TECHNOLOGY TRANSFER AND COMMERCIALIZATION: EXPERIENCES OF INDIA AND USA

Edited by

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World Technology Access Program
Michigan State University, East Lansing, Michigan, USA

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Participants of the Indo US Joint Workshop on Technology Commercialization, Michigan State University, East Lansing, Michigan, USA, July 7-14, 2012

This publication is based on the presentations made at the Indo-US Joint Workshop on Technology Commercialization held at Michigan State University campus in East Lansing, Michigan, USA from July 7 -14, 2012, and subsequent interactions with technology managers in India and USA.

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Acknowledgements

This publication is based on the presentations made at the Indo-US Joint Workshop on Technology Commercialization held at Michigan State University campus in East Lansing, Michigan, USA from July 7 - 14, 2012, and subsequent interactions with technology managers in India and USA. The workshop was sponsored by the Indo US Science and Technology Forum (IUSSTF), New Delhi, India. Many thanks to Dr. Rajiv Sharma, Executive Director of IUSSTF for his visit to East Lansing, Michigan during the workshop program and his interactions with the participants. The support and encouragement of senior officials of the Indian Council of Agricultural Research (ICAR) and Michigan State University is greatly appreciated. We are very grateful to Ms. Joy Landis and Ms. Mallory Fournier from Michigan State University IPM Program for excellent support in editing, formatting and final publication of this book.

Foreword

Food security remains one of the highest priorities of the Government of India. The Indian Council of Agricultural Research (ICAR) and the Department of Agriculture Research and Education (DARE) play an important role in technology generation and technology transfer for enhancing agricultural productivity across India. The technology transfer scenario in agriculture in India is changing. Earlier, it was mainly the public sector that was engaged in research and development (R&D). Nowadays, the private sector is playing an increasing role in R&D and technology transfer.

Public-private sector partnerships are emerging. Increasingly, the private sector is interested in getting more involved in commercializing research results and technologies that are developed in the public sector. The private sector is not only doing research, but partnering with public sector in commercializing and enhancing delivery of new technologies to millions of farmers.

The ICAR and DARE are working to create an enabling environment for intellectual property management, technology transfer and commercialization. ICAR is encouraging public-private partnerships for stimulating technology transfer and commercialization of key food security crops and other agriculture related technologies. ICAR has developed national guidelines and policy for the management of intellectual property generated by various research institutions located across India. These guidelines and policies are utilized by various agricultural research institutes and state agricultural universities in handling and management of their intellectual properties.

For handling and management of new inventions and agricultural technologies, ICAR established an IPR cell in the late 1990s. In 2010, ICAR also organized an ICAR-Industry Meet to further promote and encourage public-private partnerships. Recently, ICAR provided technical support and funding for the establishment of more than 10 business planning and development units (BPDs) that are placed at agricultural research institutes and state agricultural universities.

ICAR is very active in international collaboration, particularly with the R&D community in the US. ICAR promotes exchange of information, ideas and experiences. There has been a long-standing cooperation and collaboration between the agricultural research institutes and universities in India and the US. This handbook developed through the Indo-US Science and Technology Forum (IUSSTF) is an excellent example of this type of collaboration and will be a very valuable resource for agricultural scientists, technology managers and senior administrators that are engaged in technology transfer programs.

I strongly encourage and hope that there will be continued interactions and sharing of information between the technology transfer community in India and the US to address the food security challenges in India. We are grateful to Michigan State University and the Indo-US Forum on Science and Technology for building agricultural knowledge partnerships.

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Chapter 1. Introduction, Context and Historical Background on Technology Transfer and Commercialization in India and the United States of America

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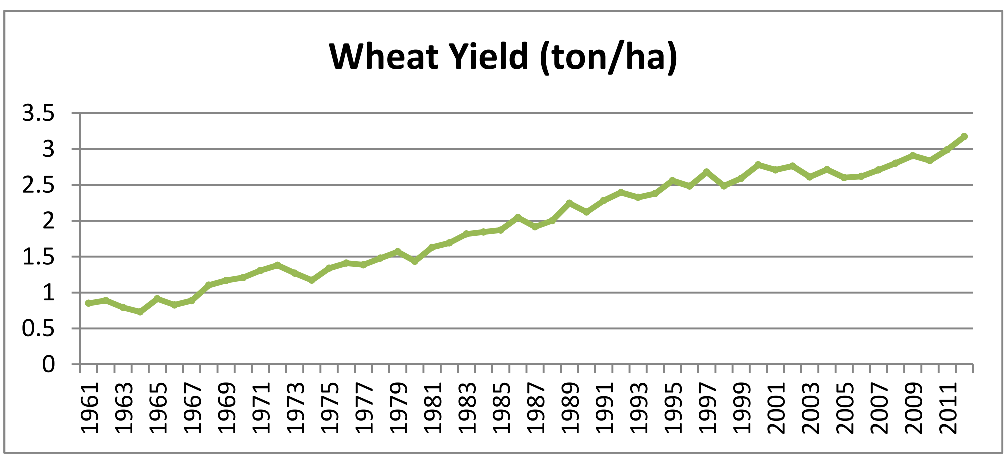
Importance of new technologies for enhancing agricultural productivity in India and the United States of America (US)

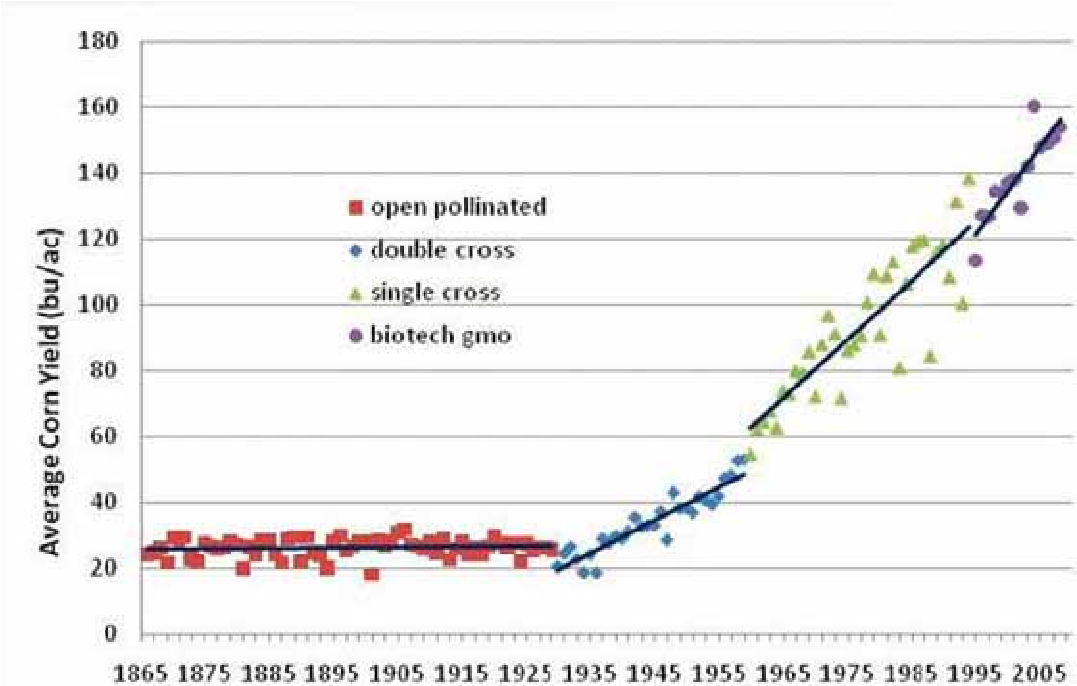
Agriculture remains an important sector in both India and the US. New innovations and technologies have played an important role in enhancing agricultural productivity all over the world. As shown in Figure 1, the semi-dwarf varieties developed in 1960s and 1970s, for example, doubled wheat production in India and led to the Green Revolution (Iqbal 2009). The hybrid technology revolutionized the maize production in the US. Technologies related to agricultural inputs and production methods, such as pesticides, fertilizers, improved seeds and planting materials, irrigation technologies, processing and storage technologies, have all contributed tremendously in enhancing agricultural productivity, farm mechanization and conservation of natural resources (Figure 2).

Additionally, technological advances in post-harvest management such as processing, packaging, cold chain, and value addition also have contributed to reducing food losses and enhancing shelf-life and marketability of agricultural products. Also, the emerging information and communications technologies (ICT) such as mobile phones, Internet and other social media are improving the information delivery and extension services for farmers and end users.



Source: FAO 2013

Figure 1. Impact of semi-dwarf wheat varieties on wheat yields in India, 1961-2011.



Source: Troyer (2006)

Figure 2. Impact of hybrid and genetic engineering technology on maize yields in the US, 1865-2005.

Although the agricultural sector plays an important role in economies of both in India and the US, the agricultural systems and socioeconomic situations and cultures of the two countries are very different. In the US less than 2% of the population is engaged in agriculture, whereas in India more than 60% of the population is dependent on agricultural-related activities. Agriculture in India is dominated by small scale subsistence farmers with land holding of less than 0.5 hectares. Many of the holder farmers are aiming to become commercial farmers so that they can participate in the global trends of market-driven agriculture. The US agriculture sector, however, is dominated by large-scale commercial farming. Regardless of the size and scale of farming, new technologies have historically played an important role in enhancing agricultural productivity.

Historical perspective on technology transfer in the US and India

Historically, technology transfer systems both in India and the US have included a range of approaches (Agarwal et al. 2004). There are a number of ways and methods that have been utilized to develop and deliver new technologies to farmers. The technology development transfer has been supported through government-run research and extension programs, agricultural universities, NGOs, private sector, informal farmer-to-farmer exchange, and international development organizations. However, the technology transfer by public institutions has been dominated by two main approaches: technology transfer through extension systems which is long standing and IPR-led technology transfer that is recently emerging.

Extension systems focus on technology and information dissemination, education and training and have an applied research and demonstration focus. The IPR-led system includes protection of new innovations through intellectual property laws, licensing and commercialization of technologies through public-private partnerships. The emphasis is more on basic research, leaving the applied research to private commercial partners. In recent years, emphasis at public institutions in the US, India and many other countries around the world, is shifting from publications and free delivery of knowledge and technologies, to protect and secure intellectual property rights on new knowledge and innovations generated out of research and development programs. Thus, the traditional model of extension-driven free delivery of technologies is shifting to IPR-led licensing and commercialization of technologies through linkages and partnerships with private sector.

History of intellectual property rights and technology transfer in the US

Even though the IPR-led technology transfer approach is practiced more and more in recent years, the patenting and protection of intellectual properties in agriculture in the US is not new. The first US Patent was granted to Samuel Hopkins in 1790 for a process of making potash, an ingredient used in fertilizer. The legal basis for the US patent system is Article 1, Section 8 of the United States Constitution, wherein the powers of Congress are defined. It states, in part: "The Congress shall have Power ... To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." The US government passed the Plant Patent Act in 1930 and the Plant Variety Protection Act in 1970. The US is also a member of WTO (since 1995) and has also signed the TRIPS agreement.

Public universities and government-supported research institutions have served as the main driving force for agricultural research and development. More than 150 years ago, the US government established the US Department of Agriculture (USDA) and passed the Morrill Act (1862), which led to the establishment of land grant universities in each state in the US. The land grant universities have played a long standing role for agricultural research, education and extension activities. The land grant universities were set up under the Morrill Act of 1862 initially focused on teaching scientific agriculture to students in each state. As the land grants evolved, the need for research to generate new knowledge and technologies was recognized. In this context, the U.S. Government, under the Hatch Act of 1887, established a system of agricultural experiment stations in conjunction with each state's land-grant university. The government also recognized transfer of new knowledge, information and technologies to farmers and end users. The Smith-Lever Act of 1914 created a system of cooperative extension that has been based at and run by land grant universities to inform local citizens and farmers about current developments in agriculture, home economics, and farming related subjects. Along with the government-supported program, private sector also became engaged with agricultural universities and public research institutions. The land grant universities started developing policies and programs for engagement with private sector. The University of Wisconsin was one of the first US universities to license a patent (1924). Since then, a number of land grant universities have followed a similar trend as the financial resources from the government have declined.

In the US, 1980 has been considered a landmark year for IPR-led technology transfer. The U.S. Congress passed the Bayh-Dole Act in 1980, which allows universities and public research institutions to retain ownership of inventions generated through federal government support. The U.S. Congress also passed the Stevenson-Wydler Technology Innovation Act in 1980, which was the first major technology transfer law, and requires federal laboratories to actively participate in and budget for technology transfer activities. Concurrently, in 1980, the US Supreme Court determined that modified living organisms are patentable subject matter (Diamond vs. Chakrabarty litigation), which gave a significant boost to private sector investments in biotechnology.

