note, however, that the respondents indicated that there is no regular staff working on their IP management units. Most of them also indicated that there is no regular budget for their IP management efforts.				

Table 6: Assessment of Institutional Capacity

International Capacity		Frequency	Percent	N
Institutional capacity rating	Very good	5	13.9	36
	Good	14	38.9	
	Fair	9	25.0	
	Poor	6	16.7	
	Very poor	2	5.6	
Effectiveness of institutional IP management program	IP management program was suited to address these programs	18	50	36
	IP management program was not effectively organized to address these problems	6	16.7	
	Did not personally deal with these problems	7	19.4	
	Not sure/Not aware	5	13.9	
	Not sure/Not aware	5	13.9	
Analysis: Most of the respondents (52.8%) considered their institutional capacity as "good enough" and well suited to address problems associated with access, generation, and technology transfer of agricultural biotechnology intellectual properties.				

Most respondents (73%) revealed that institutional IP management and technology transfer policies guide the operations of their IP offices. It was interesting to note, however, that the respondents indicated that there is no regular staff working in their IP management units. Despite limited human and financial resources (Table 6), many respondents considered their institutional capacity as "good enough" (38.9%) and well suited to address problems associated with access, generation, and technology transfer of agricultural biotechnology intellectual properties (50%).

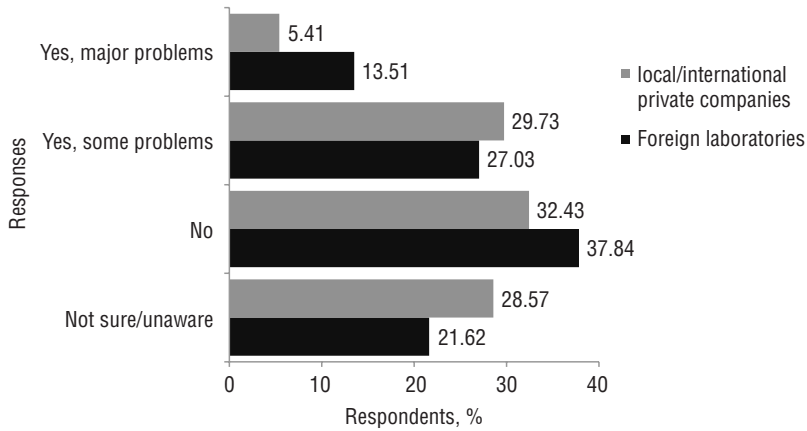

Figure 1. Percentage of respondents with experience on material exchange with different institutions. Institutional heads revealed that they did not have major problems in accessing new biological materials from other institutions, private or public, local and abroad.

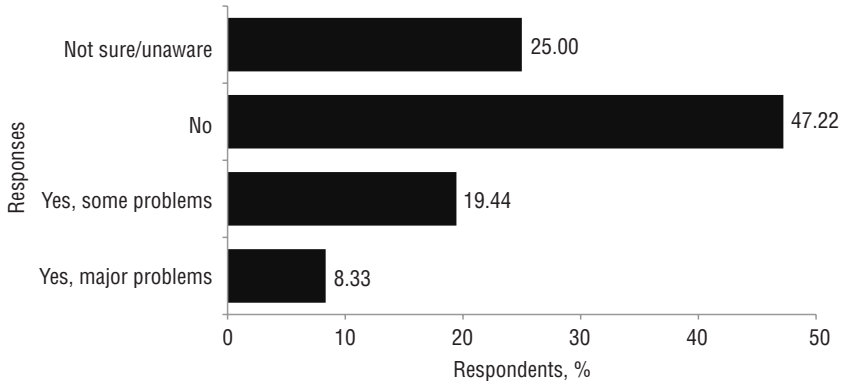

Figure 2. Percentage of respondents that claimed that their seeking protection or pursuing commercialization of their research outputs do not cause issues with their researchers and the community they serve.

IPRs are also criticized for restraining access and exchange of research tools within the global scientific community. Most of the institutional heads indicated that their institutions are not aware (50.19%) or do not have difficulties accessing proprietary materials and new genetic resources from other local and international institutions (public and private) (70.27%) (Figure 1). Should such problems arise, they cannot associate them with the strengthening of IPRs. Many respondents (47.2%) claimed that seeking protection and pursuing commercialization of their research outputs are not problematic for their researchers and the community they serve (Figure 2).

