

OVERCOMING INDIA'S FOOD SECURITY CHALLENGES: THE ROLE OF INTELLECTUAL PROPERTY MANAGEMENT AND TECHNOLOGY TRANSFER CAPACITY BUILDING

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*The growth of the Indian economy after Independence has had little impact on the food security of the country. The paper analyses the development of advanced crop varieties through the use of agricultural technologies (hereinafter "agbiotech") within the technology transfer system, a framework which comprises of the interactions of intellectual property rights law and agricultural research and development in India. Through this, the author argues that agricultural innovation in India is failing due to the absence of connections within the technology transfer system and advocates for the creation of a national program aimed at advancing IP and tech-transfer capacity in agbiotech.**

INTRODUCTION

On that spectacularly auspicious day in August 1947, when India attained independence, the day on which the esteemed last Viceroy of Her Majesty's British Indian Empire, Lord Louis F.A.V.N. Mountbatten lowered the Union Jack, handed over sovereignty, and fondly waved goodbye to India

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amongst the cheering throng of deliriously joyful and optimistically hopeful Indians proudly watching the raising of the Indian flag, respectfully and patriotically saluting as the saffron, white and green gently fluttered in the warm summer breeze, who could have possibly foreseen that within little over a decade the country would be facing a humanitarian disaster: the specter of catastrophic annihilation due to widespread famine? Food security in India was an issue then, in the decades that followed and perhaps today more than ever, as the entire global community faces the economic, environmental and demographic uncertainties of the new century.

However, in India, food insecurity appears to be particularly egregious (relating to the “hunger index”, a measure of degree of food deprivation): *“It is evident that India’s performance with respect to hunger is abysmal not only in relation to other large developing countries like China, but even in comparison to the rest of South Asia, with only Bangladesh having a higher value of the index. Indeed, India’s index value is close to that of Zimbabwe, a country which is in the throes of severe hyperinflation and collapse of domestic food markets. Within India, some of the supposedly richest states with the most rapid recent growth of GDP, such as Maharashtra, Karnataka and Gujarat perform very poorly on the hunger index, clearly much worse than Kerala and even worse than Assam.”*⁴ This is additionally alarming, considering the recent rapid economic development in India, where the gross national income has nearly doubled coincidentally as the level of hunger remains stagnant, or ominously begins to show signs of worsening.⁵

Pragmatically speaking, what are the options to confront this looming threat to food security in India? What are the constraints? And, as this article seeks to address, what are the opportunities towards sustainably addressing this in India as the 21st century unfolds?

This paper examines and analyzes one potentially important and crucial factor to address food security in India: accelerating the development and deployment of advanced crop varieties (food, fibre, feed and fodder, e.g., grain, vegetables, cotton, and animal forage) via application of advances in agricultural technologies, including, but not limited to, biotechnology, genetic-marker assisted breeding, genomics and plant tissue culture methodologies (for the purposes of this paper, these

⁴ Sunildro L.S. Akoijam, *Food Security: Challenges and Issues in India*, 1 THE INTL. J.’S RES. J. OF ECON. & BUS. STUD. 1 (2011).

⁵ ICRISAT, *Seeding Success Through Innovation and Technology*, 2012, Food 360⁰, November 5-6, 2012, Hotel Taj Krishna, Hyderabad, India. 2012.

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technologies in aggregate are referred to as agbiotech).⁶ A key consideration which will impact whether agbiotech mitigates food security threats in India is efficiency of the technology transfer (tech-transfer) system; this includes the complex interaction of intellectual property rights (IPR) laws, treaties, policy, practice and management with both public and private sector agricultural research and development (R&D) enterprises of India.

As presented in this paper, when viewed as a system, agricultural innovation in India is failing. A solution is needed, and recommended herein. This paper argues that the system has failed due to a lack of connections among the various components of the system; tech-transfer offices (TTOs) can serve as intermediaries to facilitate connections in this system via focused IP management and related tech-transfer activities; however, TTOs are, at best, nascent throughout India, indicating that this represents a key weak link in the system.

What is advocated here, therefore, is a dedicated, focused and strategic national program for accelerating IP and tech-transfer capacity in agbiotech: the establishment of a National Agricultural Innovation Academy at the National Academy of Agricultural Research Management (NAARM). A National Agricultural Innovation Academy would address the agricultural system failure in India, serving as a hub for IP law, policy, practice and management in order to raise awareness, facilitate advocacy, accelerate education, thereby advancing tech-transfer and catalyzing the application of agbiotech to India's food security crisis. Operationally, the National Agricultural Innovation Academy would focus resources, align policy initiatives, prioritize programs and coordinate activities via training a new generation of Indian IP professionals, forging global networks and creating a sustainable foundation in human capital and institutional infrastructure which would radiate out to all corners of India.

However, currently, with regard to tech-transfer, agricultural productivity and food security in India, it appears that there is a systemic dilapidation that urgently requires remediation and modernization: *“The technology diffusion mechanism for the agricultural sector in the country is through the National Agricultural Research Systems (NARS) of the Indian Council of Agricultural Research (ICAR). The technology system has not been able to make any new breakthrough in agriculture since the Green Revolution [i.e., the 1960s]. [L]ow*

⁶ Alois Leidwein, *Food Security, Climate Change and IP Rights*, WIPO MAGAZINE 3/2011 (2011).

*productivity since the 1990s has been linked to weak support systems of non-responsive agricultural research, broken-down extension mechanisms, and inadequate seed production, distribution and regulation.”*⁷ In the face of such institutional inefficiency and bureaucratic inertia, there is a critically urgent and pressing need for reevaluation, reinvestment and realignment of priorities. Therefore, whether, or not, agbiotech can effectively foster food security largely depends on the efficiency of the technology transfer system in India, that is, the human capital and institutional infrastructure specifically tasked with managing IP, driving innovation and thereby accelerating development and deployment of agbiotech as a cost effective, environmentally compatible and sustainable solution for India’s capability and capacity to adequately provide wholesome food to its growing population.

FOOD SECURITY AND INDIA

Broadly defined, “*food security is achieved when ‘all people at all times have physical and economic access to food that is sufficient to meet dietary needs for a healthy and productive life’. In this sense, achievement of food security implies producing ... sufficient food and making it accessible to all individuals throughout the year and on a sustainable basis from year to year. ... Food security thus connotes freedom from hunger and malnutrition.*”⁸ This is something that has not been achieved in India, and the threat of greater food insecurity looms.

India is facing a convergence of factors, which are expected to exacerbate an already tenuous food security scenario:

Population increase: 1.6 billion by 2050⁹

Land resources (use): reallocation of prime arable land (“diversion of cultivated land for non-agricultural purposes”) to special economic zone development will reduce already dwindling agricultural production capacity in India.¹⁰

Decline in crop productivity: India’s crop productivity is, relative to other Asian countries, amongst the lowest; depletion of soils and ground water for irrigation are contributing factors.¹¹

⁷ ICRISAT, *supra* n. 5.

⁸ Shabd S. Acharya, *Food Security and Indian Agriculture: Policies, Production Performance and Marketing Environment*, 22 AG. ECON. RES. REV. 1 (2009).

⁹ <http://www.bbc.com/news/world-asia-22907307>

¹⁰ P. S. Brahmanand et. al, *Challenges to Food Security in India*, 104 CURRENT SCIENCE 7, 841 (2013)

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Biological factors: These include herbivorous insect and arthropod crop pests, plant pathogens (nematodes, bacteria, fungi, viruses), weeds; in addition, loss in natural biodiversity has disrupted ecosystem balance.¹²

Land resources (degradation): Due to, among other factors, erosion, decline in fertility and widespread mismanagement of limited arable land and pasture.¹³

Water resources: Pressure on freshwater resources will mount, as competition among agriculture, industry and urban centres intensifies India is expected to go below the freshwater scarce threshold within 20 years time. Of India's 143 million hectares of arable land, 63 million are irrigated.¹⁴

Climate change: For India, the most impactful factors include increase in temperature and changes in precipitation, i.e., droughts and floods.

Significant shifts in arable land usage away from rice, wheat and maize production (i.e., between 2000 and 2010, thousands of hectares) to biofuel (jatropha) and medicinal plant (amla, ashwagandha, sarpagandha) cultivation.¹⁵

Change in markets and demand due to extensively accelerating urbanisation.

Recent decline in major food crop productivity due to several (biotic and abiotic) factors.¹⁶

Based on current population data and demographic trends, it has been estimated that to meet domestic demand, Indian agriculture needs to grow at 3 percent per annum, which includes not only greater food production, but also greater diversification of food products to meet the market

¹¹ R. T. Gahukar, *Food Security in India: The Challenge of Food Production and Distribution*, 12 J. OF AG. & FOOD INFO. 3/4, 270 (2011).

¹²*id.*

¹³*id.*

¹⁴ Brahmanand, *supra* n. 10.

¹⁵*id.*

¹⁶ National Academy of Agricultural Research Management, *NAARM Vision 2050*, Indian Council of Agricultural Research (2013), http://www.naarm.ernet.in/images/stories/documents/publications/naarm_vision2050_2jul2013.pdf.

demand of a rapidly emerging Indian middle class.¹⁷ This will have to be accomplished predominantly on extant arable land via fourfold, threefold and twofold increases in land stewardship, water productivity and energy efficiency respectively.¹⁸

Indeed, by 2020, projections suggest that food supply will be inadequate to meet the demand of a growing population, with a stagnant agricultural system unable to keep pace with both diversified and increased demand, with a very real scenario of starvation as a potential consequence.¹⁹ The Indian government has not adequately addressed issues of hunger and food security. *“Despite persisting food insecurity, efforts by the Indian government to eliminate poverty and hunger are still lacking. Political and social mobilization to make food security a resonant demand that cannot be ignored is therefore essential.”*²⁰ As reiteratively made clear throughout this paper, this has been, and unfortunately continues to remain, a recurring theme in recent Indian history.