Subsequent to the Bayh-Dole Act (1980), the public universities in the US have set up IP management and technology transfer programs. Michigan State University (MSU), for example, set up an IPR office in 1992, which provides support and services to MSU faculty and staff for protection, licensing, and access to proprietary technologies. Numerous US universities followed a the trend and have set up similar offices and programs with the broader goal of transfer of new technologies for public use and benefit and to provide additional source of income to support and enhance research and education.

In order to foster networking and provide continuing educational opportunities for the managers and staff members of the technology transfer offices (TTOs), an Association of University Technology Managers (AUTM) was established in the US more than two decades ago. AUTM also plays a role of policy advocacy on IP and technology management issues. There is also a Licensing Executive Society (LES), which also provides networking opportunities. More information on IP and technology transfer offices can be found through AUTM web portal (http://www.autm.net). These technology management offices are broadly categorized in three types of models: service model, business model and economic development model. These models have been utilized depending on the goal and mission of the institution. The service model has an emphasis of transfer of technologies that benefit society, with less emphasis on revenue and income generation for the institution. The business model focuses on generating profit for the institution. The economic development model broadly looks at the job creation and economic development of the local area or a specific region.

The technology transfer offices fueled by the passage of the Bayh-Dole Act have been constantly evolving. The great majority of these offices started with a small operation or program with 1-2 technology management specialists. As the invention disclosures, patenting and licensing activities grew, the size and role of these offices expanded. For example, the TTO at Michigan State University started in 1991 with 2 staff members and now has 28 staff members with MSU-T, Business-CONNECT and Spartan Innovations under an umbrella of MSU Innovation Center (http://innovation.msu.edu/). The policy and practices of patenting and IP protection and licensing have also evolved from an initial culture of patenting everything at a high cost, to now being more selective and evaluating technologies for their commercial value and market potential. Also, instead of the university bearing all or most of the costs of patenting and other forms protections, increasingly, the costs of the patenting/protection are borne by the licensee. There is also more encouragement to work with businesses to scale up and transfer technologies for the public's benefit, and at the same time, where appropriate, generate revenues for public research institutions.

Along with these tech transfer/management/licensing offices (generally referred to as TTOs, TMOs or TLOs), the universities and local governments and other stakeholders have established technology parks and incubator facilities in the vicinity of the universities to stimulate scaling up, de-risking, demonstration and commercialization of technologies. The State of Michigan, for example, has established Michigan Biotechnology Institute (MBI) as a non-profit organization, very close to Michigan State University campus that serves a similar function (http://www.mbi.org/). Wayne State University in Detroit has established TechTown, an incubator facility serving the university and the broader business community (http://techtowndetroit.org/). To provide startup funds and venture capital, the state and federal government have set up special funds for supporting entrepreneurs and for development of SMEs (small and medium enterprises). A number of private venture funds have been set up by private companies and entities.

History of intellectual property rights and technology transfer in India

Since Independence in 1947, the Government of India has placed a high priority for agricultural research development for sustainable food security. The Indian Council of Agricultural Research which was established in 1929 (as an Imperial Council of Agricultural Research under British Rule) has played a key role in development of present day agricultural research, education and extension programs in India.

The ICAR has been managing research and education in agriculture including horticulture, fisheries and animal sciences through 99 ICAR institutes and 53 agricultural universities spread across the country. The First University Education Commission recognized the importance of agricultural education and recommended establishing agricultural universities along the lines of the land grant institutions of the US (Ministry of Education 1962). The first State Agricultural University (SAU) was set up in 1960 at Pantnagar in the state of Uttar Pradesh. There are now 45 SAUs, besides five deemed universities and 4 central universities with affiliated agriculture colleges.

A number of new crop varieties were released free by the SAUs and the ICAR system during the post-green revolution period. The third Five-Year Plan (1961-66) emphasized the importance of scientific and technological research for higher crop yield. The period witnessed the initiation of a number of agricultural-oriented development activities at the state level, inclusive of the Intensive Agricultural District Programme (IADP), soon followed by a High Yielding Varieties Programme (HYVP) for cereals at different regions. During the 1970s, the Krishi Vigyan Kendas (KVKs) – the Knowledge Centers for farmers – were established by ICAR with the objective of imparting vocational training to the practicing farmers, school dropouts and field level extension functionaries. Currently, there are more than 600 KVKs operating across India.

The green revolution resulted in import of the dwarf wheat variety *Lerma Rojo 64* from Mexico. Such new varieties were grown in 10 million hectares by 1972-73. In parallel, R&D was happening on rice breed at an FAO-commissioned rice hybridization project in Cuttack, Odisha where short temperate Japanese varieties with taller Indian tropical varieties. Better yielding and semi-dwarf rice varieties developed by the International Rice Research Institute (IRRI) were widely cultivated by the 1970s.

Intellectual property rights became a concern in Indian agriculture when India joined the World Trade Organization (WTO) in 1995 and signed the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. Economic liberalization in the 1990s resulted in the Exim Policy that sought to dismantle various protectionist and regulatory policies and accelerate the country's transition towards a globally oriented economy. The Indian Patents Act, 1970 was amended during 1999-2005 to allow patents in all technical fields including drugs, agrochemicals, chemicals, biotechnology related inventions and food preparations. A new act entitled the 'Protection of Plant Varieties and Farmers' Right Act, 2001 was legislated, extending PRs to new plant varieties. The 'Geographical Indications of Goods (Registration and Protection) Act, 1999' afforded protection akin to trademarks for natural, agricultural or manufactured produces grown or produced in specific geographical territories, was introduced.

The Ministry of Science and Technology issued the 'Instructions for Technology Transfer and IPR Management', defining inventorship, ownership and benefit sharing model for IPs generated by the public funded institutions. The Science and Technology Policy of 2003 emphasized the role of Intellectual Property Rights (IPR), as an effective policy instrument that would be relevant to wide ranging socio-economic, technological and political concepts. The Policy stressed fullest possible protection and promotion of competitive intellectual property from Indian R&D programs and stressed the need for development of competent human resources to manage and leverage IPRs.

A landmark in the history of the Indian agricultural research is the 'ICAR Guidelines for IP Management and Technology Transfer / Commercialization' issued by the ICAR in 2006. Subsequently, in 2006, ICAR decentralized its IP management mechanism with a larger role for individual institutions. In response to this, a number of public institutions and agricultural universities in India established IPR Cells to create awareness on IPR issues and facilitate IPR-led technology transfer. Among the SAUs, the Chaudhury Charan Singh Haryana Agricultural University (CCS-HAU), Hisar, Haryana in 2006 started with the 'IPR Policy and Regulation' put in place. The HAU collaborated with Michigan State University (MSU) in formulating both the IP policy and establishing the IPR Cell at the CCS-HAU campus in Hisar.

In order to incentivize creation and encourage protection of intellectual properties resulting from research and development projects employing public funds and commercialization of such IPRs, the 'Protection and Utilization of Public Funded Intellectual Property Bill , 2008,' was introduced in the Parliament in 2010. The Bill defines inventorship, ownership and benefit sharing model among different players. Public funded educational and research institutions, as a recipient of public funds, are required to disclose IPs generated out of the funding to the government, retain the ownership of the IPs in designated countries, and protect and manage IPRs in such countries. Inventors have a share of not less than 30% of the net revenue generated out of licensing. The balance part would be used for creation and protection of new IPs. The bill seeks to encourage innovation in small and medium enterprises and promote collaboration between government, private enterprises and non-government organizations. The Bill currently is pending and is being examined by the Committee on S&T and Environment and Forests.

The Society for Technology Management (STEM) in India provides networking opportunities for technology managers (http://www.stemglobal.org/index.htm). STEM is a not-for-profit organization and plays a facilitative role for successful technology transfer processes and promotes best practices in technology management. STEM contributes to the professional development of technology management professionals in India and the South Asia region.

The current emphasis on technology transfer and commercialization

With the globalization of agriculture and the passage of international treaties and agreements such as WTO/TRIPS, CBD, etc., the landscape of technology transfer in India, the US and all over the world is rapidly changing. As mentioned earlier, the passage of the Bayh-Dole Act and Stevenson-Wydler Act (Federal Laboratory IPR) in the US had a major impact on technology transfer systems of public research institutions and universities in the US. More than 80% of the public institutions have their own IP Management and technology transfer policies and systems. These systems include institutional IP policies and technology management offices, as well as technology incubators and research parks in the vicinity of these institutions.

Thus, there is an enabling environment at public institutions to move beyond extension-led technology transfer systems to IPR-led technology transfer and commercialization systems (Kolady et al. 2010). In this new enabling environment, public institutions are moving away from free delivery of technologies to formal agreements, licensing and commercialization of technologies through public-private partnerships. The emphasis is shifting from patenting all the inventions to more focused commercial ventures through public-private partnerships (PPPs). During the past two decades, the government funding for public universities and research institutions has been steadily declining. The public institutions are looking at new ways of supporting research programs and generating revenues to support basic and applied research programs.

The government of India has taken positive steps in moving beyond extension-driven technology transfer systems to creating partnerships with private sector. Many public institutions have set up business planning and development units that are serving as innovative platforms for technology transfer and commercialization activities through public-private partnerships. During the past five years, the government of India has set up 11 business planning and development units (BPDs) with a plan to scale up and establish more than 100 BPDs in the next few years. To foster and strengthen linkages between public research institutions and industries working in the area of agriculture and food sector, since 2010, the ICAR in collaboration with private sector has launched annual “ICAR-Industry Meet.” In addition, the Department of Agriculture Research and Education (DARE) has established a new company called AgrInnovate India Limited in 2011 (www.agrinnovate.co.in). It acts as an interface between ICAR and stakeholders of agricultural sector to promote the development and transfer of R&D outputs through IPR protection, commercialization and forging new partnerships in India and globally.

The Department of Biotechnology (DBT) in India is providing grants to both public and private institutions for small businesses (DBT-SIBRI). The state governments in India are also setting up science and business parks to stimulate technology transfer and commercialization. A number of additional activities have been initiated by different scientific departments in India for commercialization of technologies generated by the public funded institutions. The Biotechnology Industry Research Assistance Council (BIRAC), incorporated as a Section 25 company, was promoted by the Department of Biotechnology to nurture and promote industry R&D innovation. Many schemes, including the Biotechnology Industry Partnership Programme, the Contract Research Scheme, Bio-incubators Support Scheme, Small Business Innovation Research Initiative (SBRI), are implemented by the BIRAC. The BIRAC also extends its services through contracts and agreements, IP services, technology transfer and acquisition and regulatory approval facilitation.

The World Bank supported National Agricultural Innovation Project (NAIP) implemented by the ICAR/DARE, is a major program that is also supporting technology transfer and commercialization related activities in Agriculture. The NAIP project is focusing on program related to income generation by collaborative development and application of agricultural innovation by the public research organizations in partnership with the farmer's groups, the private sector, the civil society organizations and other stakeholders. Under this project, Business Planning and Development Units (BPDs) have been established at several ICAR research institutes and state agricultural universities (SAUs).

Purpose of this publication

The US has a longer experience in terms of technology transfer and commercialization compared to India (Hyndman et al. 2005). India is, and can, definitely benefit from the rich experiences of the US in technology transfer and commercialization. This handbook is the result of a joint workshop, sponsored by Indo-US Forum on Science and Technology held at MSU from July 8-14, 2012. The joint workshop brought together more than 20 technology managers from both the countries. This handbook contains 17 chapters developed by the participants of the workshop, representing public institutions, research institutions, universities, and private sector. The chapters bring out experiences and best practices adopted by various institutions in the US and India and highlight lessons learned and a way forward.

References cited

Agarwal, S. P., Gupta, A., and Gandhi, G. P. 2004. Technology transfer trends: The Indian experience. *Tech Monitor, 21(3),* 36-41.

Hyndman, K. G., Gruskin, S. M., and Iyer, C. S. 2005. Technology Transfer: What India can learn from the United States. *Journal of Intellectual Property Rights, 10,* 399-405.

Iqbal, A. 2009. Borlaug, father of 'Green Revolution', dead. *Dawn.com.* Retrieved from http://archives.dawn.com/archives/122157

Kolady, D., D.J. Spielman and A.J. Cavalieri. 2010. Intellectual Property Rights, Private Investment in Research, and Productivity Growth in Indian Agriculture: A Review of Evidance and Options. IFPRI Discussion Paper 01031, Environment and Production Technology Division. International Food Policy Research Institute., Washington, D.C., USA.

Ministry of Education. 1962. Report of the First University Education Commission, 1949. Government of India.

Troyer, A. F. 2006. Adaptedness and Heterosis in Corn and Mule Hybrids. Crop Science 46 (2):528-543.