As shown in Table 7, many of the institutional heads indicated that they highly prioritize the further development of their institutional IP policies (29.4%), commercialization or licensing out their technologies (47.1%), and marketing their technologies (44.1%). Some of the research managers in Vietnam indicated that developing an IP policy should be a priority since IP awareness in their country is quite low. One research manager in India, meanwhile, stated that commercialization is important because it helps to accelerate the rate of transfer of technology or end products to the farmers. This helps the farming community benefit from the technology in a better and uniform fashion, instead of technology benefits trickling to only some pockets. Some respondents revealed that they give moderate priority on IP valuation (44.1%), freedom-to-operate and negotiation (32.4%), and prosecuting or filing for IPR protection (30.3%). Many of the respondents indicated that they give less priority to improving their capacity on setting up new or start-up companies (21.2%), developing legal instruments (29.4%), and technology acquisition of protected technologies (30.3%).

A Note on Interpretation of Statistics

The frequency and percentages reported here are based on a non-random sample of research administrators with email addresses available in the web and whose institutions

Table 7: Priority of Institution on Each Policy on IP Management and Technology Transfer

FIP management areas needing assistance	Frequency (Percent)					
	1 Very low priority	2 Low priority	3 Moderate priority	4 High priority	5 Very high priority	Total
Developing an IPR policy	6 (17.6)	5 (14.7)	8 (23.5)	10 (29.4)	5 (14.7)	34 (100)
Developing legal IP instruments	6 (17.6)	10 (29.4)	9 (26.5)	7 (20.6)	2 (5.9)	34 (100)
Freedom-to-operate and negotiation	4 (11.8)	5 (14.7)	11 (32.4)	12 (35.3)	2 (5.9)	34 (100)
Prosecuting/filing for IPR protection	6 (18.2)	4 (12.1)	10 (30.3)	7 (21.2)	6 (18.2)	33 (100)
Technology commercialization or licensing out of technologies	3 (8.8)	3 (8.8)	4 (11.8)	16 (47.1)	8 (23.5)	34 (100)
Technology acquisition of protected technologies	5 (15.2)	10 (30.3)	8 (24.2)	8 (24.2)	2 (6.1)	33 (100)
IP valuation	5 (14.7)	2 (5.9)	15 (44.1)	7 (20.6)	5 (14.7)	35 (100)
Marketing of technologies	3 (8.8)	2 (5.9)	8 (23.5)	15 (44.1)	6 (17.6)	34 (100)
Setting up of new or start-up companies	9 (27.3)	4 (12.1)	7 (21.2)	6 (18.2)	7 (21.2)	33 (100)
Analysis: Most of the research administrators indicated that they give high priority to developing further their institutional IP policies (29.4%), commercializing or licensing out their technologies (47.1%), and marketing their technologies (44.1%).						

are also listed in FAO-Biotech database. Results of the study are limited to the respondents of the survey and may not represent all public sector institutions working on agricultural biotechnology in the countries studied. No measurements of sampling or non-sampling errors were included in this report since the statistic generated here was not use to estimate a wider population.

Conclusions

Public research institutions, the significant supplier of technological innovations in agriculture in developing countries, now operate in an environment of intellectual property rights (IPRs). The advent of the international IPR regime, the concomitant protection of research tools and other technologies needed for research, the increased participation of the private sector in agriculture, and the increasing emergence of public-private partnerships are some of the developments that are transforming public agricultural research and pose challenges to how public research institutions manage their intellectual assets. There are profound implications for national research institutions that do not take care of the

intellectual assets within their public trust – including local germplasm, technologies, software, information, publications, vaccines, databases, methodologies and know-how. It is therefore important to understand how these institutions have adjusted to the challenges associated with the expansion of IPRs in the agriculture sector.

This study conducted a web-based survey to gain perspective on the implementation status of IP management and technology transfer among public research institutions in developing countries in Asia. Specifically, this survey consulted institutional heads from 91 public research organizations in India, Malaysia, Philippines, Thailand, and Vietnam to determine their perceptions on the impact of IPRs on agriculture and agricultural research. This research also determined their capability, as well as capacity needs, for handling IP issues especially as they relate to the use and commercialization of modern agricultural biotechnology.