THE GREEN REVOLUTION; THE GENE REVOLUTION

By 1960, scarcely 13 years after achieving independence from the British Empire, India faced famine. This was brought on by a constellation of factors, e.g., droughts, inadequate post-independence land reform and little, if any, technological advances in agriculture. Initially, massive food aid in the form of grain shipments from the United States averted a humanitarian disaster; this was the US PL-480 Program. However, a more sustainable solution was needed to address the chronic issue of food insecurity in India: the Green Revolution, which American scientist, plant pathologist, humanitarian, and Nobel Peace Prize laureate, Dr. Norman Borlaug led. Borlaug and his team rapidly and efficiently, using an accelerated method of conventional plant breeding, developed and introduced Green Revolution varieties of wheat, rice, maize and bajra.²¹ These crop varieties were dwarf/semi-dwarf, shorter statured, non-lodging, photoperiod insensitive and high yielding (cereal crop yields tripled in some areas, due to these new, semi-dwarf varieties). The Green

¹⁷*id.*

¹⁸*id.*

¹⁹ Gahukar, *supra* note 11.

²⁰*id.*

²¹ Alyssa Panning and Kishore G. Kulkarni, *Technology for Growth: Indian Green Revolution*, 8 SCMS J. OF INDIAN MGMT. 3, 47 (2011).

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Revolution varieties also had enhanced disease and insect resistance, accelerated maturation to heading, tolerance to moisture and temperature fluctuations, and greater responsiveness to added fertilizer.²² Introduction and adoption of the Green Revolution high yielding crop varieties generated yield increases of up to threefold,²³ saving millions from starvation in India. The greatest success of the Green Revolution was realized in the states of Punjab and Haryana.²⁴

Still and all, at the time there was no lack of internal Indian political opposition to implementing the Green Revolution as a strategic imperative to forestall the looming human catastrophe; however, the Indian government (ultimately persuaded and motivated by the compelling advocacy of Dr. M.S. Swaminathan), nevertheless eventually recognized that this was a crucial program that had to move forward lest starvation and death continue unabated. India was thereby rescued again from the jaws of famine by a group of U.S. and international organizations, working together under the leadership of Borlaug: the International Center for Maize and Wheat Improvement (CIMMYT), International Rice Research Institute (IRRI), US Agency for International Development (USAID), along with donor agencies such as Rockefeller and Ford Foundations. Whereas the Green Revolution in India has subsequently been the object of intense reappraisal and even criticism,²⁵ as Kolady succinctly notes: *“The current tendency is to overstate the problems of Green Revolution while forgetting the appropriate counterfactual situation: what would have been the extent of hunger, poverty, and malnutrition without the increased productivity of rice and wheat in the context of the high population growth rate?”*²⁶

Today, India once again faces the distinct possibility of food shortages. A new Green Revolution is needed, but one that taps a new source of sustainable innovation in agriculture: agbiotech, the Gene

²²*id.*

²³ Govindan Parayil, *The Green Revolution in India: A Case Study of Technological Change*, 33 *TECH. & CULTURE* 4, 737 (1992).

²⁴ Clark G. Hilden, *India and the Green Revolution*, United States Educational Foundation in India (1988). Available at <http://files.eric.ed.gov/fulltext/ED322073.pdf>.

²⁵ S. K. Das and H. Tripathi, *India's Green Revolution: Fact and Fallacy*, 5 *INTL. J. OF BIO-RESOURCE AND STRESS MGMT.* 1, 153 (2014).

²⁶ Deepthi Kolady, *Technology Failure or State Failure? A Comparison of Green Revolution and Gene Revolution Technologies in India*, 2013, Annual Conference 2013: Agrarian Crisis in India?, April 5-6, 2013, Cornell University, Ithaca, NY, USA. 2013.

Revolution. The potential benefits of the Gene Revolution are wide-ranging and significant, including food security, poverty alleviation, environmental stewardship and conservation of water, biodiversity and natural resources:

In addition to increasing food production and reducing poverty, transgenic crops [agbiotech] could alleviate some environmental problems caused by intensive agriculture. For instance, farmers who grow Bt crops can reduce their use of chemical pesticides that do harm to non-target species such as bees. Herbicide-tolerant crops let them decrease their use of the most toxic compounds, albeit with an overall increase in lower-toxicity herbicides. Herbicide-tolerant crops are also associated with the adoption of low- or no-till cropping practices, which reduce soil erosion and the disruption of soil structure and microbial communities. Thus, transgenic crops could help bring about a “doubly green revolution.”²⁷

In addition, whereas the Green Revolution focused on major grain commodity crops, requiring crop management approaches, that is a comprehensive management package, input intensive agriculture and the application of inorganic fertilizers and pesticides,²⁸ the Gene Revolution seeks to address issues that smallholder farmers encounter on marginal land, who raise and produce important, albeit neglected, “orphan crops”:

“Traits of special interest to the developing world include nutritional enhancement and resistance to production stresses such as [heat], drought, salinity, disease and pests. Crops that provide the majority of their food supply and livelihoods—rice and wheat—are being neglected, as are a variety of “orphan crops” (such as [cassava, eggplant, papaya, banana plantain], sorghum, pearl millet, pigeon pea, chickpea and groundnut). Those are staple foods in some regions and have also been largely passed over by conventional agricultural research programs.”²⁹

The Gene Revolution in India can therefore move the benefits of advanced agbiotech innovation in agriculture to arable land that does not have access to irrigation: *“The first Green Revolution targeted irrigated areas. The second [Gene Revolution] must focus on rainfed (unirrigated) areas, which cover 60% of India’s farmland, and support the vast majority of its rural poor. Drylands produce half the country’s cereals, 77% of its*

²⁷ Terri Raney and Prabhu Pingali, *Sowing A Gene Revolution*, 297 SCIENTIFIC AMERICAN 3, 104 (2007).

²⁸ Hilden, *supra* note 24.

²⁹ Terri Raney and Prabhu Pingali, *supra* note 27.

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*oilseeds and 85% of its pulses.*³⁰ Currently, this is precisely where improvements are most sorely needed in Indian agriculture. The Green Revolution forestalled catastrophic starvation in India by focusing on major grain commodity crops (wheat and rice) via conventional plant breeding in conjunction with high-input agricultural practices, e.g., irrigation and fertilizer. The Gene Revolution, in contrast, can address marginalized sectors of the population, tailoring innovation to address a broader range of challenges, e.g., heat, drought, flooding, etc., and therefore, in a very real sense, it would complement the accomplishment of the Green Revolution and extend the societal benefits to this century and beyond:

*“The original green revolution transformed Asia [e.g., India] from a continent stalked by hunger into one that could think and plan beyond the next harvest. It helped lay the foundation for the continent’s economic miracle and made possible Asia’s demographic transition from high fertility and high mortality to smaller, richer families. The second green revolution [Gene Revolution] will not do that. But it should complete the first one, mainly by bringing benefits to the poorest, who missed out first time round. It will help mechanise and move more people off farms and into more productive labour. And it should prevent Asia slipping back under the shadow of hunger and all the political and social disruptions that such misery causes. Few other things can promise as much.” (Emphasis added)*³¹

AGBIOTECH CROPS IN INDIA

In general, the status of agbiotech in India is an ongoing saga. Notwithstanding its importance to the Gene Revolution in India, and its importance to sustainable food security, progress in agbiotech continues to creep forward. Over the past three decades, there indeed has been a distinct series of (measured) steps:

“Status of Biotech crops research and use of biotech food/ agricultural products in India

- *Genetically Modified Organisms (GMOs) and products thereof including GM crops are regulated products in India under the “Rules for the Manufacture, Use/Import/Export and Storage of Hazardous Micro*

³⁰ R. B. Singh, *A Second Green Revolution?*, International Center for Agricultural Research in the Dry Areas (ICARDA) (2014), available at <http://www.icarda.org/second-green-revolution>.

³¹ The New Green Revolution: A Bigger Rice Bowl - Another Green Revolution is Stirring in the World's Paddy Fields, THE ECONOMIST (May 10, 2014).

Organisms/ Genetically Engineered Organisms or Cells” notified by the Ministry of Environment and Forests through Notification No. 621 in Official Gazette of Government of India on December 5, 1989 under the provisions of the ‘Environment (Protection) Act, 1986’. These rules and regulations commonly referred as ‘Rules 1989’ cover areas of research, as well as large scale applications of GMOs and their products.

- *Bt cotton is the only commercially approved biotech crop in India.*
- *In 2010, the Government of India (GOI) announced a moratorium on the approval process for Bt brinjal (eggplant).*
- *In May 10, 2012, on the Writ Petition (Civil) no. 260 of 2005 of Aruna Rodrigues Vs Union of India, the Supreme Court of India instituted a six-member Technical Expert Committee to review and recommend biosafety risk assessment studies for genetically modified (GM) crops.*
- *This Technical Expert Committee has recommended stopping open field trials on all genetically modified crops until a new set of conditions is enforced and a ten year moratorium on field trials of Bt transgenics in all food crops.*
- *Under current Indian regulations, all biotech food/ agricultural products or products derived from biotech plants/ organisms must receive formal approval from the Genetic Engineering Appraisal Committee prior to commercialization or imports (the GEAC is India’s apex biotech regulatory body).*
- *Soybean oil derived from Round-up Ready soybeans (glyphosate-resistant soybeans) is the only biotech food/ agricultural product currently approved for import.*
- *In India processed food products derived from genetically engineered products (where the end-product is not an LMO – a Living Modified Organism) do not require approval from GEAC for production, marketing, import and use in India. As processed food products are not replicated in the environment, they are not considered to be an environmental safety concern under the 1989 EPA. However, imports of products that are LMOs continue to be under the purview of GEAC and the 1986 EPA.”³²*

As pointed out by Kolady et al., growth in the Indian seed industry has also expanded, with a positive impact on investment in new crops, technologies and concomitant IPR protection, to a great extent via plant variety protection (PVP) pursuant to the 2001 PPV&FR Act. The sequential loosening, via nine crucial steps, of state control over the seed industry has facilitated this process:

“Indian Seed industry Policy Initiatives

³² ICRISAT, *supra* note 5.