Chapter 2. Efforts at Technology Transfer and Commercialization in India - a Synthesis

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Agricultural research and education management in India is in a state of transformation, endeavouring to also internalize new dimensions emanating from two salient international developments during the last decade of the 20th century, the Convention on Biological Diversity (CBD) and the World Trade Agreement (WTA). With the modification in intellectual property rights (IPR) regime and its extension to living organisms in the year 2005, the scientific departments and research institutions in India have been trying to bring in a more professional approach in research and development (R&D) activities, therein encouraging both collaboration and commerce. Science and technology realization at the users' end is also being facilitated through support for entrepreneurship and business incubation.

Unlike in the past, when the emphasis was mainly to generate public goods through free transfer of knowledge, skills and technologies, research in biology and agriculture is now perceived as also a means of generating commercial goods. The priorities in agriculture research and education, therefore, now in addition to increasing the productivity, include agricultural diversification and value addition in products and processes; an essential element towards real equity and livelihood security.

The Indian Council of Agricultural Research (ICAR) (www.icar.org.in) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. It is the apex national body for coordinating, guiding and managing research and education in the public sector "National Agricultural Research System" (NARS), comprising of 99 research institutes and 61 universities dealing with agriculture and allied sectors, that includes crops, horticulture, natural resource management, agriculture engineering, animal sciences and fisheries. ICAR has, since its establishment, carried out agricultural research and development activities through these and other existing institutional systems benefiting the public at large and farmer masses in particular.

The achievements of increased growth in different commodity sectors in Indian agriculture have been described as, for example, Green Revolution for food grains, White Revolution for milk, Yellow Revolution for oilseeds, and Blue Revolution for aquaculture. Lately, the phrase 'Rainbow Revolution' has also been used to acknowledge and describe the overall growth in these and other sectors of agriculture. This chapter is an attempt to provide an overview of the efforts undertaken by ICAR for catalyzing technology transfer and commercialization in agriculture and allied sectors through the public sector NARS.

A gradual change in public sector NARS

Earlier, agriculture development primarily relied on innovations in the public sector as agriculture research was not seen as a requirement in the private sector. In those times, the public sector NARS had focused mainly on management of research outputs as public good, largely emphasising free transfer of knowledge and technologies. For example, availability of improved 'seeds,' and not the issue of 'rights' on 'improved seed varieties,' was more relevant even in 1980s; and the public system's initiative to supply improved 'breeder seed' to private seed companies as well without discrimination, on the same terms and conditions as for the public sector seed corporations, was aimed at encouraging both private and public Indian seed industry. Coupled with other initiatives of the Government of India, such efforts have brought in much improved R&D-driven private companies in agriculture and allied sectors in the present times.

However, it is a long way to go, and the public sector research system continues to undertake its role as supplier of public goods, at the same time assimilating the new dimensions of commercialization of knowledge and technologies. Incentive and benefit sharing with its own contributors from the proceeds of commercialization as well as a faster realization of knowledge generated at the users' end is happening with involvement of other stakeholders. The government -supported expenditure on research has its obvious limitations and there is growing competition from the private sector. These circumstances have demanded continuous innovation to achieve ever-higher productivity in goods and services from the research system. Accordingly, the ICAR's initiative of bringing in a new policy direction through its rules and guidelines on intellectual property and technology management was an effort to adapt to the new IP regimes. Accordingly, the ICAR developed and adjusted, over time, the policy frameworks that have provided the basis for equitable adjudication between the various interests involved in a manner consistent with the ICAR primary commitment to public interest.

Managing professional service functions

The need to encourage the scientists and staff members to participate in the collaborative work with external organisations with added service functions was realized by ICAR in 1997. The separate set of rules and guidelines for Training, Consultancy, Contract Research and Contract Service provided the desired policy framework for skill and knowledge based interactive mechanism at individual and institutional level; competitive efficiency-based system; fast track for clearance of proposals; and a simple, implementable and performance oriented benefit sharing systems.

Through these guidelines ICAR provides the required policy environment in the constituent institutes to share their knowledge and expertise through partnership modes with other public sector, private sector, civil society, international research centres, and other agencies and institutions. These partnerships are expected to bring opportunities and benefits, not only to the organisation and individuals working in it, but benefits to the society at large. While creating an enabling organizational environment essential for efficient and effective means to disseminate the knowledge, skills and technologies generated in the organization, the Institutes are provided the required autonomy and transparent framework to understand the manner of utilization of their strengths of IP assets or core competence. That is, depending upon the clarity for end-result, a particular strength can be utilised either through public or proprietary domain or both.

All professional service activities conducted for external agencies are taken up as institutional with the contractual obligations are that of ICAR. The Agreements or Memorandum of Understanding (MoU) with clients are executed on behalf of ICAR by the Institute and not by an individual or the executing team. However, there could be authorized signatories as per rules and regulations in place or established practices. While it is obligatory that agreements with external agencies are made in writing beforehand, in the case of services rendered to government departments/agencies and public sector undertakings, or UN bodies/CGIAR Centers and other national agencies of similar set up or services of minor nature, the terms and conditions including payment schedules may also be negotiated and settled through exchange of letters.

Evolution of IPR regimes related to agriculture research

The period 1997-2005 witnessed an unprecedented activity in India for law making and amending, especially in terms of intellectual property rights of different kinds, and regulatory aspects related to access and utilisation of genetic resources, as the country adjusted to obligations emanating from international agreements such as TRIPs and CBD. Consequently, the entire innovation eco-system in agriculture research witnessed rapid changes in the last two decades, thereby impacting the processes through which new technologies are researched, developed and disseminated. Further, the increasing constraints on public expenditure on agriculture research coupled with increasing competition require continuous innovation to achieve ever-higher productivity in relation to economic and social development.

Responding to the contemporary needs, the ICAR implemented from Oct 2, 2006, its guidelines on 'Intellectual Property Management and Technology Transfer/Commercialization.' These guidelines provide the framework of IPR policy and establish the institutional mechanisms with elaborate directions for operationalization and management of technologies generated in the ICAR system. The adoption of these guidelines have led to consolidation of the existing IP assets and also provided the desired incentive for the scientists to undertake research in the cutting edge areas.

For an organization of ICAR's magnitude and appreciating its relationships with the other vast public and private sector R&D organisations in the country and abroad, a three-tier decentralized management mechanism was considered appropriate to avoid administrative delays as far as possible. Accordingly, Institute Technology Management Units (ITMUs) have been established in all ICAR institutes as a single-window mechanism to showcase intellectual assets of the institute and pursue matters related to IP management and technology transfer/commercialization. Five Zonal Technology Management Units (ZTMUs) were formed as the middle-tier, to facilitate IP management in synergy with the ITMUs, in their respective catchments. The existing Intellectual Property and Technology Management (IP&TM) Unit at ICAR headquarters has been performing the role of Agro-Technology Management Centre (ATMC), by providing key facilitation/coordination and monitoring functions. For effective implementation of the mechanism, functional decentralization is being promoted; and the directors of respective institutes have been delegated with the power to file patent/IPR applications at the respective offices or registries in whose jurisdiction the concerned institution is located. Likewise, these directors are empowered to deal with the indigenous private sector for transfer and realization of promising knowledge, skill and technologies.

Role of ITMUs

All the institutes under ICAR have a designated ITMU to pursue all IP protection, maintenance and transfer/ commercialization related matters at the institute level as per ICAR guidelines and any other administrative or policy decisions taken in the ICAR from time to time. To assist in collective decision making at the institute level, the Institute Technology Management Committee (ITMC) has been constituted. The ITMC is chaired by the director of the institution and is the highest decision-making body relating to all issues of IP management and technology transfer/commercialization. Each ITMU acts as the nodal point in the respective institute for creating IP environment and caters to need-based technology management at the institute and acts as a source of information for intellectual property assets for the concerned institutes by creating systematic database of the IP assets of the institute. This entails use of IP management tools for technology landscaping or mapping methods to get useful for providing information about potential areas for research and invention, partnering, or licensing opportunities. The IP management process is expected to be embedded into the technology-development process right from the project formulation stage and provide key strategic approach to new technology development, IP portfolio development and technology transfer.

The ITMU are also expected to develop appropriate framework for a stronger IP position, optimization of R&D and IP protection expenses over the long period, and minimization of the potential for patent infringement and litigation risk. While the ITMU are the nodal point for providing the support for technology evaluation, valuation and dissemination, they also provide the link with the appropriate ZTM and BPD in case incubation support is required.

Role of ZTM and BPD Units

Zonal Agro-Technology Management Centres (ZTMCs) established at the ZTM and BPD Units function as secretariat of the respective ZTM and BPD Units to advise, coordinate and pursue the IP protection, maintenance and transfer/commercialization related matters at other ICAR institutions in the zone. The ZTM and BPD Units coordinate and facilitate IP Protection/ and maintenance, and technology transfer/commercialization of the associated institutes and to IP for ICAR institutions in the respective subject matter. They facilitate effective IP management, commercialization and management of intellectual assets of the associated institutes through need-based securing and safeguarding IPRs of member institutes and assisting with the formulation of model licensing contracts/MoUs for associated institutes on the subject matter. They also have created systematic database of the technologies and established a reporting mechanism for the relevant activities of ITMUs in their zone.

The role of the ZTM and BPD has further expanded with the establishment of BPD units. They also provide support for technology incubation activities at the institutions and for nurturing the techno-entrepreneurs. The incubators are expected to enhance the activities that create commercial opportunities; and to develop and exploit partnerships between academic researcher and industry, so as to reduce both, the time to market and the costs associated with research and development of innovative technologies. They have to thus, specifically address the issues of mid-level validation of research results including technology refinement, scaling up and providing for technology verification, process or technology scale-up assistance, pilot scale design/construction/operation services, as well as identification and solutions for process scale-up and regulatory issues. Further details on the activities of the ZTM and BPD Units can be seen in the subsequent chapters.

The IP and TM Unit

To nurture the institutionalization of IP management in the ICAR institutes, additional financial support was provided through a specific scheme under the XI Plan of the Government of India. The scheme had provisions for obtaining IPR, capacity building, HRD strengthening, IPR awareness generation, access to expertise/professionals in law, business management, etc., from outside the ICAR. Further, with support from the National Agricultural Innovation Project (NAIP), 10 Business Planning and Development Units (BPD) have also been established. The BPD Units were established in five ICAR Institutes namely: National Institute for Research on Jute and Allied Fibers Technology, Kolkata (East); Central Institute for Research on Cotton Technology, Mumbai (West); Indian Agricultural Research Institute, New Delhi (North-I); Indian Veterinary Research Institute, Izatnagar (North-II); and Central Institute of Fisheries Technology, Kochi (South); thus the Zonal Units in these institutes were re-christened as Zonal Technology Management and Business Planning and Development (ZTM and BPD) Units with added functions of technology incubation and business development. In addition BPD Units were also established in five state agricultural universities: Anand Agricultural University, Anand; Birsa Agricultural University, Ranchi; Chaudhary Charan Singh Haryana Agricultural University, Hisar; Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur; and Tamil Nadu Agricultural University, Coimbatore.

At present, these business planning and development units have been instrumental in formulating business policy, planning and developing models for agri-incubation and technology commercialization not only for the institutes where they are located, but also for the identified institutes in the respective zone. These efforts have been further supplemented by IP and TM Unit through various initiatives for capacity building and outreach activities.

Capacity building

Appreciating that the National Agricultural Research System (NARS) has to evolve its IPR domain, the highest priority was given to developing institutional capabilities and human skills in the IP management area so as to catch up with the national and global IPR regimes. Thus, the IP and TM Unit conducted 12 training-cum-workshops all over the country for upgrading the knowledge base of about 450 scientists and other concerned staff from ICAR institutes and state agricultural universities and exposing them to the nuances of the overall subject of IPR. These programmes were structured to provide a special focus on various thematic areas within the IPR domain (Table 1). Besides, providing due exposure to the participants of the core areas of IPR and technology transfer, these programmes also helped in identification and consolidation of the team(s) of competent resource persons from within ICAR as well as outside the ICAR system, being from government departments, public sector research and development organizations, academia, law experts and attorneys, business experts, etc. for meeting the present and future HRD requirements in IP and Technology Management. In addition, under Indo-US Agricultural Knowledge Initiative, three programmes were organised in collaboration with the faculty from Michigan State University, United States Department of Agriculture, and the Association of University Technology Managers of USA, and the core ICAR resource persons' team. These programmes were contracted to CCS Haryana Agricultural University and about 130 participants were provided an exposure of the IPR domains.

Further, to cater to the HRD needs in IP management, ICAR scientists and other concerned staff were nominated for training in various national institutes of repute including Indian Institute of Science, Bangalore; Indian Institute of Management, Ahmedabad; Administrative Staff College of India, Hyderabad; Society for Technology Management, Ooty; and in foreign countries, viz. Cornell University, Ithaca, USA; and World Intellectual Property Organization, Geneva.

