An overview of trends in multilateral environmental agreements with an impact on biotechnology and research in Asia and the Pacific

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Abstract

The international community has responded to the call for increased management of biotechnology which may harm the environment through participation in multilateral environmental agreements (MEAs). Some of these agreements contain specific provisions which are at the heart of the foundation, both implicitly and explicitly, for international regulation of biotechnology. The implications of these agreements for biotechnology research are discussed. The membership of countries in the Asia and Pacific region to specific MEAs is discussed in the context of selected economic, political, geographical and agricultural indicators.

INTRODUCTION

Several major multilateral environmental agreements (MEAs) (Table 1) contain provisions that carry possible regulatory implications for the direction and means of biotechnology, which is broadly defined by the Food and Agriculture Organization (FAO) as, 'any technological application that uses biological systems, living organisms, or derivates thereof, to make or modify products or processes for specific use.'[1] At present, a significant portion of biotechnology and related research is funded, and self-governed, by biotech industries. Byerlee, Lead Economist of the World Bank, and Fischer, former Deputy Director General of the International Rice Research Institute state, 'There is little doubt that the private sector is the major player in biotechnology research globally'.[2] While governments form regulating bodies in accordance with MEAs to try to keep up with new technologies, the reality is that often the responsibility lies with biotech industries to direct the course of risk assessment, monitoring and management of biotechnology, especially in countries without existing or strong regulatory measures. This can result in conflicts of interest because, as stated by Mackenzie of FIELD and Newell of IDS, 'in developing countries, in particular, those conducting biotechnology research will often be the same people that will be involved in decision-making about that technology.'[3]

There is an international recognition that developing countries may lack the state-level regulations and institutions to manage all aspects of biotechnology, which can be ascertained from the inclusion of provisions specifically oriented towards strengthening the capacity of developing countries. This is of particular importance to the Asia–Pacific region. This area contains 51 countries: 5 of which are generally considered developed countries (Australia, Japan, New Zealand, Republic of Korea and Singapore), 14 of which, according to the UN, are least developed countries (LDCs)[4] (Afghanistan, Bangladesh,

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Table 1: Signatories and membership to MEAs in the Asia and Pacific Region

Signatories/Membership to MEAs in the Asia and Pacific Region	Convention on Biological Diversity	Cartagena Protocol on Biosafety	Rotterdam Convention Codex Alimentarius	Commission Membership	ICGEB Member
Afghanistan	Y	N	N	Y	Y
Armenia	Y	Y	Y	Y	Y
Australia	Y	N	Y	Y	N
Azerbaijan	Y	Y	N	N	N
Bangladesh	Y	Y	N	Y	Y
Bhutan	Y	Y	N	Y	Y
Brunei Darussalam	N	N	N	Y	N
Cambodia	Y	Y	N	Y	N
China	Y	Y	Y	Y	Y
Cook Islands	Y	NR	Y	Y	N
Democratic People's R of Korea	Y	Y	Y	Y	N
Fiji	Y	Y	N	Y	N
Georgia	Y	N	N	Y	Y
India	Y	Y	Y	Y	Y
Indonesia	Y	Y	NR	Y	Y
IR of Iran	Y	Y	Y	Y	Y
Japan	Y	Y	Y	Y	N
Kazakhstan	Y	N	N	Y	N
Kiribati	Y	Y	N	Y	N
Kyrgyzstan	Y	Y	Y	Y	Y
Lao People's Democratic Republic	Y	Y	N	Y	N
Malaysia	Y	Y	Y	Y	N
Maldives	Y	Y	N	N	N
Marshall Islands	Y	Y	Y	N	N
Micronesia (Federated States of)	Y	N	N	Y	N
Mongolia	Y	Y	Y	Y	N
Myanmar	Y	NR	N	Y	N
Nauru	Y	Y	N	N	N
Nepal	Y	NR	N	Y	N
New Zealand	Y	Y	Y	Y	N
Niue	Y	Y	N	N	N
Pakistan	Y	NR	Y	Y	Y
Palau	Y	Y	N	N	N
Papua New Guinea	Y	Y	N	Y	N
Philippines	Y	NR	NR	Y	Y
R of Korea	Y	NR	Y	Y	N
Russian Federation	Y	N	N	Y	Y
Samoa	Y	Y	Y	Y	N
Singapore	Y	N	Y	Y	N
Solomon Islands	Y	Y	N	Y	N
Sri Lanka	Y	Y	N	Y	Y
Tajikistan	Y	Y	NR	N	N
Thailand	Y	N	Y	Y	N
Timor-Leste		N	N	N	N
Tonga	Y	Y	N	Y	N
Turkey	Y	Y	NR	Y	Y
Turkmenistan	Y	N	N	N	N
Tuvalu	Y	N	N	N	N
Uzbekistan	Y	N	N	Y	N
Vanuatu	Y	N	N	Y	N
Viet Nam	Y	Y	N	Y	Y

Y – (Ratification/Acceptance/Approval/Accession/Member)
N – (Not Party to/Non-Member)
NR – (Signed not Ratified)
■ = UN LDCs
■ = AP Region's Wealthiest Countries

Bhutan, Cambodia, Kiribati, Lao People's Democratic Republic, Maldives, Myanmar, Nepal, Samoa, Solomon Islands, Timor-Leste, Tuvalu and Vanuatu).[5] An analysis of specific indicators including location, geography, political regime, country size, arable land, population, external debt, GDP, agricultural sector percentage of GDP/percentage of labour force, and industrial sector percentage of GDP/percentage of labour force, is useful to note trends related to biotechnology occurring within the region, both as a whole and in relation to identified groups of countries.