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1. *Seeds Act (1966)* Established variety release, seed certification and testing systems and established state monopoly over seed production and distribution for important food crops.
2. *National Seeds Project (1977–1991)* Led to the formation of state seed corporations and strengthened the seed system infrastructure in the country.
3. *Seed Control Order (1983)* Regulated seed dealers through dealer licensing.
4. *Industrial Licensing Policy (1987)* De-reserved Indian seed industry permitting private companies to produce and market seeds.
5. *New Policy on Seed Development (NPSD) (1988)* permitted import of germplasm for research, import of commercial vegetable seed and conditional import of seeds for coarse grains, pulses and millets.
6. *New Industrial Policy (1991)* permitted foreign direct investment in the seed industry.
7. *The Seeds Bill (2004, still pending in parliament)* proposes mandatory registration of all varieties and replaces the *Seeds Act of 1966* and the *Seed Control Order of 1983*.
8. *Protection of Plant Varieties and Farmers' Rights Act (2001)* provides an effective system for protection of plant varieties and incentives to strengthen the seed industry and the availability of high-quality seed for farmers.”³³

Perhaps there is no better manner to illustrate agbiotech in India than the few salient examples, presented herein below: Bt Eggplant, Cabbage and Cotton. Whereas they represent agbiotech innovations which have, in the case of Bt cotton, or could have, in the case of Bt eggplant and cabbage, advance the Gene Revolution in India, they exemplify the steady, albeit gradual, progress stumbles, rather than marches, forward.

BT EGGPLANT

Bt Eggplant (or brinjal; genetically engineered via cloning of the *Bacillus thuringiensis* insecticidal protein gene) is India's first genetically modified vegetable crop. Eggplant production in India is important because it is largely grown by smallholder farmers, yet is damaged heavily due to

³³ Deepthi Elizabeth Kolady, David J. Spielman and Anthony Cavalieri, *The Impact of Seed Policy Reforms and Intellectual Property Rights on Crop Productivity in India*, 63 J. OF AG. ECON. 2, 361 (2012).

infestation by the Fruit and Shoot Borer (FSB), with yield losses of up to 70%.³⁴ The Bt eggplant technology is effective against FSB, with 98% insect mortality in shoots and 100% in fruits, at the same time requiring 77% less insecticides than non-genetically engineered control eggplant; there also up to 116% increase in yield over conventional hybrids and 166% increase in Open Pollinated Varieties (OPVs), with a decrease in insecticide application, reducing farmers' exposure to chemicals and pesticide residues in the vegetable itself. It has been estimated that farmers should achieve a net economic benefit of ca. Rs. 16,299 (US\$330) to Rs. 19,744 (US\$397) per acre from Bt eggplant.³⁵

Mahyco (an Indian seed company with a 26 percent ownership stake held by Monsanto Inc.)³⁶ has developed a Bt eggplant hybrid using the cry1AC gene of Bt.³⁷ This agbiotech product, however, has encountered administrative roadblocks on its journey towards commercial release.³⁸ The same technology is being utilized by Tamil Nadu Agricultural University (TNAU) and the University of Agricultural Sciences (UAS), Dharwad for the production of backcrossed, OPVs of Bt eggplant. In addition, Bt eggplant using the cry1AC gene is also being developed by the Indian Institute of Horticultural Sciences (IIHR); the National Research Center on Plant Biotechnology (NRCPB) has successfully developed a Bt eggplant variety that expresses the cryFa1 gene and which has been successfully transferred to a number of seed companies such as BejoSheetal, Nath Seeds, Vibha Seeds and Krishidhan Seeds, for potential commercialization.³⁹

Despite having met all the regulatory requirements for its approval and release, the Minister of Environment and Forests, whom the decision for the commercial release of Bt eggplant was passed

³⁴ K. Marichamy and A. Ganesan, *Bt Brinjal – India's first biotech crop*, 1 SCIENCE PARK RESEARCH JOURNAL 14 (2013).

³⁵ Vijesh V. Krishna and Matin Qaim, *Estimating the Adoption of Bt Eggplant in India: Who Benefits from Public Private Partnership?*, 32 FOOD POLICY S23 (2007). Also see: Vijesh V. Krishna and Matin Qaim, *Potential Impacts of Bt Eggplant on Economic Surplus and Farmers' Health in India*, 2007, AAEA, WAEA & CAES Joint Annual Meeting, July 29-August 1, 2007, Oregon Convention Center, Portland, Oregon. 2007.

³⁶ <http://www.monsantoindia.com/MHPL.html>

³⁷ Marichany, *supra* note 34.

³⁸ D.A. Russel, B. Uijtewaal, V. Dhawan, D. Grzywacz, R. Kaliaperumal, *Progress and Challenges in the Bt Brassica CIMBAA Public/Private Partnership*, in THE SIXTH INTERNATIONAL WORKSHOP OF THE DIAMONDBACK MOTH AND OTHER CRUCIFER INSECT PESTS 10-27 (R. Srinivasan, Anthony M. Shelton, Hilda L. Collins eds., 2011).

³⁹ Marichany, *supra* note 34.

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to, undertook extensive consultation for several months and eventually declared a delay in its release until further undefined studies were performed. Therefore, whereas the crop variety has undergone rigorous scientific evaluation pertaining to safety of food, environment, human and animal health, and biodiversity, it has encountered administrative and bureaucratic reevaluation and delays, stalling commercialization and eventual deployment to benefit Indian agriculture and smallholder farmers in particular.⁴⁰ Now, to further complicate matters with the release of Bt eggplant, “*An Indian government agency has agreed to sue the developers of genetically modified (GM) eggplant for violating India's Biological Diversity Act of 2002. India's National Biodiversity Authority (NBA) is alleging that the developers of India's first GM food crop—Jalnabased Maharashtra Hybrid Seeds Company (Mahyco) partnered with St. Louis based seed giant Monsanto and several local universities used local varieties to develop the transgenic crop, but failed to gain the appropriate licenses for field trials.*”⁴¹

BT BRASSICA

Brassica oleracea (genetically engineered via cloning of the *Bacillus thuringiensis* insecticidal protein gene) is an important vegetable crop in India with an annual production of 6.3 million tons, but it is heavily affected by diamondback moth infestations which cause an annual loss of about US\$16 million leading to the frequent application of insecticides and increased production input costs. The development of transgenic cabbage expressing insect resistance using Bt technology is a potentially cost effective management solution for the widespread problem.⁴²

A number of institutions in India have initiated work on developing Bt Brassica varieties. There is discussion between ICAR and Bayer Crop Science regarding the development of a cry1B/cry1C gene construct for use in the transformation of important Brassica crops, the technology for which would be wholly held by the public sector and may be expanded for use in kale as well.⁴³ Additionally, this agbiotech application could be integrated into other cabbage improvement

⁴⁰ Russel, *supra* note 38.

⁴¹ Lucas Laursen, *Monsanto to Face Biopiracy Charges in India*, 30 NATURE BIOTECH. 1 (2012).

⁴² William Hennessey, Aarushi Gupta and Stanley P. Kowalski, *Practice Driving Policy: Ag-Bio-Technology Transfer as Capacity Building*, in HANDBOOK ON AGRICULTURE, BIOTECHNOLOGY AND DEVELOPMENT 314 (Stuart J. Smyth, Peter W. B. Phillips and David Castle eds., 2014).

⁴³ Russel, *supra* note 38.

programs in India, e.g., in FY 2012-13, IARI commercially released Pusa Cabbage Hybrid 1, an early-maturing hybrid variety with resistance to black rot disease, improved yield and tolerance to high temperature, in three north Indian states.⁴⁴

A noteworthy case is the Collaboration on Insect Management for Brassicas in Asia and Africa (CIMBAA), a public-private partnership (PPP) formalized in 2005 for the dissemination of Bt Brassica. Between 2005 and 2009, CIMBAA's research collaborators were able to complete transformations on both cabbage and cauliflower, and by the middle of 2009, the preferred cabbage and cauliflower lines had been selected for efficacy trials held in north and south India. However, the project stalled and sputtered in 2010 when some of its key partners (AVRDC, Cornell University) withdrew from the partnership citing liability and licensing stewardship issues, as well as discouragement due to delays in the release of Bt eggplant. As a result, field, laboratory work and further development has ceased despite having reached an advanced stage.⁴⁵

Bt COTTON

Bt cotton, genetically engineered via cloning of the *Bacillus thuringiensis* insecticidal protein gene,⁴⁶ the only agbiotech crop which has been widely commercialized and produced in India, is a spectacular success story.⁴⁷ In India, Bt cotton production has generated \$51 billion (US) in profit, clearly demonstrating the benefits of this advanced agbiotech innovation to Indian farmers; this extra income was realized via increased yields of bales of cotton fibre, reduced labor in the fields and, the environmentally friendly reduction in the application of chemical pesticides.⁴⁸ A systematic analysis by Pray and Nagarajan has provided compelling evidence for the broader positive commercial and

⁴⁴ Indian Agricultural Research Institute *Annual Report*. New Delhi, India: Indian Agricultural Research Institute, 2013, available at http://www.iari.res.in/files/Annual-Report_2012-13.pdf.

Indian Agricultural Research Institute, *Varieties Developed at IARI*, Indian Agricultural Research Institute (2010), available at http://www.iari.res.in/index.php?option=com_content&view=article&id=1253&Itemid=53.

⁴⁵ Russel, *supra* note 38.

⁴⁶ ISAAA, Pocket K No. 6: Bt Insect Resistant Technology, 2013, available at <http://www.isaaa.org/resources/publications/pocketk/6/default.asp>

⁴⁷ Kolady *supra* note 26.

⁴⁸ Judit Berman et. al, *Can the World Afford to Ignore Biotechnology Solutions That Address Food Insecurity?*, 83 PLANT MOL. BIOL. 1/2, 5 (2013).

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societal impact of this agbiotech innovation.⁴⁹ As the authors point out: “*Agbiotech has positively affected research and development in the Indian seed industry, possibly by greatly increased actual and expected market size in the seed industry, which increased research and development ... increased appropriability, which is the ability of firms to capture the economic benefits of new technologies because of the regulations [and/or] ... greatly increased technological opportunities for developing new traits ...*” However, the authors also make clear that the IPR appurtenant to the Bt agbiotech innovations is, presumably, predominantly non-Indian owned: “[F]oreign companies dominate agricultural biotech patenting: 78 patents have been granted to foreign firms and only one has been granted to an Indian company”.