Table 1: Training-cum-workshops conducted by IP and TM Unit for capacity building in NARS

Thematic Area	**Host Institute**	**Participating Institutes (participants)**		**Total Participants (No.)**
		ICAR (No.)	**SAUs (No.)**	
Procedural requirements of Patents	National Academy of Agricultural Research Management, Hyderabad	11 (32)	5 (17)	49
Patenting/ IPR in Genetic Engineering	Indian Agricultural Research Institute, New Delhi	30 (57)	5 (11)	68
Drafting Specifications and Claims	Central Institute of Fisheries and Education, Mumbai	5 (25)	6 (21)	46
Essentials of Patenting	CCS Haryana Agricultural University, Hisar	9 (19)	8 (36)	55
Trademark Protection Central Tuber Crops	Research Institute, Thiruvanathapuram	10 (37)	4 (13)	50
Protection of Designs and ICs Designs	Central Institute of Agricultural Engineering, Bhopal	4 (24)	4 (11)	35
Copyright Protection	National Institute of Research on Jute and Fibre Technology, Kolkata	8 (23)	4 (8)	31
Protection of IPR on Microorganisms	ICAR Research Complex for NEH Region, Barapani	9 (53)	3 (15)	68
Protection of Geographical Indications	National Bureau of Fish Genetic Resources, Lucknow	10 (35)	4(5)	40
Total		96(305)	43 (137)	442

With support from NAIP, 25 ICAR scientists were given international exposure. These programmes included Plant Variety Protection at Wageningen, the Netherlands; Plant Variety Protection and DUS testing at National Institute of Agricultural Botany at Cambridge, UK; and Intellectual Property Management and Technology Transfer Program at Michigan State University, East Lansing, USA. These programmes were identified since plant varieties developed by various institutes was considered as one of the major strengths in terms of IP assets in ICAR. Moreover, the legislation for seeking IPR protection for these assets in the country was relatively new; therefore, it was felt appropriate that scientists involved in these issues, particularly from crop science and horticulture divisions are exposed to the already developed and mature plant variety protection systems operating abroad. These programmes in addition, to exposure on DUS testing *per se* also considered issues related to quality and policy/legal dimensions. The scientists engaged in issues related to technology transfer and commercialisation were provided with exposure on handling technology management issues. It may be emphasised that programmes particularly at NIAB, Cambridge and Michigan State University were developed specifically on our request.

To further facilitate systematic and harmonious IP and Technology Management, including the Business Planning and Development in ICAR, nine zonal level meetings-cum-workshops were held which were attended by all the ITMUs in-charge. Institute wise and zone-wise details of the progress and constraints were discussed in the meetings with focused technical sessions on IP asset management, and planning and development of IP portfolio. The issue of technology generation and its effective transfer mechanism was also deliberated within the NARS in the internal meetings for the top management positions, such as the annual Directors' Meet and Vice Chancellors Conference. Realizing that the Heads of Divisions and Regional Stations in ICAR Institutes are the crucial link between Director and the Scientists and the staff working in the Divisions/Stations, a Meeting-cum-Workshop for them was organized to encourage and actively involve this important second line of leadership in ICAR in discussions on issues that impact their effectiveness in executing their role and functions.

Supplementing the efforts of the IP and TM Unit, in capacity building, about 60 IPR workshops/ trainings/awareness programmes were organized at Zonal/Institute levels to guide on day-to-day handling of IP and technology management dimensions. These training-cum workshops were attended by more than 2,184 scientists, technical managers, research associates, farmers, and members from private organizations. The Deemed Universities of ICAR (IARI, New Delhi; IVRI, Izatnagar; NDRI, Karnal; and CIFE, Mumbai) have initiated training courses in IPR at the post-graduate level; and NAARM, Hyderabad launched a diploma course on IP.

Outreach activities

As stated above, formal collaborations with outside agencies in ICAR started during the 1990s, encouraged by adoption of the policy framework to this effect. However, initial efforts were limited to involving outside agencies as testing partners in All India Coordinated Research Projects (AICRPs), and later on as partners to run some of the Krishi Vigyan Kendras (KVKs – The Farm Science Centres). A more organized effort fully realizing that collaboration with private sector and NGOs was made during the National Agriculture Technology Project (NATP) (1998-2005), resulting in bringing a modest participation of about 10 percent. Subsequently, the useful experience of NATP combined with compulsions of changed agricultural research context encouraged ICAR to not only consolidate the gains of collaboration under NATP, but also extend it in a significant way during the National Agricultural Innovation Project (NAIP) that followed the NATP project. The result is that in NAIP, there is about 40 percent participation of non-ICAR-SAU institutions, including private sector, especially in its Component 2 sub-projects.

The new challenge before ICAR is that the potential of research has to be realized by extending it in a manner that leads to new products, services and systems that add value to bring about significant changes in income, employment and livelihood security of people; not only in rural India but also to fuel the economy of the entire country. In other words, bringing knowledge to create value has to be at the centre of the new approach. This can be achieved if entrepreneurs are created in large number and nurtured through appropriate interventions, incentives or investments by generating new technologies, allowing access to latest technologies, providing required services and supplies to optimally use the technologies, and providing the required entrepreneurship skills. This requires setting up of an effective innovation system that nurtures entrepreneurship through networking of institutions in the public and private sectors and also social or development organizations and agencies that would interact in the production, processing, diffusion and use of new and economically useful knowledge. Rightly, therefore, IP and TM Unit has made concerted efforts for pushing the frontiers of collaboration with private sector and other stakeholders, and facilitating regular interaction with them. Some of the major initiatives are mentioned below.

The ICAR Industry Meet 2010

The ICAR-Industry Meet 2010 was organized from 28-29 July 2010 at the National Agricultural Science Centre (NASC) Complex, New Delhi to consolidate and enhance ICAR's earlier relationship with agri-industry of all kinds and scale. It was a follow-up after the long phase of several sensitization programs on understanding the diverse nuances of IPRs and technology transfer for the scientists and staff of the National Agricultural Research System in the public sector.

The specific objective of this Meet was to develop a permanent platform for industry to effectively and efficiently share knowledge, skills and resources available in the ICAR system. A special focus was kept on four thematic areas viz. i) Seed, planting material and plant biotechnological products; ii) Diagnostics, vaccines and other animal biotechnological products; iii) Farm implements and machinery; and iv) Post-harvest and value-addition. The Meet's mission was to generate business prospects for goods and services available in ICAR and also to enhance human resource competence in agriculture through mutual engagements with industry in agriculture and allied sectors. A total of 168 industry representatives and entrepreneurs and 203 ICAR and other officials participated in the Meet. More than 160 industry participants visited and expressed their interest in different technologies on display in the exhibition.

The ICAR-CII Industry Meet 2011

To augment the relationship with agri-industry the ICAR-CII Industry Meet 2011 was organised in collaboration with Confederation of Indian Industry (CII) on 23 May, 2011 at the National Agricultural Science Centre (NASC) Complex, New Delhi. The key objective of this Meet was to foster and strengthen linkages between public sector research institutions and industries working in the area of research and technology transfer in agriculture and allied sectors. A special focus was kept on three thematic areas viz. (1) research and development requirements of industry, (2) technology transfer and agri-business, and on (3) high-end research.

The mission of the Meet was to generate business prospects for goods and services available in ICAR as also to enhance human resource competence through mutual engagement with industry. The Meet included the participation of 353 stakeholders representing Industry (national/multinational), international organizations, foreign government representatives, state/central government or public sector R&D organizations, NGOs/Associations, farmer entrepreneurs, farmers and their associations; agriculture universities, ICAR scientists and administrators, CII team and many special invitees. The Meet also showcased innovative technologies developed by ICAR and Industry. More than 40 industry participants expressed their interest in one or more of the technologies on display in the exhibition organized by the Meet.

The ICAR-CII Regional Meet 2012

Realising the diversity of agriculture systems in a country like India, the ICAR and CII jointly organized four Regional Meets in partnership with the state agriculture universities with focus on region-specific technological interventions. These Meets were held at Ahmadabad, Coimbatore, Hisar and Agartala in cooperation with Anand Agriculture University, Anand; Tamil Nadu Agriculture University, Coimbatore; CCS Haryana Agriculture University, Hisar; and Central Agriculture University, Imphal. As side events of these Regional Meets, exhibitions displaying products and technologies of ICAR and other public and private sector organizations in the region were also organized to encourage effective dissemination of the technologies to the industry and farming community. These Meets brought together more than 816 major stakeholders and decision-makers related to agriculture sector on a common platform to exchange ideas, knowledge and experience at a regional level.

ICAR's Interaction Meet with NGOs and farmer entrepreneurs

In addition to market orientation, the impact of agriculture research also needs to be viewed from the context of empowering farmers and local communities. Accordingly, various technologies have been developed by ICAR institutions that have relevance to the varied socio-economic and environmental conditions of small and marginal farmers. For example, ICAR has over the years developed less expensive modern farm machinery to substitute for traditional labour intensive jobs, giving due consideration to large number of women that are engaged in agricultural operations. It is a matter of pride that the gender-friendly tools and equipment developed by ICAR institutions were appreciated by and termed as 'appropriate technologies' by none other than the President of the USA, Mr. Barack Obama, during his visit to India. Increased access to such innovations is an integral aspect to meet the welfare and developmental needs of the farming community.

In this context, the NGOs rather than the industry can play an important role in the production, processing, diffusion and use of new and economically useful knowledge. The NGOs are working at the grassroots and thus are capable of mobilising people and technical resources in support of community development. They also present a comparative advantage in articulating and responding to the needs of farmers with ability to respond to local needs with relatively more speed and flexibility as compared to the research institutions.

Earlier, ICAR has been addressing the sustainable livelihood issues through partnerships in consortia mode in collaboration with NGOs and participation of NGOs in the activities of (KVKs) for strengthening the research-extension-farmer linkages. However, in order to move forward the partnerships from a 'funding-only' relationship and take them beyond time-bound and discrete project-based interventions, ICAR organised a national Interaction Meet with NGOs and farmer entrepreneurs. The Meet created an effective platform for knowledge and technology dissemination in close collaboration with NGOs and farmer entrepreneurs. It was designed to encourage maximum interaction with the NGOs; listen to their views on shaping the agenda for research and extension and endeavor to develop effective and efficient partnerships wherein the partners have a clear vision, a mandate and well-defined roles and responsibilities.

These efforts of out-reach activities can however be considered successful if they address multi-faceted, complex problems related to agriculture research and development that require more expertise and resources that cannot be provided by a single sector. The expectation is that this approach will bring effectiveness and responsiveness from the NGO sector, efficiency from the market or private sector and judicious use of widespread resources and infrastructure from the government or public sector. Therefore, the sectors concerned need to pool resources, and complement their distinct comparative advantage in a manner that each of the partner organisations can attain its objectives more constructively than when it works individually.

Technology management

The institutionalization of IP management, mechanism for commercialization of agriculture research products/technologies generated from public research institutions and appropriate capacity building in terms of human resource has been able to create the desired awareness and in-house expertise on these issues. This has led to increased production, diffusion and use of new and economically useful knowledge and has provided desired credence for further up-scaling these components. In 2001, a total of 32 IPR protection applications were filed by 12 ICAR institutes, and in 2012 the corresponding figures were raised to 1601 IPR applications (649 patents, 876 plant varieties, 32 trademarks, and 44 copyrights for software) by 58 ICAR institutes.

Patents

A total of 649 patent applications were filed by 58 ICAR institutes during the period 2001-2012. In addition, eleven patent applications filed under the Patent Cooperation Treaty (PCT) entered into a national phase in various countries including China, EU, France, Japan, Mexico, Republic of Korea, South Africa, USA, and Uzbekistan, etc. The technologies for which patent applications have been filed comprise a varied spectrum of technologies (Table 2). In total, 81 patents have been granted so far to 20 institutes.