METHODOLOGY

The 51 countries identified by the United Nations as located in the Asia and Pacific region were studied: Afghanistan, Armenia, Australia, Azerbaijan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Cook Islands, Democratic People's Republic of Korea, Fiji, Georgia, India, Indonesia, Islamic Republic of Iran, Japan, Kazakhstan, Kiribati, Kyrgyzstan, Lao People's Democratic Republic, Malaysia, Maldives, Marshall Islands, Micronesia (Federated States of), Mongolia, Myanmar, Nauru, Nepal, New Zealand, Niue, Pakistan, Palau, Papua New Guinea, Philippines, Republic of Korea, Russian Federation, Samoa, Singapore, Solomon Islands, Sri Lanka, Tajikistan, Thailand, Timor-Leste, Tonga, Turkey, Turkmenistan, Tuvalu, Uzbekistan, Vanuatu, Viet Nam. Although there are numerous environment-oriented international agreements, the MEAs chosen for the scope of this paper were narrowed down to a list focused on the agreements with the broadest potential reach and implications for industry related to biotechnology, both globally and within Asia and the Pacific.

Table 2 provides a collection of indicators related to biotechnology for the Asia–Pacific region. These indicators are compiled from the 'CIA World Factbook, 2006', and include geographical, economic, political and agricultural data. Relationships between specific indicators potentially related to biotechnology were analysed to note trends in the region. Location and geography indicators refer to the general location in Central, North, South, Southwest, or Southeast Asia or Oceania, and whether a country is an island, has coastal access, or is landlocked, respectively.

Although political climate within a nation is often open to interpretation, it is important when discussing international agreements to note the overarching political framework within a country. A country's political regime[6] is included and summarised as republic, Islamic republic, democracy, parliamentary democracy, monarchy, constitutional monarchy, communist, federal republic, constitutional-free agreement or military junta. Indicators related to agriculture including country size in square kilometres, and the corresponding percentage of arable land, as well as the agricultural sector percentage of GDP/percentage of labour force involved in agriculture are useful to observe because many of the agreements and provisions concerning biotechnology are related to agricultural practices and related biotech industries (ie agrichemical industry). Indicators related to economics including external debt and GDP (US$bn), population and percentage of GDP/percentage of labour force involved in the industrial sector are evaluated to broadly identify countries that may be considered economically and industrially developed and therefore relatively more likely to be exporters of biotechnology and to have certain biotech-related regulatory measures in place.

MULTILATERAL ENVIRONMENTAL AGREEMENTS

Since biotechnology and the environment are interrelated, many MEAs when broadly interpreted have the potential to impact biotechnology research. However, for the scope of this paper, membership of countries to select MEAs with clear

Table 2: Select politcal, geographic, economic, and agricultural indicators related to biotechnology