Access to Bt cotton in India has been largely driven by international private sector collaborations with deals and joint ventures effectively accelerating the transfer of this technology to farmers across the country: “*Mahyco-Monsanto Biotech (MMB) - a 50:50 joint venture between Mahyco and Monsanto Holdings Pvt. Ltd. sub-licensed the Bollgard II and Bollgard technologies to more than 30 Indian seed companies. Each Indian seed company has introduced the Bollgard technology into their own germplasm. Indian farmers now have a choice of over 300 Bt cotton hybrid seeds. Bollgard is used by more than 6 million Indian farmers.*”⁵⁰

TECH-TRANSFER IN INDIA, AN OVERVIEW

In developed, innovation-driven, knowledge-based economies, such as the U.S.A., the U.K. and Israel, successful tech-transfer involves a chain of steps to be accomplished effectively, some of which may run simultaneously and may not necessarily be in the same order as listed here:

- 1) Conceptualization and creation of a technology that is market-worthy and beneficial to the industry;
- 2) Procurement of adequate IPR protection in the appropriate jurisdictions in a timely and efficient manner;
- 3) Identification of potential industry partners that may benefit from the commercialization of the technology within their business unit and also have the capacity to successfully evaluate and commercialize the technology into a useful end-product;

⁴⁹ Carl E. Pray and Latha Nagarajan, *Role of Biotechnology in Stimulating Agribusiness R&D Investment in India*, 16 *AGBIOFORUM* 2, 104 (2013).

⁵⁰ <http://www.monsanto.com/improvingagriculture/pages/history-of-bollgard-cotton.aspx>

- 4) Demonstration of proof-of-concept of the technology by the inventor, an external party, or both, possibly through a joint development or corporate-sponsored research agreement;
- 5) Upon demonstration of the technology's value proposition and de-risking via additional research, implementing a technology license agreement with the company on pre-negotiated financial terms;
- 6) Monitoring periodically the commercialization of the licensed technology, its time to market, as well as the distribution and receipt of royalty payments from the licensee based on the set financial terms.

Whereas this model is appropriate in these developed countries, India will likely need to adapt tech-transfer, especially in agbiotech, to address its current food security challenges and level of innovation, whether such innovation is present or needs to be developed or absorbed.

Most of the research in India is motivated by research publication, granted patents, and the prestige that result, and not by tech-transfer and its potentially significant returns to the inventor as well as the community. This reflects the stasis in India, which is especially the case in the public sector agricultural research and development. *“So far, governance of agricultural research in India has largely meant adopting government laws, rules and procedures in a command and control regime. While this mode of governance was adequate in the early phases of the growth of NARS, it is no longer so in view of the pluralistic nature of research and tech-transfer, and demands for more speedy, effective and efficient performance with greater transparency and accountability of decision processes.”*⁵¹ The traditional system still prevails, and the transition from the public goods based Green Revolution to a global innovation based, transactional, proprietary Gene Revolution requires refinement and development of a system through which agbiotech innovation moves.

As noted by Graff: *“Most [Indian] academic intuitions still lack IP management capacity, with the exception of the leading Indian Institutes of Technology (IITs) and a few other universities. TTOs or centers are now found at:*

IIT New Delhi

IIT Bombay

IIT Kharagpur

IIT Kanpur

IIT Guwahati

⁵¹ National Academy of Agricultural Research Management, *supra* note 16.

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IIT Roorkee

IIT Chennai

Delhi University

Govind Ballabh Pant University of Agriculture & Technology, Pant Nagar

Bidhan Chandra Krishi Vishwavidyalaya

*Jadavpur University*⁵²

Hence India does have a TTO foundation, and has several tech-transfer establishments, some of which have been long-existent (e.g. NRDC, FIIT) and others that are relatively recent (e.g. ICAR's IP&TM Unit).⁵³ India has, since fairly recently, begun to see developments in agbiotech transfer capability in some of its key publicly owned, agricultural R&D institutions such as ICAR.⁵⁴ Many such institutions have made an effort to take on human resources that would oversee the protection of early-stage innovations, through the implementation of dedicated 'IP Cells', or in other words, the Indian TTOs (e.g. ICAR, NBPGR).⁵⁵ Despite these developments, some important challenges and drawbacks remain in the effective management of agricultural IP, mostly due to lacking awareness of

⁵² Graff GD. 2007. Echoes of Bayh-Dole? A Survey of IP and Technology Transfer Policies in Emerging and Developing Economies: In *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A Krattiger, RT Mahoney, L Nelsen, et al.), MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A. *available at* www.ipHandbook.org.

⁵³ See National Research Development Corporation, *Mission*, National Research Development Corporation (2014), <http://www.nrdcindia.com/mission.htm>; See Also Foundation for Innovation and Technology Transfer, *About FIIT*, Foundation for Innovation and Technology Transfer – Indian Institute of Technology Delhi (2004), *available at* <http://www.fitt-iitd.org/about-fitt.aspx>; See Also Indian Council of Agricultural Research, *Commercialisation of Technology: Intellectual Property & Technology Management (IP&TM) Unit*, Indian Council of Agricultural Research (2010), *available at* <http://www.icar.org.in/en/node/372>.

⁵⁴ See Indian Council of Agricultural Research, *Commercialisation of Technology: Intellectual Property & Technology Management (IP&TM) Unit*, Indian Council of Agricultural Research (2010), *available at* <http://www.icar.org.in/en/node/372>.

⁵⁵ *Id.*; See Also National Bureau of Plant Genetic Resources, Technologies and IPRs: Institute Technology Management Unit (ITMU), National Bureau of Plant Genetic Resources (2013), *available at* http://www.nbpgr.ernet.in/Technologies_and_IPRs.aspx.

tech-transfer opportunities.⁵⁶ Primarily, while these institutions have adopted an aggressive strategy for IPR protection for their agricultural innovations (i.e. mostly in the form of plant variety protection), the same cannot be said for their efforts in the utilization and commercial dissemination of these technologies as so far there are apparently no immediate records of agbiotech transfer success stories that are attributable to these Indian TTOs.⁵⁷ A summary of several TTOs and tech-transfer organizations follow.

NATIONAL RESEARCH DEVELOPMENT CORPORATION

Before IPR had been established in India to the extent that they exist today, the National Research Development Corporation (NRDC) had already begun working on technology commercialization for the benefit of the public. Established in 1953 with the objective to promote, develop and commercialize the technologies and know-how coming from various Indian R&D institutions, it may be entitled as the oldest government organization for tech-transfer. However, it is notable that this institution appears to have not undertaken any tech-transfer projects and technologies pertaining to improved crop varieties.

NRDC's website enlists certain major technologies licensed by NRDC in India over the past decade, these include innovations in agriculture, chemistry, food and the life sciences.

Among these is the rice husk particle board, which utilizes rice husk waste and has been the subject of patents filed in India and many other rice growing countries. This board has emerged as a versatile substitute for wood in a wide range of applications. It should be noted that the information provided by NRDC apparently does not include readily accessible data on the ownership of IPR related technologies, nor is information about the types of agreements between NRDC and various innovating bodies. The role of NRDC as an interface between the innovating organization and the one that implements it, however, is an important aspect of its mission.

⁵⁶ Purohit, Shashwat, *SpicyIP: IP Management in Indian Agricultural Research*, UNH Law Blawgs: ITTI: The International Technology Transfer Institute at UNH Law (31 May, 2009), available at <http://blogs.law.unh.edu/iti/2009/05/spicyip-ip-management-in-india.html>.

⁵⁷*Id.*; See Also Protection of Plant Varieties & Farmers' Rights Authority, India, *List of Registered Varieties Certificate Issued Upto Dates: 01.04.2014*, Protection of Plant Varieties & Farmers' Rights Authority, India (2014), available at http://www.plantauthority.gov.in/List_of_Certificates%20upto%2001.04.14.mht.

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)

This premier industrial R&D organization in India is an autonomous body established in 1942 by a government resolution. It is recognized as one of the world's largest publically funded R&D organizations. *"In 1996, CSIR developed an IP policy for the purpose of maximizing 'the benefits of CSIR from its intellectual capital by stimulating higher levels of innovation through a judicious system of rewards, ensuring timely and effective legal protection of its IP' and forging strategic alliances from enhancing the value of its IP. As a part of the implementation process CSIR has also established an R&D, Planning and Business Development Division, responsible for tech-transfer and licensing, as well as an Intellectual Property Management Division, responsible for filing and prosecuting patent applications, managing IP portfolio and even litigating IP matters. It should also be noted that as early as 1990, CSIR has introduced a royalty sharing system to reward scientists and since, several other research centers followed its footsteps".*⁵⁸

CSIR's role in science and technology human resource development is noteworthy. A pioneer of India's IPR movement, CSIR today is also strengthening and building on its patent portfolio: CSIR filed 174 patents in India and 220 abroad during the year 2010-2011 whereas it was granted 260 patents in India and 361 abroad during the year. CSIR has (according to its 2010-2011 Annual Report) 3046 foreign patents and 2278 Indian patents in force. Continuing to create niches in technology licensing, CSIR has signed a unique deal with M/s Nostrum Pharmaceuticals Inc., USA for world-wide licensing of clinical development of new generation thrombolytic molecules. CSIR will be receiving over US\$ 150 million through various milestone payments and royalties. This is an outstanding example of Public-Private-Partnership that will ultimately benefit humankind. The effort is part of CSIR's endeavour of providing affordable healthcare.

INDIAN INSTITUTES FOR TECHNOLOGY (IITs) AND INDIAN INSTITUTE OF SCIENCE (IISc)

While NRDC has identified the essential industry-academia gap in the ecosystem, the IITs and the IISc are heavily focused on bridging that gap. Both of these premier institutions have established designated offices to manage the protection of IPR and overlook their tech-transfer activities.⁵⁹ The IITs, with nearly each of their numerous nationwide branches, have such offices in place.⁶⁰

⁵⁸ Julia Siripurapu, *An Overview of Technology Transfer Practices in India, as of 2007*, 42 LESNOU 573 (2007).

⁵⁹*id.*

⁶⁰*id.*

IIT DELHI⁶¹

Currently, the Foundation for Innovation and Technology Transfer (FIIT) is the autonomous body that handles the patent filing, IP marketing and tech-transfer activities. It was established in 1992 with the primary motive of helping IIT-Delhi build partnerships with the industry such that the institution can devise programs to conduct applied research and customize technology as per industry needs. FIIT is also in the process of commercializing a range of technologies. As an example, it is marketing a protective coating technology that is useful for preserving fresh produce in hot climates and is in demand from various tropical and sub-tropical countries where it could solve the grievous problem of preserving fresh produce. *“IIT- Delhi has its IP policy which allows the institute to retain ownership of the inventions developed by IIT Delhi person while working at the institute. The inventions developed through sponsorship may be owned by the institute or may be jointly owned. The IP management policy of the institute includes invention disclosure requirement, assessment of the innovations, patent filing procedure and commercialization of IP. 60% of the revenue is shared by the inventor, 20% to the institute and 20% to the department where the invention came from.”*⁶² However, as was the case with NRDC, FIIT has not dealt with innovations pertaining to crop improvement, primarily because IIT-Delhi does not contain an agricultural school within its institutional capacity.⁶³

IIT BOMBAY⁶⁴

“Established in 1972, the Industrial Research and Consultancy Centre (IRCC) at IIT Bombay is responsible for fostering R&D activities at the institute, serving as an interface between the institute and industry, the administration and management of sponsored research programs; and protecting, managing and commercializing the Institute's IP assets. The IRCC also manages the Technology Business Incubation program funded by government agencies to encourage and support academic entrepreneurship.” IIT - Bombay joined the Association of University

⁶¹ Partha Bhattacharya, *Technology Transfer from a Technical University: A Case Study of IIT Delhi*, 10 J. OF INT. PROP. RIGHTS 413 (2005).