Table 2. Subject areas of technologies for which patents have been applied for by ICAR institutes

Subject Area	Technology Applied for Patenting
Veterinary and Dairy Sciences	
Animal Health Diagnostics	Bio-Marker Based Detection of Bovine Sub-Clinical Mastitis; Kits for Parentage Verification; Solid State Bioreactor; Bio-formulations for Carbendazim Tolerance; Antibodies Detection Kit, Primers, and Method for Sex Determination in Chicks
Animal Based Value Added Products	Herbal Meat Product; Use of Goat Milk Fat in Meat Products; Process for Aurvedic Paneer, Flavoured Milk and Whey Drink; AJAS Goat Milk Based Products; RTE Salty Crisp Milk Product; RTC Milk Chips; Production of Xylo-oligosaccharides from finger millet straw
Crops and Horticulture	
Bio-formulations	Process for Improved Yield of *Trichoderma biomass;* Samfungin: Novel fungicide; Wettable Powder Formulation of Paecilomyces Lilacinus; Organic Fertilizer of Banana Pseudostem; Production of Coir Pith Cake; Extraction of Bio-pesticide; Multi-Nutrient Organic Manure; Compost-Gypsum Blocks
Biotechnological Processes	Production of Antibodies for ELISA Based Diagnosis; Genetic Engineering of Male Sterility and Transgene Containment in Plants; Anti Cancer activity of cyclic dipeptide isolated from novel bacteria
Crop Production/ Protection	Production Process of High Quality White Pepper; Decontamination of Pesticide Residues; Light Trap for Managing Insects; Insect Parasitoid and Predator Collection Device
Farm Implements and Machinery	
Farm Implements and Machinery	Machine for Peeling Litchi and Scooping Out the Pulp; Guar Dehulling Machine; Banana Fibre Spining System; Fineness Tester of Jute and Allied Fibers; Water Application Device-LEWA; Design of Device to Assess Leaching of Chemicals; Straw Reaper; Combine Harvester; Palm Climbing Device; Potting Machine for Nursery; Sugarcane Bud Chipping Machine; Jute Ribboning Machine; Auto-cleavable microencapsulation system
Nano-technological Processes	Slow Release Nano-Formulations; Nano-copper based formulation; Nano-induced Bacterial Polysaccharid; Ohmic Heating System for Food Products; Production of Nanocellulose
Post Harvest Products and Processes	Candy of Banana Pseudostem; Enzymatic Pretreatment to Cottonseed kernel; Integrated Grading System of Jute; Dietary Fiber rich Biscuits; Fiber Extraction from Mango Processing Waste; High Protein Carotene Rich Pasta
Fish Products and Processes	
Fish Product and Processes	Medicated Feed Mix; Nutra-pharmaceutical feed mix for fungal treatment in aquatic animal; Extruded fish product; Fish Enriched Noodles; Fiber Glass Sheathed Rubber Wood Canoe; Seafood Self Heating Pack; Fish Gravy Powder; Concentrates from Seaweeds; Feed for Improved Growth in Fish; RTE Thermal Processed Smoked Tu; Insulation Fish Bags; Taurine Extraction From Fish Head
Testing Kits/ Diagnostics Methods	In Vitro Culture of Glochidia Larvae; Extraction of Caroteinoprotein; Production of High Purity Glucosamine Hydrochloride; kit for Identification of White Spot Disease; Collagen-chitosan- Tissue Regeneration Membrane; Fish De-scaling Machine; Development of Fish Gel; Depuration System for Bivalves

Plant varieties

The process of varietal development is undertaken by ICAR through the country-wide, synergistic network of All India Coordinated Research Projects. It has crop-based active multidisciplinary research centers housed in the various ICAR institutes and SAUs. Plant variety protection has been operational in the country from 2006 and registration process started only from 21 May 2007. Since then, the genera and species eligible for registration as new varieties have been periodically notified. As the Protection of Plant Varieties Protection and Farmers' Rights Authority notified new genera, the cumulative total of 970 applications (864 extant; 96 new varieties and 10 Farmers) were filed by ICAR for plant variety registration which included cereals (wheat, rice, maize, sorghum, pearl millet) 513; oilseeds (sesame, groundnut, castor, sunflower, soybean, linseed, Indian mustard, safflower, yellow sarson, toria, gobhi sarson brown sarson) 82; pulses (pigeon pea, lentil, chickpea, mung bean/green gram, pea, kidney bean, urd bean/black gram) 179; commercial crops (jute, cotton, sugarcane) 152; and horticultural crops (chrysanthemum, ginger, turmeric, black pepper, small cardamom, potato, cauliflower, cabbage, brinjal, tomato) 44. A total of 426 varieties were granted registration certificates, these included wheat(84); rice(30); maize(69); sorghum(25); pearlmillet(31); pigeonpea(18); lentil(10); chickpea(29); mung bean/green gram(22); pea(20); kidney bean(5); urd bean/black gram(10); jute(11); cotton(41); sesame(2); castor(3); small cardamom(1); soybean(1); sunflower(2); sugarcane(11); and cauliflower(1).

Other forms of IPRs

Trademarks. ICAR institutes secured 28 trademarks to distinguish the ICAR products and services offered by these institutes as shown in the following table.

S No	Name of ICAR Institute	Trademark Name	Product Details
1	Central Avian Research Institute, Izatnagar	CARISWETA(Guinea fowl)	Quail breeds
2	Central Avian Research Institute, Izatnagar	CARIPRIYA(Chicken layer)	Quail breeds
3	Central Avian Research Institute, Izatnagar	CARIBRODHANRAJA(Quail)	Quail breeds
4	Central Avian Research Institute, Izatnagar	KADAMBARI(Chicken broiler)	Poultry breed
5	Central Institute of Fisheries Technology, Cochin	FIFERS	Fish-based food items
6	Central Institute of Fisheries Technology, Cochin	MARICREAM	Fish-based food items
7	Central Institute of Freshwater Aquaculture, Bhubneshwar	CIFABROOD	Fish-rearing machinery
8	Central Institute of Freshwater Aquaculture, Bhubneshwar	JANYANTI ROHU	Poultry breed
9	Central Institute of Freshwater Aquaculture, Bhubneshwar	CIFAX	Poultry breed
10	Central Marine Fisheries Research Institute, Kochi	CADALMIN	Pain killer capsules (made from fish by products)
11	Central Plantation Crops Research Institute, Kasargod	Kalpa	Coconut products
12	Central Research Institute for Jute and Allied Fibres, Barrackpore	CRIJAF SEED	Institute Logo for Jute Seed Sale
13	Central Research Institute of Dryland Agriculture, Hyderabad	CRIDA	Institute Logo for Product Sale

S No	Name of ICAR Institute	Trademark Name	Product Details
14	Directorate of Rice Research, Hyderabad	DRR Word and Logo	Institute Logo for Product Sale
15	Directorate of Sorghum Research, Hyderabad	EATRIGHT	Sorghum Food Products
16	Directorate of Sorghum Research, Hyderabad	JAICAR PCS	Sorghum food products
17	Directorate of Sorghum Research, Hyderabad	JAICAR FOODS	Sorghum food products
18	Directorate of Sorghum Research, Hyderabad	JAICAR SEEDS	Sorghum food products
19	Indian Agricultural Research Institute, New Delhi	PUSA	Institute Logo for product sale
20	Indian Agricultural Statistical Research Institute, New Delhi	AGRIdaksh	Software for agricultural practices
21	Indian Institute of Horticultural Research, Bangalore	ARKA	Institute Logo for product sale
22	Indian Institute of Spices Research, Calicut	IISR	Institute Logo for product sale
23	National Bureau of Agriculturally Important Insects, Bangalore	Shatpada	Institute Logo for product sale
24	National Research Centre for Banana, Trichi	NRCB	Institute Logo for product sale
25	Project Directorate on Poultry, Hyderabad	Krishilayer	Poultry breed
26	Project Directorate on Poultry, Hyderabad	Krishibro	Poultry breed
27	Project Directorate on Poultry, Hyderabad	Gramapriya	Poultry breed
28	Project Directorate on Poultry, Hyderabad	Vanaraja	Poultry breed

Copyright. Forty-four copyrights were registered to protect their software's from unauthorized copying by Central Institute of Agricultural Engineering, Bhopal, Central Institute of Freshwater Aquaculture, Bhubaneswar, Central Institute for Research on Cotton Technology, Mumbai, Central Research Institute for Dryland Agriculture,, Hyderabad, Directorate of Soybean Research, Indore, Indian Agricultural Research Institute, New Delhi, Indian Veterinary Research Institute, Izatnagar, National Bureau of Fish Genetic Resources, Lucknow, and National Bureau of Plant Genetic Resources, New Delhi.

Name of Institute	Title
National Bureau of Fish Genetic Resources, Lucknow	Fish chromosome search software
National Bureau of Plant Genetic Resources, New Delhi	Development of crop DNA fingerprinting database software package
Central Institute of Freshwater Aquaculture, Bhubaneswar	Mechanical pond applicator
Directorate of Soybean Research , Indore	Screens of the web based soybean disease diagnosis and information system.
Directorate of Soybean Research , Indore	Soybean disease database
Directorate of Soybean Research, Indore	Web –based soybean disease diagnosis and information system
Directorate of Soybean Research, Indore	Screens of data management system for AICRPS agronomy trials data.
Directorate of Soybean Research, Indore	Database structure for agronomy trials data of AICRPS.

Name of Institute	Title
Directorate of Soybean Research, Indore	Data management system for AICRPS agronomy trials data.
Central Institute of Freshwater Aquaculture, Bhubaneswar	Mechanical fish harvester
Central Institute of Freshwater Aquaculture, Bhubaneswar	A diesel operated new aeration device for large aquaculture ponds
National Bureau of Plant Genetic Resources, New Delhi	Software "IINDUS" (Indian Information System as per DUS Guidelines).
National Bureau of Plant Genetic Resources, New Delhi	Development of Bandsize-Binary Program
Central Institute of Agricultural Engineering, Bhopal	Software for design and layout of drip and sprinkler irrigation systems.
Central Institute of Agricultural Engineering, Bhopal	Decision Support System for farm machinery management for optimum selection and matching with power sources.
Central Institute for Research on Cotton Technology, Mumbai	Software for design and layout of drip and sprinkler irrigation systems.
Central Institute for Research on Cotton Technology, Mumbai	Decision Support System for farm machinery management for optimum selection and matching with power sources.
Directorate of Soybean Research, Indore	Database structure for plant breeding AICRPS trial data
Directorate of Soybean Research, Indore	Data management system for AICRPS plant breeding trial data
Directorate of Soybean Research, Indore	Screens of data management system for AICRPS plant breeding trial data.
Directorate of Soybean Research, Indore	Web-based data entry system for AICRPS plant breeding trial data
Directorate of Soybean Research, Bhopal	Development of design software for subsurface drip and micro-sprinkler irrigation.
Central Institute of Agricultural Engineering, Bhopal	Software for management of images of mangoes taken using digital radiography, CT, MRI and digital photography.
Central Institute for Research on Cotton Technology, Mumbai	Development of design software for subsurface drip and micro-sprinkler irrigation.
Central Institute for Research on Cotton Technology, Mumbai	Software for management of images of mangoes taken using digital radiography, CT, MRI and digital photography.
Central Research Institute for Dryland Agriculture, Hyderabad	Book entitled "Methodology for evaluation of Sustainability of watershed projects in India"
Central Research Institute for Dryland Agriculture , Hyderabad	Map of "Geographical Information System maps with insect pest data superimposed on weather parameters and derived indices"
Indian Veterinary Research Institute, Izatnagar	Health Information System for Animals (Marathi language)
Indian Veterinary Research Institute, Izatnagar	Health Information System for Animals (English language)
Central Research Institute for Dryland Agriculture , Hyderabad	Weather Cock (Weather Analysis Tool) software package
Indian Agricultural Research Institute, New Delhi	ResourCeS- A Regional Resource Characterizing System
Indian Agricultural Research Institute, New Delhi	USAR- An EIA Tool for managing salt affected agricultural lands and irrigation waters
Indian Agricultural Statistics Research Institute, New Delhi	Design Resource Server
Indian Agricultural Statistics Research Institute, New Delhi	Software for Survey Data Analysis (SSDA 1.0)

Name of Institute	Title
Indian Agricultural Statistics Research Institute, New Delhi	Statistical Package for Agricultural Research data analysis (SPAR 2.0)
Indian Agricultural Statistics Research Institute, New Delhi	Statistical Package for Animal Breeding (SPAB2.0)
Indian Agricultural Statistics Research Institute, New Delhi	Statistical Package for Augmented Designs (SPAD)
Indian Agricultural Statistics Research Institute, New Delhi	Statistical Package for Factorial Experiments (SPFE 1.0)
Indian Veterinary Research Institute, Izatnagar	Livestock and poultry diseases information system (LPDIS)
Indian Veterinary Research Institute, Izatnagar	Pashu Evam Pakshi Rog Jankari Pranalika
Indian Veterinary Research Institute, Izatnagar	Digital Pashuwasthya Aum Pashupalan Prashnottri
Indian Agricultural Statistics Research Institute, New Delhi	Expert System for Maize Crop (MaizeAGRIdaksh)
Indian Agricultural Statistics Research Institute, New Delhi	Monograph Hadamard Matrices
Indian Agricultural Statistics Research Institute, New Delhi	Monograph α-designs

Commercialization of technologies

Dissemination of ICAR technologies in partnership with public and private sectors is based on the principles of joint IPR ownerships and pre-decided licensing rights on mutually agreed terms as illustrated in the ICAR guidelines for IP management and technology transfer/commercialization. The technologies generated at the ICAR institutes are being transferred or commercialized through Memorandum of Understandings (MoU), licensing agreements, consultancies, contract research, contract service etc to farmers, NGOs, government organizations and private organizations (including seed/veterinary/processing/pesticides companies). About 200 such partnerships were developed by 39 research institutes with around 120 public and private organizations. Some of the important new technologies commercialized are given in the following table.