Country	Geography *	Location	Political Regimes **	Country Size (sq km)	Arable Land %	Population	External debt (billions of US$)	GDP (billions of US$) purchasing power parity (PPP)	Agricultural Sector % of GDP	Industrial Sector % of GDP	Services Sector % of GDP	Agricultural Sector % of Labor force	Industrial Sector % of Labor Force	Services Sector % of Labor Force	Est. GDP per capita (US$) (GDP PPP/population) ***	External Debt as percentage of GDP (PPP) ***
Afghanistan	L	S Asia	IR	647,500	12.13	29,928,987	8.50	21.5	60	20	20	80	10	10	718	39.53%
Armenia	L	SW Asia	R	29,800	17.55	2,982,904	0.91	13.65	22.9	36.1	41.1	45	25	25	4,576	6.63%
Australia	I	Oceania	D	7,686,850	6.55	20,090,437	0.31	611.7	3.4	28.2	68.4	3.6	26.4	70	30,447	0.05%
Azerbaijan	L	SW Asia	R	86,600	19.63	7,911,974	1.83	30.01	14.1	45.7	40.2	41	7	52	3,793	6.10%
Bangladesh	CA	S Asia	PD	144,000	62.11	144,319,628	19.97	275.7	21.2	27.1	51.7	63	11	26	1,910	7.24%
Bhutan	L	S Asia	M	47,000	3.09	2,232,291	0.25	2.9	45	10	45	93	2	5	1,299	8.45%
Brunei Darussalam	CA	SE Asia	CM	5,770	0.57	372,361	0.00	6.842	5	45	50	10	42	48	18,375	0.00%
Cambodia	CA	SE Asia	CM	181,040	20.96	13,607,069	2.40	26.99	35	30	35	75	NA	NA	1,984	8.89%
China	CA	E Asia	C	9,596,960	15.40	1,306,313,812	233.30	7,262	13.80	53	33.30	49	22	29	5,559	3.21%
Cook Islands	I	Oceania	PD	240	17.39	21,388	0.14	0.105	17	7.8	75.2	29	15	56	4,909	134.29%
Democratic People's R of Korea	CA	E Asia	C	120,540	20.76	22,912,177	12.00	40	30.2	33.8	36	36	NA	NA	1,746	30.00%
Fiji	I	Oceania	R	18,270	10.95	893,354	0.19	5.173	16.6	22.4	61	70	NA	NA	5,791	3.63%
Georgia	CA	SW Asia	R	69,700	11.44	4,677,401	1.80	14.45	20.5	22.6	56.9	40	20	40	3,089	12.46%
India	CA	S Asia	FR	3,287,590	54.40	1,080,264,388	117.20	3,319	23.60	28	48.00	60	17	23	3,072	3.53%
Indonesia	I	SE Asia	R	1,919,440	11.32	241,973,879	141.50	827.4	14.6	45	40.4	45	16	39	3,419	17.10%
IR of Iran	CA		IR	1,648,000	8.72	68,017,860	13.40	516.7	11.2	40.9	48.7	30	25	45	7,597	2.59%
Japan	I	E Asia	CM	377,835	12.19	127,417,244	NA	3,745	1.30	25	74.10	5	25	70	29,392	NA
Kazakhstan	CA	Central Asia	R	2,717,300	7.98	15,185,844	26.03	118.4	7.4	37.8	54.8	20	30	50	7,797	21.98%
Kiribati	I	Oceania	R	811	2.74	103,092	0.10	0.79	30	7	63		NA	NA	7,663	12.66%
Kyrgyzstan	L	Central Asia	R	198,500	7.30	5,146,281	1.97	8.495	38.5	22.8	38.7	55	15	30	1,651	23.19%
Lao People's Democratic R	L	SE Asia	C	236,800	3.80	6,217,141	2.49	11.28	49.5	27.5	23	80	NA	NA	1,814	22.07%
Malaysia	CA	SE Asia	CM	329,750	5.48	23,953,136	53.36	229.3	7.2	33.6	59.1	7.2	33.6	59	9,573	23.27%
Maldives	I	S Asia	R	300	13.33	349,106	0.28	1.25	20	18	62	22	18	60	3,581	22.48%
Marshall Islands	I	Oceania	C-FA US	181	16.67	59,071	0.87	0.115	14	16	70	21.4	20.9	58	1,947	752.17%
Micronesia (Federated States of)	I	Oceania	C-FA US	702	5.71	108,105	0.53	0.277	50	4	46	NA	NA	66	2,562	191.70%
Mongolia	L	N Asia	PD	1,564,116	0.77	2,791,272	1.19	5.332	20.6	21.4	58	42	NA	29	1,910	22.34%
Myanmar	CA	SE Asia	Military Junta	678,500	15.19	42,909,464	6.75	74.3	56.6	8.8	34.5	70	7	23	1,732	9.09%
Nauru	I	Oceania	R	21	0.00	13,048	0.33	0.06	NA	NA	NA	NA	NA	NA	4,598	555.00%
Nepal	L	S Asia	CM, PD	140,800	21.68	27,676,547	2.70	39.53	40	20	40	81	3	16	1,428	6.83%
New Zealand	I	Oceania	PD	268,680	5.60	4,035,461	47.34	92.51	4.6	27.4	68	10	25	65	22,924	51.17%