Forty-three out of 91 respondents (47%) participated in the survey. The summary of major findings and their implications are as follows:

Respondents are aware of the features and advantages of IPRs and are positive towards their implementation in public research institutions and their impact on public agricultural research. Most of the institutions (70%) have one-stop shop IP offices in place (in charge of evaluation, protection, dissemination, and commercialization), backed with internal IP policy on management and technology transfer. Yet these are different in US settings (with different entities doing the evaluation, protection, marketing and commercialization of technologies). This indicates their appreciation of the importance of IP management and acceptance that the implementation of IP infrastructure and processes is now important to help address their IPR-associated concerns on agricultural research (especially on agbiotech), and help in their institutional IPR decisions whether to deliver services and technologies for free or license them to other institutions for a fee.

The institutional heads (47.22%) indicated that they did not experience conflicts with their researchers and the community they serve with regards to protecting and commercializing their research outputs. This may indicate that their researchers and their clients understand and support their IPR initiatives. However, the institutions' policy and procedures are not well supported with regular personnel and budget. Public institutions need more than just policy to enable ownership and protection of intellectual assets. These findings may indicate that the institutions surveyed deal with IPR management through an ad hoc committee. The nonprofit international agricultural research, International Rice Research Institute (IRRI), for instance, dealt initially with IPR issues using a similar committee, but subsequently built an in-house facility due to increasing IP management activity. This area needs further review and consideration.

The strengthening of IPRs in agriculture does not impair each institution's access to proprietary technologies from other institutions that are needed for research. This implies that despite the proliferation of patent protection in some research tools, the practice

of "sharing" among public sector institutions as part of their cultural norms continues. According to Kent (2004) and Pardey, Wright, Nottenburg, Binenbaum, & Zambrano (2003), the argument that access to biotech tools by public sector researchers in developing countries is restrained by IPRs is misunderstood, since certain key biotechnologies are rarely protected in developing countries. Such territorial limitations of IPR (e.g American patents enforceable only in US territory) provide far greater freedom to operate for public agricultural research centers in developing nations.

Most of the respondents considered their institutional capacity on IP management and technology transfer as good, but consider technology commercialization or licensing as their highest priority needing capacity assistance. Competency training, focused on understanding the process of licensing new agricultural innovations to the private sector, will be important for these institutions to bring their research outputs into the commercial marketplace.

A survey conducted by Maredia (2001) of 27 researchers and managers in 28 developing countries identified four indispensable broad areas that are vital in implementing the IPR framework in public research institutes. These areas include: human resources development focused on training and awareness creation on IPR issues, negotiation skills, research and marketing tools to value intellectual properties; institutional capacity building focused on establishment of an IP management office, development of guidelines, policies, and handbooks; and financial resources to meet the expenses of protecting and accessing IP technologies. Almost a decade after that study, the survey reported in this manuscript has proved that public institutions in developing countries are still faced with the same capacity challenges on IP management and technology transfer. However, these are understandable as IP management and technology transfer are quite novel concepts for these institutions. Embracing IPRs, an organizational innovation in government-funded institutes, is not an easy task. Institutional policies can be slow to take shape, dedicating resources and establishing offices. Deploying staff for these functions takes time and commitment.

The number of institutions surveyed may not be indicative of the entire picture of IP management and technology transfer in developing countries in Asia. However, this study shows that the surveyed institutions are supportive of IPRs and their management despite negative stories about impact of IPRs on public mission of public research institutions. This also indicates that the changing mindset towards managing and exploiting IP is taking shape in the public research institutions surveyed. In spite of this shift in perspective, the efficiency of the institutions' IP management structure cannot be fully deduced considering the lack of regular personnel and budget to support their IP management efforts. Pefile & Krattiger (2007) recognize this lack of funding and inadequacy of human and financial resource capacity to invest in institutional IP management policies and resources in developing countries.

Coherent IP management and technology transfer strategies and institutional policies are essential to ensure that benefits from new technologies resulting from investments in agricultural research (e.g., agricultural biotechnology) are developed and flow to the public. This can be an expensive activity, very difficult to implement and justify. Institutions

and countries with limited resources may consider other options to achieve the same goals (e.g., a common office for various institutions, or appointing an IP officer rather than establishing a full-fledged office). IP management bottlenecks can also be overcome creatively by building strategic alliances, outsourcing, building a seed fund, and asking for external resources. The positive perception and remarkable start of IP management and technology transfer by these institutions should guide them in further improving and/or strengthening their IP structures and procedures. Overall, this study presents the current status of IP management in surveyed institutions in India, Malaysia, Philippines, Thailand, and Vietnam, and can serve as a reference for international institutions aiming to build capacities of these institutes on IP management and technology commercialization.

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