Important technologies commercialized by ICAR

CROPS AND HORTICULTURE
Plant Variety: Wheat: HI 1544; Rice: Pusa RH-10, DRRH-2 and 3, Ajay (CRHR-7), CR Dhan 701 (CRHR-32), Rajalaxmi (CRHR-5); Maize: Vivek QPM 9 and VL Babycorn-1; Chilli: MSH 206, Arka Harita & Arka Meghana; Chrysanthemum: Pusa Anmol; Cymbidium hybrids; Tomato: Arka Rakshak; Turmeric: IISR Alleppey Supreme & Pratibha; Ginger: IISR Varada; Nutmeg: IISR Viswashree; Ajmer coriander-1; Ajmer Fenugreek 1 & 2; Ajmer Fennel 1.
Bio-formulations: Arka Fermented Coco Peat, Bio-bactericide Composition B5, DOR Bt-1 formulation, PCR based detection kit of pomegranate, Rapid Detection of Bt-Cry Toxin, Bio-pesticides (e.g. Paecilomyces lilacinus, Pochonia chlamydosporia)
Biotechnological Products: Bacillus thuringiensis Cry2Aagene, Okra SSR Markers
Crop Protection Devices: Insect Rearing Cage, Ariel Insect Trap, UV Chamber for Corcyra Eggs, Egg Cleaning Device, Pheromone Trap, Helicoverpa Oviposition Cage; Insect Handling Device, Light Trap
Post Harvest Products and Processes: Banana Flower Pickle, Stem Pickle, Juice/RTS and Fiber Products; Candy from fruits; Coconut chips,; Nutraceutical concentrates; PUSA Bajra Puff; PUSA Fruit Drink; PUSA Nutri Cookies; PUSA Pearl Puf; Insulated Ventilated freight Containers for Horticulture train; Automatic machine for scooping out the pulp; Lac based fruit coating formulation
DAIRY AND VETERINARY SCIENCES
Animal Breeds and Production Technologies: Poultry Breeds: Vanaraja and Gramapriya; Production Technologies of CARIBRO Dhanraja, CARIBRO Vishal, CARI Pearl, CARI Priya
Animal Health, Diagnostics and Vaccines: Peste des Petits Rminants (PPR) Vaccine, Vero cell based sheep pox and Goat Vaccine, Classical Swine Fever cell culture Vaccine, Brucella abortus cotton Strain-19 Vaccine, ELISA Blue Tongue antibody detection kit, Area specific Mineral Mixture
Value Added Products: Technology for Emulsion based chicken products and Meat and Meat Products, development of pork products

The way forward

The ICAR has more recently focused on the demand-driven research and technology and on the development of innovation systems, because strengthened research systems may increase the supply of new knowledge and technology, but they may not necessarily improve the capacity for innovation throughout the agricultural sector. The research activities that take place within NARS albeit within the context of its external linkages and government policies are just one component of innovative system. In general, the advantages of the innovation system are based on the ability of an organization to (a) successfully define its scope, (b) manage and coordinate the technology management within the organization as well as relationships with stakeholders, and (c) be aware of market demand characteristics and respond to them appropriately.

An analysis of the agricultural technologies generated in the ICAR institutions reflect their diverse nature and may be categorized on the basis of social span, scope of microenterprise, revenue generation potential and scope of industrial application. Therefore, the technologies which have high social span and scope for microenterprise development can be disseminated directly to farmers and end-users through the extension network or, wherever applicable, suitable entrepreneurship programmes can be taken up for the grass-root innovators and entrepreneurs. However, there are many technologies that have high industrial application and revenue generation potential but are generally at ‘proof of concept’ stage. Rendering them fit for commercialization requires catalytic support and facilities for demonstration of innovative product and process technologies so as to traverse the journey from ‘laboratory’ stage to ‘pilot’ stage and then commercial production. Compounding the dilemma are the regulatory aspects of research that have become increasingly burdensome, complex and difficult to understand and comply with.

It is largely felt that the initiative of establishing the ITMUs and the incubation facilities in the NARS have shown considerable promise for enhancing appropriate technology development and generating agri-business opportunities in diverse sectors of agriculture research. Therefore, the focus is on creating an innovation system and agri-incubation network that would provide the conducive environment in NARS, for appropriate technology development and its faster dissemination by creating an interfacing and networking mechanism between R&D institutions, industries, farmers and grassroots innovators. It would also create the required entrepreneur friendly atmosphere in the research institutions through effective IP asset management and inculcating a corporate business culture within the existing R&D system.

In this endeavour the ZTM and BPD are expected to provide the crucial link between the ITMUs in the institutes and the incubation network to be established. It shall also provide the required link and feedback from the 'market' for strategic planning to innovate new and appropriate technologies. The ZTM and BPD Units are being reorganised in congruence with the existing in Subject Matter Divisions (SMDs) in ICAR Headquarters. This would create specialized subject specific human resource that can facilitate the entire process of IP management, technology commercialization and business incubation; undertake capacity building and soft skill development in the specific subject area.

AgrInnovate India Limited

A major initiative of DARE to promote development and spread of R&D outcomes is the establishment of Agrinnovate India Limited, a registered company owned by Government of India. It aims to work on the strengths of ICAR for production, marketing and popularization of ICAR products, processes and technologies in agriculture and allied sectors, viz. seed, planting material, vaccines, diagnostics, other bio-technological products, value added inputs and products, farm implements and machinery, other technologies etc. It shall also provide professional extension of skilled services from ICAR, such as consultancies, contract research, contract service, customised capacity building, technical support for turnkey projects etc., in agriculture sector. It is also expected to create public-private partnerships in research, education and other capacity building in agriculture and allied sectors.

Epilogue

The agriculture research had been largely directed towards product innovation, i.e., creating new products as per the client (farmers, agri-industry) requirements. However, in the changing socio-economic context, process innovations that significantly improve production or delivery method, reduce the costs and help in conservation and sustainable utilization of the natural resources have become equally important. Further, the research and development priorities, in addition to increasing the productivity, are now required to be oriented towards devising strategies to enhance agricultural diversification and value addition of agricultural products; thereby providing real livelihood security.

The ICAR over the last few years has been successful in creating an institutional mechanism adopting an innovation system centric policy. The focus has been on creation of new knowledge with both social and economic perspective. It is to be realised that it is not just the new invention or a discovery that is important, but it is crucial to recognise the potential of research by putting it into practice and develop it in a manner that leads to new products, services or systems that add value to bring about significant changes in society. In this endeavour concerted efforts have been made for networking of institutions in the public and private sectors as well as social organisations, so that they interact and become partners in the production, diffusion and use of new and economically useful knowledge that would further enhance the innovation process.

While there is no dearth of knowledge and innovative technologies being created in the ICAR institutes, there is need to explore the potential of the generated technologies and their transfer to market at a faster rate. The agri-business entrepreneur often faces the constraints of identifying a good commercially viable product, getting trained personnel, better equipment and adequate technical backstopping. The technology incubators established by ICAR should thus create the additional mechanism for commercialization of agriculture research products, technologies and services generated from public research institutions. These units are being strengthened to provide the physical infrastructure necessary for technology incubation and to launch new business, including offices and lab space and shared resources such as specialized equipment and technical support services. Appropriate capacity building in terms of human resource is being undertaken by engaging/contracting professional help and providing required national and international trainings to the existing inter-disciplinary professionals in the area of technology management and enterprise creation to spearhead the change process and provide leadership for managing the change. These new initiatives thus shall supplement and reinforce the wide-ranging agricultural extension and education activities under the public sector NARS and hasten the process of technology transfer and realization at the ground level.

Web links and publications related to IP management and technology transfer published by ICAR

http://www.icar.org.in
http/www.icar.org.in/en/search/node/intellectual+property+guidelines
http://www.naip.icar.org.in/
http://ztmbpd.iari.res.in/
http://ivri.nic.in/ztmbpd/
http://www.agriincubator.com/
http://www.nirjaft.res.in/bpd/bpd.htm
http://www.niabi.in/niabi//content/network-partners
http://bpdcircot.com/

Chapter 3. Technology Transfer and Commercialization at the Jawaharlal Nehru Agricultural University, Jabalpur, Madhya Pradesh

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Agricultural Universities/Research institutes are primary source of improved technical knowledge popularized as ‘package of practices’ for enhancing crop productivity. Unlike in the West, much of this knowledge has so far been disseminated freely among the farmers and other stakeholders under the Indian agricultural research system. Although, the National Agricultural Research System (NARS) in India is by far the largest in the world, the national investment into agricultural research and development (R&D) is only 0.05 percent of the nation’s GDP and is further declining. Keeping in view the need to encourage innovations into agricultural research and also to fall in line with the changing global trade order, India adopted its Intellectual Property policy in 2006. The Jawaharlal Nehru Krishi Viswa Vidyalaya (JNKVV), Jabalpur being a premier agricultural research institute in Central India with substantial investments in agriculture research and development programmers funded through state and national as well as international agencies, has been identified as one among the 25 institutions for adopting the IPR policy of ICAR. The following pages present the profile, expertise and experiences of JNKVV in technology transfer and commercialization efforts, post-ICAR’s IP policy adoption.

Brief background about the University

Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV) is located in the heart of India, named after the architect of modern India, Pt. Jawaharlal Nehru. It is a multi-campus university established in October 1964. At present, JNKVV encompasses five agriculture colleges (Jabalpur, Rewa, Tikamgarh, Ganjbasoda and Balaghat); one agricultural engineering college (Jabalpur); four zonal agricultural research stations (Jabalpur, Powarkheda, Tikamgarh, Chhindwara); four regional research stations (Rewa, Sagar Dindori and Waraseoni); four agricultural research stations (Garhakota, Sausar, Tendini and Nawagaon-Chhatarpur) and 20 Krishi Vigyan Kendras (KVKs) (Badgaon, Betul, Chhattarpur, Chhindwara, Damoh, Dindori, Harda, Jabalpur, Katni, Mandla, Narsinghpur, Panna, Powarkheda, Rewa, Sagar, Seoni, Shahdol, Sidhi, Tikamgarh, Umaria) in six agro-climatic zones spread over 25 districts of the State (1). The mission and mandate of the university is to conduct education, research and extension for enhancing productivity, profitability and sustainability of agricultural production systems and quality of rural livelihood in the state of Madhya Pradesh. Its mandate is two-fold: 1) to serve as a centre of teaching and research in the field of agriculture and allied sciences, and 2) to disseminate technology to farmers, extension personnel and organizations engaged in agricultural development through various extension programs (1).

Over its more than four decades of existence, it has developed sound infrastructure and human resources that make it capable of addressing emerging technological challenges in agriculture. It has produced competent human resources for managing the activities of agriculture and allied sectors and has also played a pivotal role in the growth and development of agriculture in the state. Need-based research in agriculture and allied sectors along with its dissemination to the farmers have led to all around improvement in productivity of crops on sustainable basis in the state.

Technologies Generated at JNKVV
JNKVV has developed a number of proprietary technologies, such as hybrid rice (JRH 5 and JRH 8), and a multi-channel electronic choke indicator for tractor-driven seed drill, protected by patent (Patent No. 232368)(8). JNKVV has also released public sector hybrids and varieties that have been notified by the Government of India but could not be popularized among farmers due to lack of strong seed extension support systems. These technologies are promoted by the director of Extension through Krishi Vgyan Kendra (KVK) and entrepreneurship development programmes.

Establishment of the IPR Cell and Business Planning and Development Unit

JNKVV has developed various technologies in agriculture and allied fields from its research system, which help the stakeholders in promoting agribusiness. Most of these technologies were disseminated among the producers and other stakeholders free of cost for a long time. Following the policy decision of the Indian Council of Agricultural Research (ICAR), New Delhi, to protect innovative technical knowledge through patents and other intellectual property rights, in 2006, JNKVV also set up an Intellectual Property Rights (IPR) Cell to cater to the institutes' needs for protecting its intellectual properties. Further, a Business Planning and Development (BPD) Unit has been established at JNKVV under the aegis of National Agriculture Innovation Project (NAIP) to accelerate the commercialization of agricultural technologies. The vision of this program is to protect the intellectual proprieties developed through innovations in agriculture research and promote agribusiness entrepreneurship for technology commercialization. Entrepreneurs will be provided with incubation services from the BPD Unit at JNKVV. The BPD Unit at JNKVV will work to increase public awareness and opportunities for innovators and entrepreneurs for successful collaborations. The objectives of the BPD are:

- To promote market responsive products and technologies through effective entrepreneurship development.
- To promote public private partnership for commercialization of technologies.
- To develop human resources for entrepreneurship promotion.