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Niue	I	Oceania	C-FA NZ	260	15.38	2,166	0.04	0.0076	NA	NA	55	NA	NA	NA	3,509	550.00%
Pakistan	CA	S Asia	FR	803,940	27.87	162,419,946	33.97	347.3	22.6	24.1	53.3	42	20	38	2,138	9.78%
Palau	I	Oceania	C-FA US	458	8.70	20,303	NA	0.174	NA	NA	NA	20	NA	NA	8,570	NA
Papua New Guinea	I	Oceania	CM, PD	462,840	0.46	5,545,268	2.46	11.99	34.5	34.7	30.8	85	NA	NA	2,162	20.54%
Philippines	I	SE Asia	R	300,000	18.95	87,857,473	55.60	430.6	14.8	31.9	53.2	36	16	48	4,901	12.91%
R of Korea	CA	E Asia	R	98,480	17.18	48,422,644	160.00	925.1	3.2	40.4	56.3	8	19	73	19,105	17.30%
Russian Federation	CA	N Asia	F	17,075,200	7.33	143,420,309	169.60	1,408	4.90	34	61.20	12	22.70	65	9,817	12.05%
Samoa	I	Oceania	CM, PD	2,944	21.20	177,287	0.20	1	14	23	63	NA	NA	NA	5,641	19.70%
Singapore	I	SE Asia	P R	692.7	1.64	4,425,720	19.40	120.9	0	32.6	67.4	NA	24	60	27,318	16.05%
Solomon Islands	I	Oceania	PD	28,450	0.64	538,032	0.18	0.8	42	11	47	75	5	20	1,487	22.55%
Sri Lanka	I	S Asia	R	65,610	13.86	20,064,776	10.85	80.58	19.1	26.2	54.7	38	17	45	4,016	13.46%
Tajikistan	L	Central Asia	R	143,100	6.61	7,163,506	0.89	7.95	23.7	24.3	52	67.2	7.5	25	1,110	11.17%
Thailand	CA	SE Asia	CM	514,000	29.36	65,444,371	50.59	524.8	9	44.3	46.7	49	14	37	8,019	9.64%
Timor-Leste	I	SE Asia	R	15,007	4.71	1,040,880	NA	0.37	25.4	17.2	57.4	NA	NA	NA	355	NA
Tonga	I	Oceania	CM	748	23.61	112,422	0.63	0.244	23	13	64	65	NA	NA	2,170	259.84%
Turkey	CA	SW Asia	PD	780,580	30.93	69,660,559	16.90	508.7	11.7	29.8	58.5	35.9	22.8	41	7,303	3.32%
Turkmenistan	CA	Central Asia	R- AP	488,100	3.72	4,952,081	2.40	27.6	28.5	42.7	28.8	48.2	13.8	37	5,573	8.70%
Tuvalu	I	Oceania	CM	26	0.00	11,636	NA	0.0122	NA	NA	NA	NA	NA	NA	1,048	NA
Uzbekistan	L	Central Asia	R- AP	447,400	10.83	26,851,195	4.35	47.59	38	26.3	35.7	44	20	36	1,772	9.14%
Vanuatu	I	Oceania	P R	12,200	2.46	205,754	0.84	0.58	26	12	62	65	5	30	2,819	144.31%
Viet Nam	CA	SE Asia	C	329,560	19.97	83,535,576	16.55	227.2	21.8	40.1	38.1	63	NA	NA	2,720	7.28%

NA = not available
■ = UN LDCs
■ = AP Region's Wealthiest Countries
* Coastal Access, CA; Island, I; Landlocked, L
** Republic, R; Islamic Republic, IR; Democracy, D; Parliamentary Democracy, PD; Monarchy, M; Constitutional Monarchy, CM; Communist, C; Federal Republic, FR; Constitutional Free Agreement, C-FA
*** These are my own calculations to provide supplemental indicators of relative GDP and country indebtedness.
Estimated GDP per capita is based on GDP divided by population.
External debt as a percentage of GDP is external debt divided by GDP, multiplied by 100 for a percentage.

implications for biotechnology is reviewed (Table 1). The Convention on Biological Diversity (CBD) and the Rotterdam Convention were chosen for discussion because they are foundational 'umbrella' conventions that cover issues related to biotechnology in a general sense, while providing the framework for related protocols, codes of conduct, etc., through measures including informed consent procedures (Rotterdam) and transfer of technology (CBD). The Cartagena Protocol and the International Treaty on Plant Genetic Resources for Food and Agriculture were chosen as examples that expand upon these conventions with procedures specifically related to industry including risk assessment and advance informed agreement (Cartagena), labelling and information exchange (Cartagena and the Treaty). The FAO's Codex Alimentarius provides guidelines and standards applicable to biotech industry, including pesticides and chemicals in food, as well as guidelines for genetically modified foods. Members of the International Centre for Genetic Engineering and Biotechnology (ICGEB) encourage technology transfer and capacity building via working directly with industry, with special consideration for developing countries.

The Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) resulted from the United Nations Environmental Programme (UNEP) 1992 Rio Conference on Biodiversity. Signatory countries acknowledge that the environment has intrinsic value, the benefits of which should be equally shared, and that states have the responsibility to not harm the environment of other states. In order to achieve this, the CBD provides guidelines so that states may create their own environmental agenda to promote the protection, conservation and sustainable use of biodiversity in accordance with the Convention. The CBD is ratified, accepted or joined by accession by 49 of

the 51 states in the Asia and Pacific region. The CBD entered into force on 29th December, 1993.

The Cartagena Protocol

The Cartagena Protocol on Biosafety was developed in 2000 as a supporting agreement to the CBD in order to provide legally binding guidelines specifically regarding the protection of biodiversity from organisms modified by biotechnology, and was backed up by UNEP. The guidelines contain the precautionary principle first found in the Rio Declaration. The Protocol establishes a Biosafety Clearing House in order to manage and disseminate information regarding living modified organisms (LMOs). The Protocol is ratified, accepted or joined by accession by 31 of the 51 states in the Asia and Pacific region.[7] The Protocol entered into force on 11th September, 2003.