⁶² Siripurapu, *supra* note 58.

⁶³ See Foundation for Innovation and Technology Transfer, *About FIIT*, Foundation for Innovation and Technology Transfer – Indian Institute of Technology Delhi (2004), <http://www.fitt-iitd.org/about-fitt.aspx>; See Also Indian Institute of Technology Delhi, *Academic Units*, Indian Institute of Technology Delhi (2011), available at <http://www.iitd.ac.in/>.

⁶⁴ Arumugam V. and Karuna Jain, *Technology Transfer from Higher Technical Institutions to the Industry in India - A Case Study of IIT Bombay*, 17 J. OF INT. PROP. RIGHTS 141 (2012).

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Technology Managers (AUTM) in 2006. Since then, it has been successful in generating considerable sponsored research and achieving IPR protection for technologies coming out of IIT-Bombay. "IIT - Bombay has an IP management policy that deals with ownership rights decided by an assignment between the inventor and the institute. It further states the rules related to ownership in a sponsored research, evaluation of the invention by a committee, filing of national and international patent applications, commercialization of IP and revenue sharing".⁶⁵

IIT KANPUR

The research and development office at IIT-Kanpur functions as the interface between the institute and research sponsors and is responsible for the initiation and administration of sponsored research projects. In 2001, IIT Kanpur established the SIDBI Innovation and Incubation Centre (SIIC) Small Industries Development Bank of India (SIDBI) to promote R&D activities and entrepreneurship in the institute. According to the Director's Annual report of 2012 - 2013, "*during the year, twelve technologies developed at the Institute were licensed for commercialization while the institute filed eighteen national patents including two design patents. Twenty-two companies are currently being incubated at SIDBI Innovation and incubation Centre (SIIC) while twenty-one have graduated. SIIC has successfully incubated eight Bio-Tech Companies with two more in the pipeline.*"⁶⁶

IIT KHARAGPUR

"Established in 1982, the Sponsored Research and Industrial Consultancy (SRIC) center is the IPR and Industrial relations cell at IIT-Kharagpur. SRIC serves as the institute's connecting wing with government and industrial sponsors for the purpose of initiating and managing research and consulting projects. Since the inception the center has administered 1,221 sponsored research projects valued at approximately \$21.3 million."⁶⁷ The Centre's website states, "*the institute has an IP policy which strongly believes that the Intellectual Property Rights of a person are not only to be protected but also commercially exploited. The institute is also active in organizing workshops and seminars to enlighten the faculty, scientists and students on various IPR issues. 127 patents have been filed so far on various innovations/ development of technologies, of which about 25 patents have been granted. A few tech-transfer agreements*

⁶⁵ Siripurapu, *supra* note 58.

⁶⁶ IIT Kanpur, Director's annual report of 2012-2013 available at http://www.iitk.ac.in/dord/templates/r_d/data/Annual_Report/Annual_Report_2012-13.pdf

⁶⁷ Siripurapu, *supra* note 58.

have been made on enzyme based unhairing process using agro-residues, acid-proof cement & allied products from rice-husk ash, low cost portable weigh bridge, nano-sized zirconia powder, heat resistant cable insulants, etc are two major know-how transfers that have been finalized.”⁶⁸

INDIAN INSTITUTE OF SCIENCE (IISc)

The IISc has created several interfaces with the industry. The Institute established the Center for Scientific and Industrial Consultancy (CSIC) in 1975 for the purpose of promoting and enhancing its existing relations with industry and engaging in tech-transfer transactions. IISc took a further step in commercializing its technologies by setting up the Society of Innovation and Development in 1991. During the fiscal year 2004 -2005, CSIC and SID initiated approximately 270 industry sponsored research projects.⁶⁹ *“A rigorous IP policy has been set-up by the institute that lays down the rules related to the ownership and profit sharing of the innovations from IISc. The institute also has partnership agreements with Think Village, LLC Boulder, Colorado, USA and Intellectual Ventures Asia Pte. Ltd. Singapore, to help market IISc's IP to industry and enable the IISc's researchers in the fields of IP productivity and commercialization.”⁷⁰*

INDIAN COUNCIL OF AGRICULTURAL RESEARCH AND AFFILIATES

The Indian Council of Agricultural Research (ICAR), which is among the top, public-funded agricultural organization in India, recognized the need for a systematic management of its technologies and services for the purpose of transfer and commercialization of those technologies into end products beneficial for the public.

As articulated by Elsy et al.:

“The Indian Council of Agricultural Research (ICAR) is the apex body for planning, promoting, coordinating and undertaking research and its application in agriculture and associated sciences at Central and State Agricultural Universities, colleges and other agricultural organizations across the country. In response to the changing scenario of technology generation, protection and dissemination, ICAR has developed a policy framework for intellectual property management and tech-transfer/commercialization. This policy is for stimulating research and promoting enterprise growth, all for the ultimate benefit of the farming community. These guidelines became effective October 2, 2006 (ICAR, New Delhi, India, 2006). Many of

⁶⁸ <http://www.iitkgp.ac.in/sric/>

⁶⁹ Siripurapu, *supra* note 58.

⁷⁰ <http://www.ipcell.iisc.ernet.in/ip/aboutus.html>

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the State Agricultural Universities are now developing their own policies for IP protection and management in tune with the ICAR guidelines.”⁷¹

In addition, recognizing agriculture as the principal source of livelihood for over 58% of the Indian population and the main driver of India's economic growth, as well as wanting to act upon the detrimental reduction in the growth rate of agricultural GDP in the past several years, ICAR, with the help of funding from the World Bank and the Government of India, devised the National Agricultural Innovation Project (NAIP) to seek new strategies and innovative solutions to combat the slowing GDP as well as meeting the average farmer's lopsided input-output ratios. In 2006, ICAR implemented the establishment of a decentralized, three-tier IP management infrastructure, wherein

The first tier enables individual research institutes affiliated with ICAR to enter into commercial license agreements with interested industry partners (public or private) having the potential to develop products in that particular scientific space.

The middle tier consists of five Zonal Technology Management & Business Planning and Development Units (ZTM&BPD, or hereafter, BPDs) that act like their very own indigenous TTOs undertaking the commercialization efforts for those ICAR affiliates that fall under their respective geographic zones. Many of these BPDs offer incubation and business consultation services to aspiring entrepreneurs and startups whose business plans revolve around one of ICAR's technologies.

For the third tier, ICAR has established a central Intellectual Property & Technology Management Unit (IP&TM) primarily for the purpose of overseeing international patent filings, while at the same time overseeing policy matters related to tech-transfer and public-private partnerships.

⁷¹ Cheruvathoor Elsy, U. Deepa and Karim Maredia, Intellectual Property Protection, Management and Technology Transfer Policies and Practices in India, in USAID, USDA-ARS, USDA-FAS and Michigan State University, *Intellectual Property Policies and Technology Transfer Practices in the South Asia Region*, 2008, Proceedings of the Special Session Organized at the Association of University Technology Managers (AUTM), February 29, 2008, San Diego, CA, USA. 2008. pp 11-20. See also Indian Council of Agricultural Research, *ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization*, Indian Council of Agricultural Research (2006).

ICAR has via the “*mandate of the Institute Technology Management Unit (ITMU) [pursued] registration of patents, facilitation of contract research projects and consultancies by the Institute scientists, IPR, and interaction with the agri-business industry.*” For example, ICAR has “*With reference to protection of intellectual property ... filed six new patents, renewed nine patents, protected eight varieties of different crops with PPV & FRA and signed 15 MOUs for commercialization of LARI technologies.*”⁷²

STEM - SOCIETY OF TECHNOLOGY MANAGERS

Initiated by Sathguru Management Consultants Pvt. Ltd., STEM is a non-profit organization that provides a facilitative environment for successful tech-transfer processes and promotes best practices. This organization is like the AUTM (Association of University Technology Managers) of India. It provides an environment that is supportive to entrepreneurship and contributes to the professional development of technology management professionals in diverse technical domains and provides proper guidance and assistance to inventors and corporations in matters of IPR.

"The main goals of the governing council are:

- 1. To offer a platform for Technology Management professionals to facilitate their knowledge by peer interactions.*
- 2. To promote best practices in Technology Management and engage in capacity-building.*
- 3. To operate as a catalyst in professional development of technology managers for commercial benefits of innovations.*
- 4. To organize annual meetings and seminars to benefit Tech-transfer professionals nationwide.*
- 5. To spread awareness among the stakeholders about Intellectual Property Laws and its increasing importance.*
- 6. To help inventors and corporations in dealing with Intellectual Property including the practical situations and the legal ramifications involved.*
- 7. To promote the economic growth of the constituent members.”*⁷³

Although, the organization has had annual IP summits since its conception in 2008 and these events have been supported by AUTM, it is hard to believe the unpopularity of STEM amongst the premier research institutes and organizations in India. .

⁷² Indian Agricultural Research Institute, *supra* note 44.

⁷³ <http://stemglobal.org/>

IP LAWS AND TREATIES RELATING TO AGBIOTECH IN INDIA, AN OVERVIEW

Hereinbelow is a brief overview of laws and treaties which are related to agbiotech and tech-transfer related thereto. This is only a cursory overview, purely illustrative in nature to introduce this aspect of the “agbiotech innovation system”, and the reader is advised to seek references with greater depth to better understand these bodies of law.