The BPD advocates promoting business opportunities for the technologies developed by them, including seeds, biofertilisers and medicinal and aromatic plants etc.

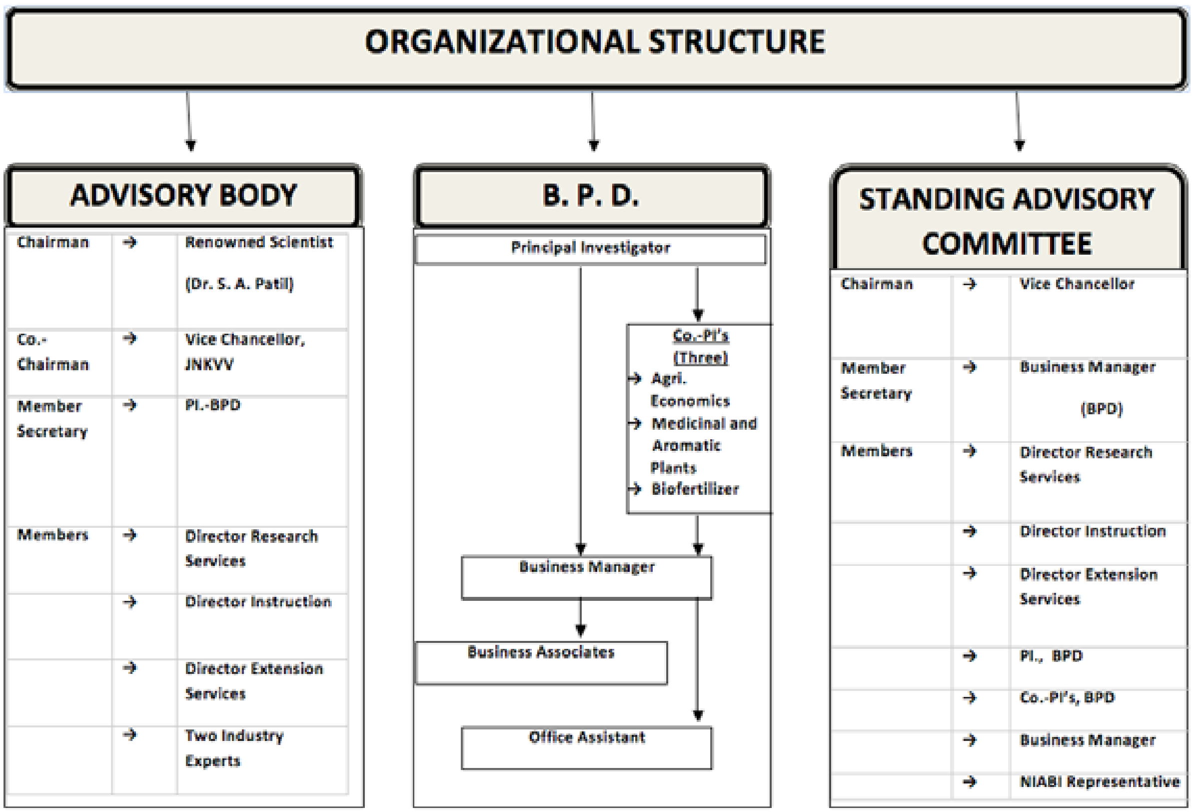
Organizational structure of the BPD Unit

The vice chancellor of the university is the leader of BPD Unit. One of the directors of the university is the principal investigator of the project and there is an implementation team comprised of a business manager, two business associates and an office assistant (3).

A two-tier advisory system monitors day-to-day activities and provides guidance. The standing advisory committee is chaired by the vice chancellor and comprised of senior scientists of the university. An outside expert chairs the advisory body, which meets once or twice per year and provides strategic direction to the BPD. See a detailed chart on the next page.

Negotiations committee. A committee comprised of the business manager, the scientist responsible for developing the technology, and two more co-investigators of the BPD will negotiate license agreements (for commercialization of the product or services) on a case-by-case basis. The final agreement will be signed by the authorized persons for its implementation.

Preparation of legal documents. Legal documents may need to be prepared occasionally during the technology commercialization process. These may include Material Transfer Agreements (MTA), licensing agreements, royalty agreements, and agreements for providing consultancy services for agri-business development and capacity building programs, and so on. Detailed project reports and business plans for agri-business development projects may also be required. Memorandum of Understanding (MoUs) may also need to be signed in developing institutional linkages for agri-business promotion. Careful attention to the legal implications of the words used in the documents, as well as benefits and liabilities to the Institutions, is required. Hence these agreements are very carefully drafted by the committee and vetted through the legal advisor, and finally approved by the project leader. If required, the Board of Management of the University will give final approval of the documents before signing these agreements with the different clients.



Success story of technology transfer for seeds and biofertilisers and medicinal and aromatic plants by JNKVV

The modalities adopted for technology transfer and commercialization of seeds, biofertilisers and medicinal aromatic plant technologies have been presented as case studies in this section.

Seeds

JNKVV has released more than 230 varieties of various crops; of these, 62 varieties were released since 2000 through Central Variety Release Committee and State Variety Release Committee. JNKVV has maintained the first rank in producing breeder seed since the inception of the breeder seed production program in 1980. JNKVV has contributed 18.31% (2009-10), 18.99% (2010-11) and an estimated 19.73% (2011-12), respectively, to the National Seed Procurement during the last three years (Figure 1, next page).

The major crops are soybean and paddy in the kharif season (early June to October each year, largely dependent on monsoon rains), and wheat, pea and chickpea during rabi season (mid-October to February each year, largely dependent on external irrigation sources). These seeds are sold to various companies that are multiplying and distributing the seed to the farmers, resulting in enhanced production and a strengthened food security system in India. Improved varieties and certified seed are made available to the farmers through local seed supply systems, which has resulted in improved seed replacement rate. The promotion and commercialization of improved varieties/hybrids through the agriculture production system has served as a model for employment generation, increasing livelihood security of farmers and realizing the benefits of innovations through seed systems.

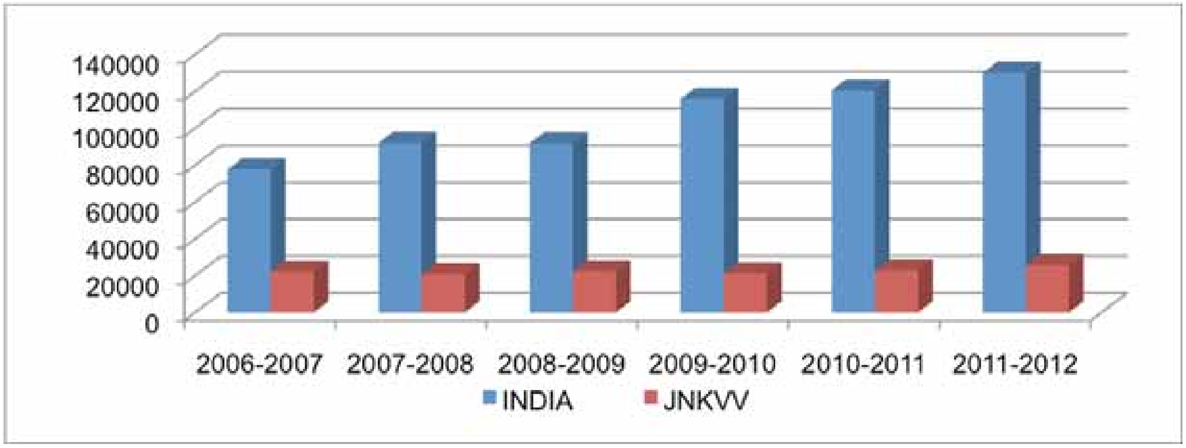


Figure 1. Contribution of JNKVV produced Breeder seeds to the National Seed Basket

Technology transfer mechanism

A unique technology transfer mechanism for seeds has been developed by the BPD unit. Improved varieties and hybrids developed by the university being an important technology area, a ***seed consortium*** has been developed with specific guidelines for technology transfer of seed varieties through the consortium. Similar guidelines are being developed for other technologies as well.

A consortium thus formed is crop specific, initially covering rice, horticultural crops, pulses, wheat, millets, maize and oilseeds. Seed companies who wish to avail the new technologies developed by the university have to pay a consortium membership fee for a 5-year membership in order to access parental materials and hybrids for a fee after signing an agreement.

Twelve seed companies have already become members of the seed consortium. These companies are mainly interested in hybrids of rice, maize, pigeon pea and castor. Seven companies have shown interest in hybrid rice and four companies have licensed the new rice hybrids under the trade name of JRH- 5 and JRH-8 and have supplied hybrid seeds to over 10,000 rice growers in the state. Similarly, five companies have shown interest in promoting maize hybrids, and three of these had already taken parent materials of maize hybrids for production and marketing.

As per the terms of the memorandum of agreement between the University and the company, the seed company cannot grant sub-licenses or transfer the right to produce the hybrids to any other company, or sell or use the parent materials in any breeding program without the permission of JNKVV. The member company is also responsible for certifying its own derived varieties and accepts all liabilities for germination and quality of the seeds produced and marketed. JNKVV accepts responsibility for the quality of the breeder seed supplied by the university. The member company also agrees to use JNKVV nomenclature of the crop variety as quoted in notification on all seed packets produced as per MOU with JNKVV.

JNKVV offers technical services for hybrid seed production and plot visits as per consultancy services guidelines of the university. JNKVV also coordinates multi-location trials of hybrids developed by the consortium members as per JNKVV product testing and consultancy rules. Member companies are required to furnish feedback on a quarterly basis on the popularization and spread of the hybrid and present the information at consortium meetings.

Promotion of seed business through farmers' seed cooperative societies and small scale seed companies
Thirteen farmers' seed cooperatives and small-scale seed companies have been registered as members of the BPD unit to avail the technology and business support services. Seed business services will be provided to these companies, which have regular interaction with BPD for technology and business related seminars. All companies have been supplied with breeder seeds of improved varieties of soybean, wheat, rice and other important crops. They have seen benefits in production and marketing of certified seeds in Madhya Pradesh from networking among themselves (Figure 2).

Figure 2. Organizational structure of seed farmers' cooperative societies in Madhya Pradesh

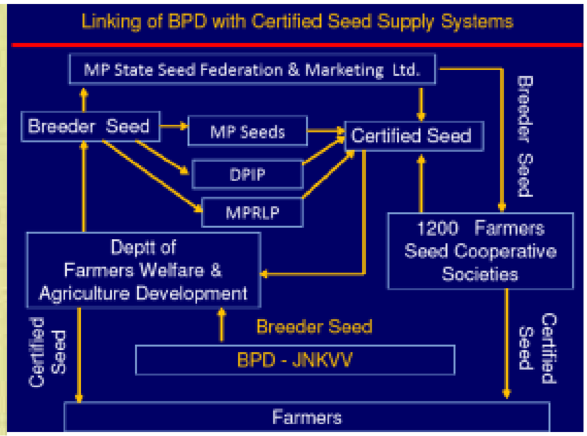


Figure 3. Linking of BPD with seed cooperative system in Madhya Pradesh

More than 1,200 farmers' seed cooperative societies have been established in Madhya Pradesh. JNKVV played a key role in their promotion, and the BPD unit provides capacity building for governance and seed production, support for business plan development, and supplies them with breeder seed (Figure 3).

For example, the BPD Unit is promoting the Jabalpur Agri. Producers Company Ltd. (JAPCL), a farmers' producers company formed by 11 farmers' cooperative societies. The JAPCL is formed to do business across the entire agricultural value chain. The company is focusing on seed production and marketing. JNKVV is providing the breeder seeds, and JAPCL is expecting to produce 10,000 metric tons of certified seeds of soybean, rice, pigeon pea, wheat and chickpea in 2012-13. JAPCL will also produce hybrid pigeon pea developed by JNKVV and ICRISAT.

In another example, the BPD Unit has also facilitated the formation of a federation of ten farmers' seed cooperative societies. Overall management of the company is performed by a chief executive officer (CEO). The BPD Unit provides business incubation services and space, and has facilitated business collaborations with several companies and development of a long-term plan. These efforts in seed commercialization have resulted in increased availability of certified seeds to the farmers, reflected in high Seed Replacement Rate (SRR) (Figures 4 and 5, next page).

Biofertilizers

The Biofertilizer Production Centre (BPC) at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, was launched to meet the large demand for various biofertilizers amongst farmers and small-scale cultivators of Madhya Pradesh. The biofertilizers produced by BPD are recognized as high quality and are the result of extensive laboratory and field experiments. Strict quality control measures are in place to assure the quality of the products, which are tested with various microbiological qualitative and quantitative tests on representative samples before being stored in temperature-controlled environments.