The International Treaty on Plant Genetic Resources for Food and Agriculture

In line with the spirit of the CBD, the 2001 Treaty on Plant Genetic Resources expands upon the CBD provisions of sustainable use and equitable sharing of plant genetic resources via measures such as monetary funding and technology transfer. These measures are regulated with the establishment of the Multilateral System for Access and Benefit-sharing. The Treaty has been ratified, accepted or joined by accession by 10 of the 51 countries in the Asia and Pacific region. The Treaty came into force on 29th June, 2004.

The Rotterdam Convention

Efforts to monitor the international trade of hazardous chemicals began in the 1980s with voluntary information exchange programmes overseen by the FAO and UNEP. In accordance with Agenda 21 of the Rio Declaration, the Rotterdam Convention was established in 1998 to provide mandatory guidelines for the monitoring and trade of hazardous chemicals and pesticides. It expands upon the voluntary prior informed consent procedures of the London Guidelines for the Exchange of Information on Chemicals in International Trade (1987) and the International Code of Conduct on the Distribution and Use of Pesticides (1985). The Convention is ratified, accepted or joined by accession by 18 of the 51 states in the Asia and Pacific region, and it entered into force on 4th February, 2004.

FAO Codex Alimentarius

In 1963, the FAO and the World Health Organization created the Codex Alimentarius to provide international standards for food and food related industry. This includes, for example, the ad hoc establishment in 1999 of an international committee on biotechnology (Intergovernmental Task Force on Food Derived from Biotechnology) to provide risk and safety assessment of biotechnology and foods. The Codex Commission regards biotechnology and food safety, including genetically modified foods, from a 'pure scientific perspective'[8] in contrast to a perspective guided by the precautionary principle. Membership of the Codex Alimentarius Commission includes 41 of the 51 countries in the Asia and Pacific region.

INTERNATIONAL TRENDS REGARDING INDUSTRIAL ACTORS AND STATES

Because globally, biotechnology research and regulation is largely concentrated in the areas of agriculture, health and the environment, special consideration was given to industries related to these areas (ie agrochemical and biopharmaceutical) and the provisions to which they are related. Noting the overarching goals in all MEAs discussed of minimising risk to human health, protecting biodiversity and minimising risk to the environment to promote its sustainable use by humans, most of the provisions in the select agreements relating to biotechnology

research fall under the following four themes as illustrated in Figure 1: monitoring and management, industry to state communication (I/S), state to state communication (S/S) and industry to consumer communication (I/C). Within the provisions falling under these four themes are significant implications for cooperation of companies in the implementation of the MEAs.

Monitoring and management

Because they are the primary actors in the conduct of biotechnology research, monitoring and management regarding biotechnology in MEA provisions assented to by states will in many cases trickle-down to private companies. Companies must, at a minimum, work in cooperation with state authorities in order for governments to have the tools necessary to monitor and manage biotechnology themselves. Often governments must delegate many of these monitoring and management functions to industry.

In Article 7 of the CBD, contracting parties are required to both identify activities considered 'likely to have significant adverse impacts on the conservation and sustainable use of biological diversity',[9] and collect, maintain and organise data related to these risks, which requires cooperative transparency of industries that may in anyway cause harm to biodiversity. CBD Article 8(g) further requires the regulation and control of identified risks related to the 'use and release of modified organisms resulting from biotechnology' and CBD Article 14:1(a) calls for companies to draft and submit mandatory 'environmental impact assessments' of project proposals.[9]

The scope of the Cartagena Protocol carries possible implications for all industries involved in the 'transboundary movement, transit, handling and use of all LMOs' that are considered risky to biological diversity.[10] Specifically, Article 18:3 calls for the development of international standards regarding 'identification, handling, packaging and transport practices' of such LMOs.[10] These standards have the potential to be legally binding, and would require companies involved in related industries (ie agrichemical industries) to comply with international regulations as opposed to state guidelines. In contrast, the Rotterdam Convention does not carry provisions pertaining to the monitoring and management of biotechnology.

Select MEAs and Articles Relevant to Biotechnology	Convention on Biological Diversity	Cartagena Protocol	Rotterdam Convention
Types of Provisions	Relevant Articles		
Management and Monitoring	7c,d; 8g; 14:1a	4:Scope; 18:3	
Industry to State (I/S)	8e; 10b,e; 15:1; 16:1; 16:2; 16:4; 16:5; 19:1	8:2; 14:1; 16:1; 16:3; 17:3c,d,e; 18:1; 21:3	11:1b; 12:1; 13:2; 13:3; 15:2
State to State (S/S)	14:1c,d,e; 16:3; 17:2	20: 3a; 21:3; 21:5; 22:1; 24	14:1a
Industry to Consumer (I/C)	19:3`	18:2a,b,c; 22:2	13:2; 13:3; 15:1b