PATENTS

“On December 26, 2004 the Indian government promulgated the Patents (Amendment) Ordinance 2004 and also the Patents (Amendment) Rules, 2005 to comply with the TRIPS obligations. The patents are administered by the Controller General of Patents, Designs and Trademarks under the control and supervision of the Ministry of Commerce and Industry, Department of Industrial Policy and Promotion, Government of India. The Head Office of the Patent Office has been established at Kolkata and branches are located in Mumbai, New Delhi and Chennai. The Office of the Controller General is in Mumbai. India became the 98th contracting state of the PCT on September 7, 1998, and as such, nationals and residents of India are entitled to file international patent applications at any of the country's Patent Offices.”⁷⁴ It should be noted that the language of Section 3(j) is a verbatim translation into India law of Article 27.3 (b) of TRIPS Agreement (India signed TRIPS in 1994): “Parties may exclude from patentability plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. However, parties shall provide for the protection of plant varieties either by patents or by an effective sui generis system or by any combination thereof.”

PROTECTION OF PLANT VARIETIES

“Article 27.3 (B) of the TRIPS states that member countries are required to grant protection of plant varieties either by patents or by an effective sui generis system or by any combination of these. India has opted for a sui generis system and enacted The Protection of Plant Varieties and Farmers' Rights Act, 2001 (PPV & FR) and Rules 2003. It is unique in that it is the only one that covers both plant breeders' and farmers' rights. It protects the IP rights of farmers in respect to their contribution made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. The Central Government has established the Protection of Plant Varieties and Farmers' Rights Authority for implementing the PPV & FR Act. Plant varieties that conform to the criteria of

⁷⁴ Cheruvathoor Elsy, *supra* note 71.

*distinctiveness, uniformity, stability and novelty are registerable under this Act. Plant Breeders' Rights are the same for the breeder of a variety and breeder of essentially derived variety (EDV) (PPV & FR Act, 2001)."*⁷⁵

BIOLOGICAL DIVERSITY

*"India is one of the eight Vavilsonian centers of origin and diversity of cultivated plants and is one of the 12 mega centers of biodiversity at the global level. It is estimated that there are at least 45,000 species of plants and 77,000 species of animals in the country and it is ranked 10th among the plant rich countries of the world. Numerous endemic species are present in the biodiversity hotspot areas of Western Ghats and Eastern Himalayas and hence India has taken initiatives to protect its sovereign rights over biodiversity in tune with CBD (The Convention on Biological Diversity, India Signed onto the CBD in 1992 and then ratified in 1994). The Biological Diversity Act, 2002 enacted the various provisions for conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising from the use of biological resources and knowledge, and for matters connected therewith or incidental thereto. It is instrumental in protecting the IP rights over biological material in India."*⁷⁶

*"The conservation and sustainable use of biodiversity, based on local knowledge systems and practices, are engrained in Indian ethos and enshrined in the Constitution of India (Article 48A and Article 51(g)). Other Key laws and treaties related to biodiversity specifically in the agricultural sector include the Protection of Plant Varieties and Farmers' Rights (PPV & FR) Act and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)"*⁷⁷

"The ITPGRFA [The International Treaty on Plant Genetic Resources for Food and Agriculture, which India signed and ratified in June 2002] was adopted by the FAO conference in November 3, 2001, stating its objectives to be the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security. Notwithstanding the reference to the CBD, however, it bears emphasizing that the ITPGRFA represents a marked departure from the approach of the CBD. Whereas the CBD represents an assertion of national sovereign ownership of biological diversity generally, and thus apparently envisages a series of bilateral negotiations over access to such diversity and benefit sharing, the ITPGRFA represents a waiver of those sovereign

⁷⁵*id.*

⁷⁶*id.*

⁷⁷ <http://www.cbd.int/countries/profile/default.shtml?country=in>

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*rights with respect to the sixty- four food and feed crops that are included in the ITPGRFA's Multilateral System which creates a form of limited common property in crops that account for the bulk human nutrition.*⁷⁸

BAYH-DOLE LEGISLATION

India is one of the countries that is contemplating in transplanting the Bayh-Dole structure in its IP legislations based on the skeletal model provided under the Bayh-Dole Act of 1980 in the United States. The Indian Government introduced the Protection and Utilization of Public Funded Intellectual Property Bill 2008 in the Upper Parliament in January 2009. The Bill is currently undergoing scrutiny, e.g. by a Parliamentary standing committee, after which it may pass before the two houses of Parliament for approval. Much like its U.S. parent, this bill vests institutes with the right to acquire title to patents for inventions derived from publically funded research and development grants, etc. The Bill purview may extend beyond patents, covering other forms of IP such as copyright, plant varieties, semi-conductor layout and trademarks.⁷⁹

CURRENT POLICY; CONTINUING CONSTRAINTS

Ironically, although the Gene Revolution embodies enormous promise to stabilize food security in India well into the current century, as with the Green Revolution of 50 years ago, policy paralysis, linked to inadequate and disorganized human capital and institutional capacity, once again presents challenges and obstacles for coherent application of such advanced agbiotech innovation to address pressing food security issues facing India.⁸⁰ This apparently extends to an inability of the public sector to drive the development of appropriate agbiotech applications sorely needed in India to address food security threats, whether via research and development in the public sector agricultural system, e.g., universities and government institutes, or more importantly, via public-private partnerships to accelerate the development and deployment of crucial agbiotech innovations: “The Indian seed companies such as Rasi Seeds and Nuziveedu Seeds lead the Bt cotton seed market. In

⁷⁸ Charles R. McManis and Eul Soo Seo, *The Interface of Open Source and Proprietary Agricultural Innovation: Facilitated Access and Benefit-Sharing Under the New FAO Treaty*, 30 WASH. U. J. L. & POL'Y 405 (2009).

⁷⁹ Shamnad Basheer and Shouvik Guha, *Outsourcing Bayh-Dole to India: Lost in Transplantation?*, 23 COLUM. J. ASIAN L. 269 (2010). Mrinalini Kochupillai, *The Protection and Utilization of Public Funded Intellectual Property Bill, 2008: A Critique in the Light of India's Innovation Environment*, 15 J. OF INT. PROP. RIGHTS 19 (2010).

⁸⁰ Kolady, *supra* note 26.

this context, instead of arguing that it is the role of the State to protect farmers from multinational companies, *wouldn't it be more meaningful to ask why public sector is not successful in developing Bt cotton hybrids or varieties ... ?*"⁸¹ This situation appears to not be inconsistent with the observations of Pingali and Raney, who lament that the Gene Revolution will be stymied unless developing countries (e.g. India) invest in building an institutional foundation which will facilitate its sustainable implementation: "Only if formidable institutional challenges are met can transgenic crops achieve their full potential to improve the livelihood of farmers in the developing world".⁸²

As further articulated by Pingali and Raney, the urgency for transition from the public goods based Green Revolution to a global innovation based, transactional, proprietary Gene Revolution increases in direct proportion to food insecurity:

*"The past four decades have seen two waves of agricultural technology development and diffusion to developing countries. The first wave was initiated by the Green Revolution in which an explicit strategy for technology development and diffusion targeting poor farmers in poor countries made improved germplasm freely available as a public good. The second wave was generated by the Gene Revolution in which a global and largely private agricultural research system is creating improved agricultural technologies that flow to developing countries primarily through market transactions. The Green Revolution strategy for food crop productivity growth was based on the premise that, given appropriate institutional mechanisms, technology spillovers across political and agro-climatic boundaries can be captured. A number of significant asymmetries exist between developed and developing, e.g.: agricultural systems, market institutions and research and regulatory capacity. These asymmetries raise doubts as to whether the Gene Revolution has the same capacity to generate spillover benefits for the poor. A strong public sector – working cooperatively with the private sector – is essential to ensure that the poor benefit from the Gene Revolution. (Emphasis added)."*⁸³

The pressing question that must be addressed in order to move from Green Revolution to Gene Revolution involves the necessity in developing countries, e.g., India, for a fundamental policy shift with corresponding capacity building initiatives. As pointed out by Pingali and Raney, "[t]hree

⁸¹*id.*

⁸² Terri Raney and Prabhu Pingali, *supra* note 27.

⁸³ Prabhu Pingali and Terri Raney, *From the Green Revolution to the Gene Revolution: How Will the Poor Fare?*, FAO ESA WORKING PAPER NO. 05-09 (2005).

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interrelated forces are transforming the system for supplying improved agricultural technologies to the world's farmers. The first is the strengthened and evolving environment for protecting IP in plant innovations. The second is the rapid pace of discovery and growth in importance of molecular biology and genetic engineering. Finally, agricultural input and output trade is becoming more open in nearly all countries.” (Emphasis added)⁸⁴

In addition, the reality is that, over the past several decades the private sector has performed the bulk of research in crop improvement with regard to agricultural innovation (agbiotech), e.g., multinational corporations such as DuPont, Syngenta, Bayer and Monsanto, with public sector, e.g., the various research universities, national agricultural research systems (NARS) and the CGIAR (Consultative Group on International Agricultural Research), albeit of crucial and ongoing importance, proportionally contributing less: “*The World's top ten multinational bioscience corporations' collective annual expenditure on agricultural research and development is nearly three billion U.S. dollars. In comparison the CGIAR, which is the largest international public sector supplier of agricultural technologies, spends less than 300 million U.S. Dollars annually on plant improvement research and development.*” (Emphasis added)⁸⁵

Therefore, this, when viewed in the context of the advocacy of Pingali and Raney (as rearticulated), i.e., that “[a] strong public sector – working cooperatively with the private sector – is essential to ensure that the poor benefit from the Gene Revolution”, unequivocally indicates that facile ability to catalyze dynamic international collaborative research and development in agbiotech will depend on the forging of PPPs as engines to drive the Gene Revolution and thereby address food security in India.

Hence, as this clearly implies, advanced innovations in agriculture, largely owned by the private sector, will be the fuel to drive the Gene Revolution. The ability to identify, access, absorb, adapt and apply such agricultural innovations to the given agricultural challenges which developing countries need to address will determine how effectively the Gene Revolution can be implemented, which, in turn, will impact management of ongoing food security concerns in countries such as India. What will this require? A dedicated and focused commitment to strategically build capability and capacity in human capital and institutional infrastructure for managing IP and tech-transfer in

⁸⁴*Id.*

⁸⁵*Id.*

order to accelerate implementation of Gene Revolution solutions for food security and poverty alleviation in India needs to be prioritized at all levels. Once again, Pingali and Raney point out that “[d]eveloping countries are facing increasing transactions costs in access to and use of technologies generated by the multinational sector. Existing international networks for sharing technologies across countries and thereby maximizing spillover benefits are becoming increasingly threatened. *The urgent need today is for a system of technology flows which preserves the incentives for private sector innovation while at the same time meeting the needs of poor farmers in the developing world.*” (Emphasis added)⁸⁶ The urgent need to address “a system of technology flows” is the commitment to capacity building stated immediately hereinabove. There is no alternative. The inexorable juggernaut of globalization is driving the rapid expansion of a global innovation market. Agricultural innovations are included in this market, bought, sold, leased and exchanged via various transactional mechanisms, with IP rights playing a key component facilitating transactions and movement of agbiotech innovation ultimately to where it is most needed, e.g., the marginalized, dry-land, smallholder farmers.