Figure 1: Select MEAs and articles relevant to biotechnology

Industry to state (I/S) communication

When states enter into MEAs that promote free technology (including biotechnology) exchange, provisions pertaining to I/S communication may either affect how industries are able to exercise their intellectual property rights, or protect industry rights over sentiments agreed to in international agreements. For example, Article 16:1 of the CBD lauds both the access and exchange of technology as 'essential elements' to achieve the goals of the Convention, calling for regulatory measures regarding equitable transfer of environmentally sustainable biotechnologies, with special consideration to developing countries. However, according to Article 16:2, this exchange is viable only if the transfer of technology is made in accordance with existing intellectual property law. Given the concentration of rights holders in developed countries with more stringent intellectual property laws, one must assume compliance with existing intellectual property rights limits the practice of technology transfer. Byerlee and Fischer summarise a related paradox of research and development stating:

> While most of these [biotechnology research and development firms] are located in the industrialized world . . . they own tools and products and have specialized skills that are often relevant to developing world problems. However, this group has little direct investment in developing countries, except for a small number of companies located in a few large developing countries.[2]

Recognising these possible limitations, the CBD contains clauses regarding regulatory legislation of biotech companies and research. Article 16:4 and 16:5 call specifically for supportive legislative measures in which private companies are required to facilitate the access and technology transfer themselves.

There is some variety in the international community among ethical guidelines for international research, for example the Council for International Organizations of Medical Sciences (CIOMS), the Nuffield Council of Bioethics and Fogarty International Center of NIH. However, there is solid legal basis within these MEAs regarding collection of genetic materials and companies are ultimately subject to the national regulations of the host county, as well as the country in which they are registered. According to CBD Article 15:1, the access to genetic resources falls fully under the national jurisdiction of the providing country and as stated in Article 19:1, companies must allow for 'the effective participation in biotechnological research activities' of countries providing those genetic resources as research materials.[9]

It is widely known that most of the biodiversity on Earth exists within developing countries, and these provisions seek to protect this biodiversity from research-related exploitation by ensuring that some form of compensation or technology transfer is exchanged for the research and development of genetic materials in developing countries. Although they are not legally binding for companies, provisions concerning non-legislative measures to promote sustainable development and protection of biodiversity may also impact industry. For example, CBD Article 10b,e calls for I/S communication to encourage sustainable use of biodiversity as well as to 'avoid or minimize adverse impacts on biodiversity', while Article 8e seeks to ensure the prevention of environmental harm caused by unsustainable development to areas surrounding government protected areas of biodiversity.[9] Such articles may have particular implications for development-related industries. For instance, in order to comply with the CBD, governments may further regulate the agrichemical industry to ensure contained use of certain chemicals on cropland surrounding protected areas.

Although many articles pertaining to

the regulation of LMOs serve as guidelines, some require legally binding regulations for industry and, according to Cartagena Article 14:1, related multilateral agreements, and corporations by extension, are subject to the standards set in the Protocol. Article 8:2 calls for legislative measures to ensure the 'accuracy of information' provided by the exporting country concerning LMOs.[10] The transboundary movement of LMOs requires an initial biological risk assessment (Article 16:1, 16:3), the timely success of which lies in open I/S communication in order to ensure the accurate exchange of information and understanding of potential harm.

Certain provisions within the Cartagena Protocol regarding I/S communication implicitly rely on transparency of biotech industries. One can infer that in order for states to comply with the notification requirements of Article 17:3c,d,e, companies must also maintain government-accessible records of all relevant information pertaining to risks associated with transboundary movement of LMOs. Article 18:1 requires biotech-related industries to inform governments of LMOs transported across boundaries and extends to all related industrial activities, including 'handling, transport, packaging and identification' of LMOs.[10] Although such provisions mean increased regulation of industry, the information exchange of I/S communication can be mutually beneficial by, for instance, allowing states to make informed decisions, while the state can provide industry with better access to resources and certain protections. For example, confidentiality of related biotechnology 'commercial and industrial information, including research and development' is protected in Article 23.

The success of the Rotterdam Convention rests on cooperative I/S communication to ensure that both importing and exporting parties are fully informed about hazardous chemicals in trade. Article 11b calls for legislative measures to compel chemical exporters to act in accordance with decisions of importing parties regarding restricted importation of hazardous chemicals.

The Rotterdam Convention also implicitly requires the cooperation of companies for notification and labeling. In order for states to comply with the notification requirements of Article 12:1, companies must file export permits. Environmental and health labelling of chemicals included in Annex III is required for export from all countries (Article 13:2), and labelling of chemicals not included in Annex III is required from countries with domestic bans on the chemical of export (Article 13:3). Furthermore, states are required by Article 15:2 of the Convention to provide the public with information and access to 'alternatives that are safer for human health or the environment than the chemicals listed in Annex III.'[11] These provisions have the potential to greatly affect agrochemical and biochemical industries, particularly in developing countries, because of the inherent required transparency of risk and the presence of accessible alternatives.