CONCLUSIONS AND RECOMMENDATIONS

The reality of India’s pressing food security has been repeatedly articulated in workshops, symposia, summits, impact fora and white papers:

“The Indian agricultural sector needs to be revitalised to meet the demand of food and nutritional security of a growing population amidst challenging situations. While the first Green Revolution helped in meeting the production demands in the 1960s, the next revolution needs to focus on holistic development of the sector and sustainable in the long run. The key to revitalising the Indian agricultural sector lies in successfully establishing an Agricultural Innovation System based on a convergence strategy, in which the civil society, public and private sector comes together to develop solutions to sustain productivity, provide opportunities for innovation leading to growth of sector and thus boost the economy. The system should leverage on the strengths of each stakeholder and harness innovative technologies in order to reform the sector which will help in supporting the livelihood of millions of people engaged in the agricultural value chain.” (Emphasis added)⁸⁷

⁸⁶*id.*

⁸⁷ ICRISAT, *supra* note 5.

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How can such a broad policy aspiration become strategically focused and operationally implemented? That is, what will it take to move from well-intentioned, policy-laden, sincere rhetoric towards tangible reality that is increasingly and urgently needed? It will be necessary to move away from crippling paradigms and advance towards informed strategy.

First of all, it's time to move from relentless academic analysis and policy fora towards action. For example, whereas theoretical population increase models have been applied to analyze impact that demographic momentum will have on food security in India, these sorts of analyses, albeit satisfying basic academic instincts and intellectual urges, are no longer necessary and actually quite pointless when it comes to the situation in India. Just as one might see a tractor trailer truck careening onward, it is obvious that India's convergence of population and food availability is an urgent and critically important issue that demands action and not only analysis, policy discussions and aspirational proclamations of what "should" be done. One can analyze the speed and direction of the oncoming truck with great accuracy, and then be smashed into oblivion; likewise, the food security of India can be analyzed until another famine crisis arises, perhaps several decades in the future, and one can then witness the catastrophe. Or, one can take action, and begin to build a system which will address the issues: as a sand pile will stop truck, so an efficiently functioning ag-innovation system in India will overcome food insecurity, a Gene Revolution which will foster sustainable stability and move India towards greater knowledge-based economic development.

Furthermore, in India, all too frequently, an unproductive mix of activist agendas⁸⁸ and misinformed anxiety dominate public discourse; as when discussions turn to IP, patents and agriculture, there is no lack of hand-wringing apprehension with little, if any, coherent analysis of the global role of IP as a property rights system that, in fact, facilitates and accelerates the movement, absorption, adoption and development of crucial innovations in agriculture. For example, whereas the hereinbelow mentioned appears to embody legitimate concerns, perhaps it would be wise to temper such angst-ridden rhetoric with a more balanced and informed appraisal (e.g., just which patents is the author referring to?) of the precise role of the IP system in driving innovation and development: "*Under the*

⁸⁸ E.g. *see* Farming Free: An Interview With Food Sovereignty Activist Vandana Shiva, *available at* <http://www.motherearthnews.com/nature-and-environment/food-sovereignty-zm0z14jjzchr.aspx#axzz31nH1toEp>

free trade agreement, it is now possible and easy for farmers to obtain patents for any innovation or charge the corporate sectors for any genetic local crop races and other natural resources used for crop improvement. A new class of patents covers plants derived from conventional breeding. These patents even claim harvest and derived food products such as milk, butter, and bread. Such patents would become a major threat to food security, food sovereignty, and innovation, since the whole chain of seed, harvest, trade, and food production might be controlled by a few big international companies, leading to a monopoly via patent laws. These consequences would be reflected in genetic resources that would be subjected to seed patents and might increase food crises. Small farmers would be deprived of access to seeds, a productive resource essential for their livelihood, and the price of food could rise, making it less affordable for poor people.” (Emphasis added)⁸⁹

Such misguided, misinformed supposition is also apparent in another report, wherein the author presupposes that in the text of the Convention on Biological Diversity (CBD) that “*The Article 8(j) ... seems to affirm that the holders (subject to national legislation) have rights over their knowledge, innovations and practices, whether or not they are capable of being protected by IPRs.*”⁹⁰ However, said CBD Article neither explicitly nor implicitly refers to IPR: “*Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.*” This rather alludes to the necessity of establishing functional Access and Benefit Sharing systems in the developing countries, i.e., something that is in fact being coherently addressed in India.⁹¹ Furthermore, the CBD provides templates as “*[m]odel ABS agreements and model contractual clauses can also play a key role in building capacity to negotiate mutually agreed terms and promoting equity and fairness in negotiations.*” These are in the form of materials transfer agreements (MTAs, i.e., bailment of a chattel pursuant to contractual obligations).⁹² Rights are not inherent, but need to be established via contract; ergo, these two cases

⁸⁹ Gahukar, *supra* note 11.

⁹⁰ Rachitta Priyanka. UPOV AND RIGHTS OF FARMERS - AN INDIAN PERSPECTIVE, *available at* <http://www.intelproplaw.com/>

⁹¹ <https://www.cbd.int/countries/default.shtml?country=in>

⁹² <https://www.cbd.int/abs/resources/contracts.shtml>; See Also Bennett AB, WD Streitz and RA Gacel. 2007. In *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices* (eds. A

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(confusion over patents and misinterpretation of the CBD) reiterates the need for capacity building in tech-transfer and IP management as they relate to agbiotech and food security.

However, progressive, informed and enlightened thinking and strategic discussions are entering the public agenda on food security in India. A recent report from the National Academy of Agricultural Research Management (NAARM) provides vision and encouragement.⁹³ Building on the concept of value-added agricultural innovation, the report identifies the inherent weakness of linkages in the Indian agricultural innovation system (The Indian National Agricultural Research System, NARS), including, but not necessarily limited to inadequate human resources, inadequate tech-transfer, inadequacies in management, monitoring and evaluation, weak inter-disciplinary and inter-institutional linkages, and insufficient focus on individual and institutional learning for change. However, the report does not end on this pessimistic note, but rather optimistically advocates for dynamic capacity building, i.e., what will be necessary to drive a Gene Revolution in India: *“Institutions of NARS will need to build capacities and identify appropriate policies and institutional mechanisms for integrating new sciences and emerging technologies into agricultural research and education, and strategic management of intellectual property. They will also need to institutionalize processes for valuing and licensing technologies, engaging in public-private partnerships for research and technology transfer, and informing policy makers, farmers and consumers of the risks, benefits and safety aspects of the new technologies and products.”* Furthermore, as part of the National Academy of Agricultural Research Management (NAARM), articulated strategy would also seek to *“enhance capacities for technology foresight and strategic management of intellectual property and commercialization of technologies.”*

The challenge, therefore for India, will be the proper, careful, thoughtful application of IP and tech-transfer to the agricultural innovation system, that is, appropriate for accelerating India's innovation base towards sustainable food security. In other words, what is needed is capacity in IP and tech-transfer, structured in such a way that it takes into account the developmental context of Indian agbiotech innovation. This will likely necessitate the ability to identify, import and adapt innovation

Krattiger, RT Mahoney, L Nelsen, et al.). MIHR: Oxford, U.K., and PIPRA: Davis, U.S.A. Available online at www.ipHandbook.org.

⁹³ National Academy of Agricultural Research Management, *supra* note 16.

as much as, if not more than, indigenous invention and innovation. Such a tailored approach is consistent with the observations of Ray and Saha, who have stated that:

“Universities, institutes and laboratories, which are the pillars of public-funded research in India, do not uniformly perform in terms of the quality of research or human resource generation. Only a handful of premier institutes and universities can compare themselves with international standards. Such a skewed research performance may be linked to the concentration of good minds in the top-tier institutions only. Therefore, it remains to be seen how a uniform IP law can be tailored to suit every tier of the quality spectrum in India, if at all. Different constituencies are expected to respond differently to a new institutional framework triggered by a new law. It is here that one fears that a “one size fits all” approach could prove to be counter-productive. [What has] worked very well in some cases, the Silicon Valley around Stanford University and the Route 128 around MIT [might not be appropriate for developing countries]. [I]f we attempt to replicate these models in universities in India or elsewhere simply by institutionalizing IPRs for academic research, ignoring the realities of the differences in context, environment, culture and levels of scientific achievements, we may end up with misplaced priorities.”⁹⁴

A carefully structured strategy which takes into account India’s current agbiotech base and the likely need to identify, access, absorb and adapt agbiotech is conceptually consistent with the open-innovation paradigm. *“Open innovation stresses that organizations should use external as well as internal knowledge to drive innovation and advance technology towards commercialization”*.⁹⁵ Under the open-innovation concept, innovation moves in multiple directions as it flows through the global system. In rapidly emerging global knowledge-based economy, organizations must not rely solely on their own research efforts, but should instead buy or license patented processes or articles as inputs when necessary to accelerate their technological progress. Hence, a rapidly emerging technospace is increasingly driven by economic opportunities for development and new applications, leading to an omni-directional and global tech-transfer ecosystem, yielding spillovers of technologies from the developed countries to be absorbed by the developing countries.”⁹⁶ Recognizing this fundamental concept of the global technospace and open innovation, there are several models for building

⁹⁴ Amit Shovon Ray and Sabyasachi Saha, *Patenting Public-Funded Research for Technology Transfer: A Conceptual-Empirical Synthesis of US Evidence and Lessons for India*, 14 THE J. OF WORLD INT. PROP. 1, 75 (2010).

⁹⁵Hennessey et al., *supra* note 42.

⁹⁶*id.*

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agbiotech innovation in India: “[T]hree possible avenues for public sector institutions in developing countries to gain access to transgenic technologies [could be]: (i) directly import private or public-sector transgenic varieties developed elsewhere, (ii) develop an independent capacity to develop and/or adapt transgenic varieties, and (iii) collaborate on a regional basis to develop and/or adapt transgenic varieties.”⁹⁷ This is particularly the case with advanced/appropriate agricultural innovations, e.g., Golden Rice, wherein multiple components and processes are assembled/embedded in order to develop a rice variety which can supplement vitamin A dietary requirements; appurtenant IP rights related thereto required careful management (e.g., via an efficient PPP that brought together an international group of both public and private stakeholders), which is precisely such a task the Agricultural Innovation Academy might have undertaken.⁹⁸

Therefore, in India, food security in the coming century will depend on widespread improvements in national agricultural production systems, which, in turn will depend on how well India can connect to and function in the global innovation system. Perhaps it also should be mentioned that a...

“system is a set of interdependent components forming an integrated whole, involving elements and relationships wherein there is movement and interaction. Agricultural innovations, e.g., agbiotech, increasingly exist in a global innovation system, said system including the developers, producers and owners of agbiotech; the various laws and treaties (including IP laws such as patent, PVP, trade secrets and germplasm) that regulate the protection, flow of, and access to agbiotech; and the elements (technological components and processes which comprise agbiotech) which includes crop varieties, germplasm resources, plant genetic resources, biodiversity and advanced agbiotech (e.g., genetic engineering inputs, and tools, such as genomics, gene maps and banks). The interconnectivity of these components forms a global innovation marketplace. The functioning of every component in this system determines its overall efficiency—the costs of transacting between the components is key. With adequate human resource capacity and capability, a developing country should itself be able to identify and access multiple pieces of agbiotech in this open innovation market.”⁹⁹

⁹⁷ Pingali, *supra* note 83.

⁹⁸ Hennessey et al., *supra* note 42.

⁹⁹ *Id.*

The components comprising an Indian agricultural innovation system are present, more or less, in each category, e.g., laws and treaties related to IP, tech-transfer and crops are in place; nascent tech-transfer capacity and capability, as shown herein, has been established; an agricultural research and development infrastructure has been present for years. However, there is an imbalance and lack of connectivity among these systemic components, which impede efficient functioning of an agricultural innovation system in India, so sorely needed to address impending food security challenges. For example, in the public research and development sectors of India, much remains to be done with regard to tech-transfer capacity building:

Apart from elite scientific institutions that have institutionalized some policies and practices, only 5 percent of the research organizations have technology transfer offices like in Indian Institute of Technology (IITs). There are very few skilled people to handle technology transfer and licensing in India, and academic institutions do not have patent cells except a few academic institutions. According to the Department of Biotechnology (DBT) almost 60 percent of institutions do not have policy guidelines for patent cells.¹⁰⁰

Whereas the government of India has, ostensibly, articulated the urgent priority of building a science, technology and innovation infrastructure and system in the country, it remains to be seen how this might be implemented in a coherent, sustainable manner:

The principal governmental body responsible for the development of science and technology and for promoting, organizing and coordinating science and technology activities in India is the Department of Science & Technology (DST). One of the principal responsibilities of DST is to formulate policy statements and guidelines on science and technology [e.g.] the Science and Technology Policy (2003). With respect to technology transfer, the policy states that “*every effort will be made to achieve synergy between industry and scientific research*” and that “*autonomous Technology Transfer Organizations will be created as associate organizations of universities and national laboratories to facilitate transfer of the know how generated to industry.*”¹⁰¹ (Emphasis added)

¹⁰⁰ Rajashree Sharma, *Public Funded Research in India – A Reckoner on Recent Legislative Actions*, 45 LESNOU 255 (2010).

¹⁰¹ Siripurapu, *supra* note 58.

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Albeit “every effort will be made to achieve synergy” suggests aspirational sincerity at some level as well as a measured degree of comfort and assurance, it is totally insufficient for building an agricultural innovation system that will drive the Gene Revolution in India. To address the pressing national issue of food security in India, tangible and strategic actions are needed: An Agricultural Innovation Academy in India must be established, for example this could be hosted/situated at NAARM as part of implementation of its Vision 2050 strategy.

The general concept of an IP-focused Academy as a nationally-centralized, IP capacity-building, innovation-accelerator has been proposed, in one form or another, for decades. An Agricultural Innovation Academy in India could serve as an institutional platform which anchors IP/development activities and thereby fosters and facilitates sustainable progress; from a pragmatic operational perspective in India, NAARM is one possible location for an Agricultural Innovation Academy. As articulated by Hennessey et al., such capacity building organization can function as the hub from which IP and tech-transfer networks, capacity, capabilities and expertise radiate, i.e., spokes from the hub; however, resources need to be focused and strategically organized in order to achieve sustainable forward momentum. *“Pragmatically speaking, developing countries need personnel trained in tech-transfer, IP management and related business, technical and legal disciplines. These personnel need to be focused in institutional entities, whether called **ITECs**, **TTOs** or **TISCs** ...”*¹⁰²

A supportive legal environment is necessary but not sufficient for... effective technology transfer ... must be supplemented by the establishment of an Innovation and Technology Entrepreneurship Center (ITEC) to handle ... spinning-in, adapting for local use, and spinning-out technology. This organization can either be a newly established entity or an existing unit within an established organization (Inclusive Innovation Center or university technology transfer centers), retrofitted to carry out new functions.

A framework to allow technology transfer to the public institutes of developing countries must be stimulated and developed. This has been addressed in some countries by the establishment of TTOs. TTOs are often located in a governmental unit associated with some aspect of agriculture. These offices work with researchers, allowing them to develop new crop varieties, and with government

¹⁰²Hennessey et al., *supra* note 42.

officials to develop appropriate laws and policies for intellectual property protection. They develop means for providing plant variety protection, biotechnology invention protection and intellectual property management. TTOs can play multiple roles in research and development (R&D) institutes, [including] protection of intellectual property ... revenues through licensing of intellectual property ... education and awareness, networking ... creation of new start-up companies ... institutional policies related to technology transfer [and] service to society.

Technology Innovation Support Centers (TISCs) act as service-oriented providers to: allow local users to benefit effectively from the increased accessibility of intellectual property information offered by internet searches through direct personal assistance; assist local users in creating, protecting, owning and managing their intellectual property rights; strengthen the local technological base by building up or reinforcing local know-how, and to increase technology transfer, e.g. by investigating the possibilities of licensing, joint ventures, etc. In short, TISCs are established so as to act as local drivers of innovation. The training of TISC so as to be able to assist local users and deliver these services is one of the most important elements ... and while initial training may be focused on searching patent and non-patent technology databases ... further training in other areas of intellectual property rights is considered particularly useful, as it not only continues to develop staff knowledge and their personal development, but also offers a one-stop-shop as regards other elements of intellectual property rights and of innovation support.

Another key component for an Agricultural Innovation Academy agenda would be to provide the tools, knowledge and motivation for fostering the formation of public-private partnerships (PPPs), collaborative endeavors to accelerate the development and deployment of crucial innovations in agbiotech. In PPPs, IP (as both an asset and tool) can function as a property-rights-system mechanism which operationalises transactions. This facilitates and accelerates the movement of technology and innovation across the globe, *i.e.*, both into and out of the Indian agricultural innovation system. IP will also enhance financial sustainability for agricultural innovation-driven development in India, via incentives for investment, licensing revenue and attracting venture capital for start-up companies, spin-off initiatives and related Small and Medium Enterprises (SMEs). Furthermore, in PPPs, SMEs need to become leaders in agricultural innovation development and commercialization in India, and hence need to become active participants in the IP and tech-transfer capacity building initiative that will flow from the Agricultural Innovation Academy.

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In summary, the concept of the Agricultural Innovation Academy seeks to build beyond the five percent of elite universities, where IP management and tech-transfer already (more or less) exist, to the other 95 percent, to foster the institutional infrastructure, networked human capital and capacity needed to address food security in India, towards the Gene Revolution. A commitment towards investing in building a core resource which advances food security in India, driving a Gene Revolution, would therefore be a grand gesture and a most auspicious occasion for the celebration of the 70th jubilee gala of India's independence. Indeed, the opening and launch of an Agricultural Innovation Academy at NAARM would signal to India and the world that strategic investment in and management of IP is a key factor in accelerating tech-transfer capacity building, and thereby access to, absorption, adaption and utilization of agbiotech for the benefit of all in India. How better to celebrate India's global leadership, as the assembled throng, singing the national anthem of India, paying homage to the national flag and standing together, confident in knowing that food security for all of India forms the unshakable foundation for the nation's continued development into a global innovation power.

A LEGAL-COMPARISON OF THE INDIA SOFTWARE LAW AND THE SOFTWARE LAW OF GERMANY

Thomas E. Soebbing*

India has emerged as one of the leading destinations for offshore outsourcing in the software industry and has attracted the attention of software industries of several countries including Germany. In order to sustain this outsourcing relationship, the legal frameworks of these countries play a very important role. In this article, the author conducts a comparative analysis of Indian and German laws that impact the software industry, mainly dealing with three fields: first, Copyright Law impacting the protection of intellectual rights over software; second, Contract Law specifically dealing with software contracts and nature of such transactions and, finally, the remedies available in both the countries under their civil, criminal and administrative law to ensure protection of software.

I. IT-ITES MARKET IN INDIA AND GERMANY

The Information Technology- / Information Technology Enabled Service industry (IT-ITES) and the business process outsourcing (BPO) sector are major parts of the economy of India. The growth in the service sector in India has been led by the IT-ITES/BPO sector, contributing substantially to an increase in GDP, employment, and exports. The sector has increased its contribution to India's GDP from 1.2% in FY1998 to 7.5% in FY2012. According to NASSCOM, the IT and BPO sector in India aggregated revenues of US\$100 billion in FY 2012, where export and domestic revenues stood at US\$69.1 billion and US\$31.7 billion respectively, growing by over 9%.¹ Export dominates the IT-ITES /BPO services, and constitutes about 77% of the total industry revenue.

In 2013, the German chamber of IT business (called 'Bitkom') estimated in its report in 2013 that the German market for information-technology and telecommunication (without the BPO – business) at a value of €153 billion (≈US\$203 billion or ≈ Rs.13.739 billion). The Top Five Indian IT

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¹ NASSCOM, *The IT-BPO Sector in India: Strategic Review 2012* (Retrieved 15 December 2012.)