State-to-state (S/S) communication

Similar to I/S communications, provisions concerning S/S communication and biotechnology implicitly require transparency of companies in order to facilitate S/S information exchange regarding all aspects of chemical products and particularly the risk and effects of those products on human health, the environment, biodiversity, etc. For example, Article 14:1a of the Rotterdam Convention requires parties to facilitate full S/S information exchange including legal, 'toxicological, ecotoxicological and safety information', regarding all hazardous chemicals referred to in the Convention.[11] The obligations of signatory governments to other parties, which control the impacts of biotechnology, have the further effect of

placing a significant burden of responsibility on private industry. Article 16:3 of the CBD states that even where technologies are protected by intellectual property laws, companies still have to ensure transfer of that technology to states that provide genetic information for their research. The broad exchange of related information in Article 17:2 includes the 'results of technical, scientific and socio-economic research' and possible 'repatriation of information'.[9] CBD Article 14:1c,d,e implicitly requires transparency of biotech companies in order to properly assess biological risks of projects and to delineate appropriate procedures to minimise and control such risks.

The Cartagena Protocol provides the formal structure for a Biosafety Clearing-House in order to better facilitate S/S biotechnology transfer and exchange of information. To support the advanced informed agreement procedure, Article 20: 3a urges states to take legal and regulatory measures to provide the Biosafety Clearing-House with all information regarding LMOs required to successfully implement the Protocol. To strengthen this, Article 24 explicitly extends the scope of the Protocol to include encouragement of non-parties by parties to adhere to notions and objectives in the Protocol. This carries implications for biotech industries in non-party countries, which are subject to Protocol guidelines by association.

As previously mentioned, confidentiality regarding information exchanged in adherence to advanced informed agreement procedures must be protected by state-employed measures. However, Article 21:5 has particular implications for developing countries by protecting the confidentiality of all states equally, stating that a country 'shall protect the confidentiality of such information in a matter no less favorable than its treatment of confidential information in connection with domestically produced [LMOs].'[10]

Paradoxically, with the increased burden of responsibility comes increased control; by widening the scope of industry involvement to include everything from risk assessment to subsequent management of biotechnology, private industries thereby limit the ability of governments to control the direction of biotechnology research. For instance, effective technology transfer and capacity building relies on S/S facilitated communication of industrial knowledge and appropriate technology. This is recognised in Article 22:1 of the Protocol, which specifically calls for biotech industry involvement with 'the development and/or strengthening of human resources and institutional capacities in biosafety'.[10]

Industry to consumer (I/C) communication

Although the MEAs discussed are intergovernmental agreements, they include several provisions that facilitate or guide I/C communication. Often, these provisions extend the responsibilities placed by governments on industries and include measures that seek to involve consumers, both directly and indirectly (ie safety training and labelling). CBD Article 19:3 and 19:4 sets the stage for the Cartagena protocol to provide guidelines regarding 'safe transfer, handling and use of any living modified organism' with known or possible risks to biodiversity and the environment to be applied to anyone living within a party's jurisdiction.[9] Cartagena Protocol Article 22:2 calls for capacity building in major areas of biosafety, including technical management of biotechnology, which implicitly demands the involvement and expertise of biotech industries. In Article 15:1b, the implementation of the Rotterdam Convention explicitly includes 'the encouragement of initiatives by industry to promote chemical safety' which can be required through legislative measures.[11]

Labelling of biotechnology also carries implications for industry, which bears the responsibility of ensuring that LMOs and

hazardous chemicals are clearly marked with environmental and health risks as well as safety directions. According to article 18:2a,b,c of the Protocol, all LMOs for contained use or introduction into the environment must be clearly identified and carry labels regarding 'safe handling, storage, transport and use', and in the case of LMOs for release, a declaration of conformity with the Protocol must also be included.[10] Article 13:2 and 13:3 of the Rotterdam Convention requires the labelling of all hazardous chemicals for export that are banned or severely restricted within the exporting country and, as previously mentioned, all chemicals listed in Annex III must be clearly labelled with safety and risk-related information.

REGIONAL TRENDS IN ASIA AND THE PACIFIC

By examining relationships between specific biotech-related indicators and country membership to MEAs, some regional trends of interest can be observed.

Economic indicators

Although the MEAs discussed contain specific provisions related to biotechnology for developing countries, there is a trend for poorer countries to be disproportionately under-represented as member parties (Table 1). For example, the two MEAs with the most provisions pertaining directly to strengthening capacity building, technology transfer and protective measures for developing countries regarding biotechnology are the Cartagena Protocol and the Rotterdam Convention. Only 1 state (Samoa) of the region's 14 LDCs is a member of the Rotterdam Convention, whereas the wealthiest 5 countries in the region in terms of GDP purchasing power parity (PPP) and GDP PPP per capita are all members (Table 2).

The mean GDP PPP of Asia and Pacific countries is US$430.81bn. The mean GDPs PPP of countries that have ratified, accepted or joined by accession the Cartagena Protocol and the Rotterdam Convention are well over the regional mean with US$556.50bn (31 countries) and US$986.83bn (18 countries), respectively. In sharp contrast, countries that are not members of these MEAs have a much lower mean GDP PPP. The mean GDP PPP of non-member states to the Cartagena Protocol is US$236.00bn (20 countries), while the mean GDP PPP of non-member states to the Rotterdam Convention is only US$127.53bn (33 countries). Of the eight most heavily indebted countries with over 100 per cent external debt as a percentage of GDP, only two states (Marshall Islands and Cook Islands) are members of the Rotterdam Convention. In the region, the average GDP PPP per capita is US$6,108 and members of the Codex Alimentarius Commission have a mean GDP PPP per capita of US$6,767. Non-members of the Commission have an average GDP PPP per capita of US$3,408, or a little over one-half the mean of members.

Geographical and political indicators

Although political groupings are often the source of debate, republics, federal republics, parliamentary democracies and constitutional monarchies with parliamentary democracy, were grouped together for the purposes of this paper as countries with some form of democratic representation. Of these 30 countries, 97 per cent are members of the CBD, 83 per cent are Codex Alimentarius Commission members, 60 per cent are members of the Cartagena Protocol, and 30 per cent are members of the Rotterdam Convention (Table 1).

It is interesting to note some of the trends suggested by geographical indicators including location and geography. There are 23 island countries, including 7 LDCs and 4 of the 5 wealthiest countries (Table 2). Island countries have the least percentage of representation in the Codex Alimentarius Commission, with 16 member countries

(69 per cent). The 10 landlocked states (4 LDCs) and 18 coastal access countries (3 LDCs) have much higher membership of 94 per cent and 80 per cent respectively. Seventy per cent of landlocked countries and 65 per cent of island countries are members of the Cartagena Protocol whereas only half of coastal access countries are members. Thirty per cent of both landlocked and island states are members of the Rotterdam Convention. Forty-four per cent of coastal access countries are members.

Agricultural indicators

MEAs are designed to help regulate and protect the environment and related activities internationally. Since most, if not all, agricultural processes rely on interactions with the environment, one might assume these MEAs have particular implications as well as appeal for countries most reliant on agriculture for GDP and livelihoods. By comparing the MEA membership, 'top ten', 'bottom ten' and mean within a group of agricultural indicators, one can observe regional trends related to biotechnology in agriculture. Of the 'bottom' ten countries with the least percentage of agriculture in GDP (between 0 and 9 per cent), five are the wealthiest countries in the region (Table 2). All are members of the Codex and seven are members of the Rotterdam Convention. Only three states are members of the Cartagena protocol.

Four of the wealthiest countries are also among the 'bottom' ten countries with the least percentage of labour in agriculture (between 3.6 and 21.4 per cent). Of these countries, six are members of the Rotterdam Convention and five are members of the Cartagena Protocol. In contrast, none of the 'top' ten countries (seven of which are LDCs) with the highest percentage of labour in agriculture (67.2 to 93 per cent) signed the Rotterdam Convention, and seven are members of the Cartagena Protocol. Only one of the ten countries with the highest percentage of GDP from agriculture (between 35 and 60 per cent) is a member of the Rotterdam Convention. Five of the 'top' ten countries with the largest percentage of arable land are members of the Rotterdam Convention, while only two of the 'bottom' ten countries are members.

CONCLUDING REMARKS

Once a MEA enters into force, it becomes legally binding to member parties. Participation in such agreements signals to the international community an acknowledgement of the importance of the issues addressed. By assenting to the provisions of the agreements, governments not only accept the responsibility of enforcement, but also acknowledge the relevance and importance of standards and regulations within MEAs.

So why do the majority of LDCs neglect to sign on to MEAs that carry provisions specifically pertaining to their protection and capacity building, while the most wealthy countries are members? Perhaps part of the answer lies in the disparity between the strong management of hazardous chemicals in wealthy countries, and the absence and shortcomings of similar institutional regulations in developing countries. According to Wahlstrom, UNEP chemicals Senior Scientific Advisor, many hazardous chemicals and pesticides that are banned or severely restricted in developed countries are 'still manufactured and used in developing countries and countries with economies in transition. In particular, thousands of tonnes of DDT per annum are manufactured in some developing countries.'[12] Wealthier countries have strong management regulations in place, and the increased regulation and transparency required by MEAs of both government and industry in countries where such chemicals are already banned or severely restricted does not carry the burden that such regulations would impose on developing countries.

As considered in this paper, indicators can offer insight into underlying trends

and sentiments in the region concerning industry, research and biotechnology. Helpful further research would include developing indicators to measure national policy and legislative support, and the implementation of these agreements to explore the meaning of these trends.

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