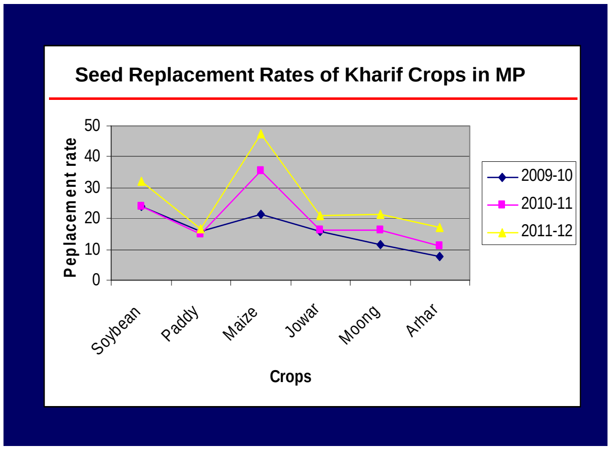


Figure 4. SRR of Kharif Crops in MP

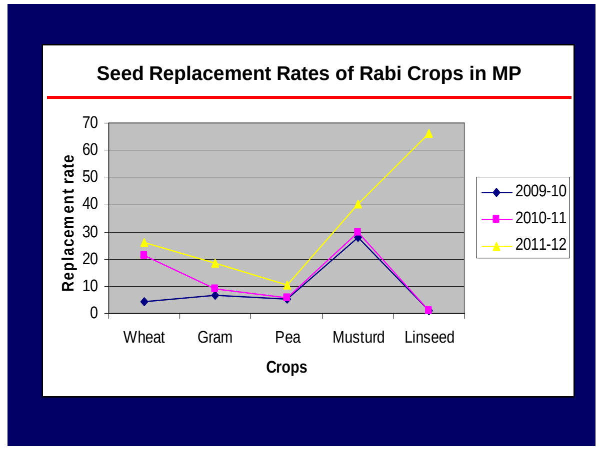


Figure 5. SRR of Rabi Crops in MP

The center produces Jawahar Biofertilizer Rhizobium for legumes, Jawahar Biofertilizer Azotobacter and Azospirillum for non-legumes, Jawahar Phosphate Solubilizing Biofertilizer for all crops, and Jawahar Biofertilizer BGA for paddy crops. These are mainly supplied to Madhya Pradesh State Agriculture Department, MP State Marketing Society Federation Corp., Krishi Vigyan Kendras, JNKVV Research Stations, JNKVV Farms, and farmers directly. On an average the center produces 252,440 packets (200g/packet culture) and sells 232,890 packets per year.

An Agribusiness Development Camp on Biofertilizers was organized in January 2012, where entrepreneurs learned about entrepreneurship opportunities in the Biofertilizers sector and the incubation services available with BPD JNKVV, which include:

- Access to information on bio-fertilizers
- Training programs at JNKVV on Biofertilizers production technologies
- Access to microbial mother cultures
- Field visits by scientists
- Access to programs and exhibitions conducted by BPD
- Business plan preparation

So far, one state of the art Biofertilizers plant is being established in JNKVV under BPD project, and the BPD has the capacity to host a large number of Biofertilizer entrepreneurs for incubation.

Agribusiness Development Camp on Biofertilizers

Medicinal and aromatic plants

Business ventures based on medicinal and aromatic plants are excellent opportunities due to ever increasing demand for ayurvedic medicines and nutraceuticals, and entrepreneurs can use the services provided by JNKVV to establish and grow their business.

These services include:

- Access to information on medicinal and aromatic plants
- Training programs on packaging and processing technologies
- Access to planting materials
- Field visits by scientists
- Access to programs and exhibitions conducted by BPD
- Business plan preparation
- Networking with agencies and government
- Commercialization of single and multiple herbal drug products

An Agri-business Camp on Medicinal and Aromatic Plants was held in March 2011 at JNKVV Jabalpur. Fifteen entrepreneurs with medicinal and aromatic plant products businesses attended the meeting.

Agribusiness development camp on medicinal and aromatic plants.

Strengths of JNKVV in medicinal and aromatic plants

JNKVV has many advantages in the area of Medicinal and Aromatic Plants, including access to plant materials, techniques and procedures, infrastructure, and residential and commercial facilities. JNKVV hosts a gene pool-rich herbal garden with a collection of over 11,000 plant species belonging to 450 genera and 110 families that serves as an educational site for students, farmers and entrepreneurs engaged in pharmaceutical preparations and trade of the Indian system of medicine. JNKVV has also developed agronomic techniques for 30 of the most in-demand medicinal and aromatic plants and standardized analytical procedures to determine active ingredients in potentially viable medicinal herbs. It has the required infrastructure, including greenhouse, glasshouse, mist chamber, polyhouse, analytical library with modern equipment, and processing and value addition units. It also has residential facilities for trainees, an information center and a commercial nursery for selling planting material.

Services and activities of the BPD Unit

Business Incubation Services

The BPD Unit provides business incubation services for agribusiness ventures in the seed sector. The Seed Business Incubation is a program of BPD-JNKVV aimed at promoting rural seed business ventures to bridge the gap between the demand and supply in the seed industry through public-private partnership. Support services provided for seed ventures include project reports, capacity building and business training for company officials, access to breeder seeds of various crops, quality control of seed production, and seed processing (3).

Signing of MoU for JRH-5 with DSP Seeds Pvt. Ltd.

Awareness campaigns

JNKVV's BPD unit has taken various steps to create awareness about itself as well as the technologies of the university.

Date	**Title**	**Participants**	**Achievement**
May 2010	Launching Workshop	100+	At JKNVV; created desired publicity through publication in local and national newspapers.
July 2010	Participation in ICAR-Industry Meet		Technologies of seeds, biofertilizers, medicinal and aromatic plants and multi-channel electronic choke indicator were displayed in the exhibition. Reputed seed companies showed interest in collaborating with JNKVV in production and marketing of early maturity rice hybrids.  Technologies exhibited during ICAR-Industry meet
September 2010	Agribusiness Development Camp	Large number of entrepreneurs	Explored the possibilities of collaboration in agribusiness entrepreneurship; emphasized the collaboration between university and industry in transfer of technologies. Fifteen entrepreneurs registered as the members of BPD unit to avail support services in their entrepreneurial venture.
October 2010	Participation in Global Investors Meet		Technologies of seeds, biofertilizers, medicinal and aromatic plants and multi-channel electronic choke indicator were displayed in the exhibition. Many visitors inquired about the technologies available in the university and services provided by BPD unit for setting up agribusiness ventures.
23 Sept. 2010	Sensitization Workshop for Scientists of JNKVV	25 Scientists of JNKVV	Sensitized scientists toward agribusiness development through incubation, the business incubation process, and its importance in agribusiness development; emphasized that the role of scientists is of paramount importance in the development of market-oriented innovations, and that scientists can also help entrepreneurs by mentoring them.

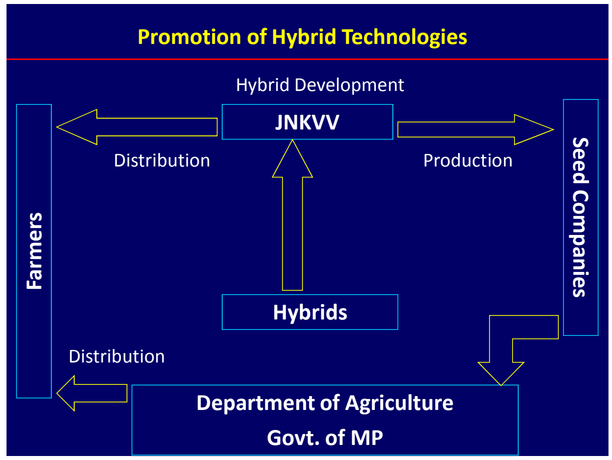
Date	Title	Participants	Achievement
March 2011	Participation of Global Agribusiness Incubation Conference-2011	200 agribusiness professionals	Network of Indian Agri Business Incubators (NIABI) conducted at ICRISAT, Hyderabad. All Business Planning and Development Units of India participated, as well as representatives from Africa, Latin America, and Philippines. During technical sessions deliberations were made on addressing challenges in agriculture through the agribusiness incubator, next generation agribusiness opportunities, key success to agribusiness, entrepreneurship of women in agriculture, social entrepreneurship for agriculture development, smart startups, sending the incubator of impacts, funding opportunities for startups, and an investors-startup forum.  **BPD Stall in Global Agribusiness Incubation Conference -2011**
February 2011	Participation in FarmTech 2011		Organized at Bhopal by Govt. of Madhya Pradesh and PHD Chamber of Commerce. Improved technologies of JNKVV were displayed in this exhibition, which attracted thousands of farmers and other stakeholders in agriculture.
February 2012	2nd Global Agribusiness Incubation Conference – 2012		Organized by NIABI (Network of Indian Agri Business Incubators) at IARI, New Delhi; Technologies were displayed
	Agribusiness Development Camp		One agribusiness development camp was organized which was sponsored by Small Farmers Agribusiness Consortium (SFAC) where entrepreneurs had been sensitized about the venture capital scheme of SFAC for agribusiness ventures. Two proposals from entrepreneurs had been selected for further processing during Global Agribusiness Incubation Conference at Delhi.

Other efforts in enhancing visibility of JNKVV

Commercialization of hybrid rice JRH-5 and JRH-8 through field days

The institute/BPD organizes field days for demonstration and dissemination of hybrid rice technology to the farmers and farmer seed companies every year. More than thirty-five seed companies from the private, cooperative and public sectors have attended and observed the performance of early duration rice hybrids, both released and upcoming. This showcase resulted in the licensing of hybrid rice varieties to four companies to begin marketing in 2013. Three companies have licensed JRH-5 and one has licensed JRH-8.

Company representatives observing hybrid rice trials



Model Developed for promotion of hybrid rice

Showcase of wheat and chickpea varieties

A showcase of wheat and chickpea varieties was held at JNKVV in February 2011, and 41 participants from private companies, cooperative societies and MPDPIP attended. The objective of organizing this showcase was to demonstrate the strength of the technologies developed. The need for public-private sector collaboration in transferring improved wheat and chickpea seeds to farmers was highlighted. Participants visited the wheat and chickpea trials at JNKVV Farm and made critical observations on various varieties. Participants expressed interest in production and marketing of some of the varieties. A similar showcase for wheat varieties was organized in March 2012.

Representatives of seed companies observing performance of a wheat crop.

Human resource development

The Business Planning and Development unit has taken important steps to train entrepreneurs in agribusiness since its inception.

Date(s)	Duration	Participants	
September 2010	10 days	15 Chief Executive Officers (CEOs) of seed producer companies and four scientist	Trained by faculty of the university and of seed industry; field visits and visit to a seed processing plant of one cooperative society in Jabalpur
September 2010	2 days	Seed Cooperative Societies	Training on business management aspects/issues of seed co-op societies at Rewa
July 2012	1 day	Agricultural students at College of Agriculture, Rewa	Sensitization workshop on opportunities and challenges in the agribusiness sector

Consultancy assignments

The Business Planning and Development Unit has assisted ICRISAT in data collection and preparation of detailed project reports for five farmers' producers companies in Madhya Pradesh. Recently, BPD unit has been asked to prepare a business plan, organizational framework and detailed project report for seed processing plants for Madhya Pradesh State Cooperative Seed Producer and Marketing Federation Ltd. Bhopal.

Lessons learned and way forward

The Public Private Partnership (PPP) model has shown great success so far, but for the BPD Unit to become commercially viable, it must develop synergy between itself and various entrepreneurship development programs of the state and central government. The BPD unit should also seek the involvement of NGOs for agri-entrepreneurship development needs in the future.

Implementing the technology commercialization process in a public sector organization without previous experience is difficult and comes with many challenges, but through this experience, the BPD Unit learned valuable lessons in the theories and practices of the commercialization of agricultural technologies and the basics of business incubation to promote entrepreneurship. This experience has helped the team and the university's scientists learn the skills of negotiation and marketing of new technologies.

Way forward

The following steps are suggested for improved efficiency in running the BPD Units:

1. Revise the technology portfolio of the University and listings for commercialization.
2. Provide inputs to the research advisory council to reorient research towards for the industry needs.
3. Conduct research on behalf of industry.
4. Market existing technologies aggressively.
5. Develop capacity in modern methods of commercialization.
6. Entrepreneurship development through attracting the involvement of champions to promote technology transfer.
7. Initiate registration for Geographical Indicators and Plant Variety Protection under the PVP & FR Act.
8. Promote more producer companies to increase grassroots-level transfer of existing technologies.
9. Collaborate with state and central government for funding under agricultural development projects.
10. Build capacity in business planning and development for students of agriculture and related fields.
11. Obtain IPR protection and registration of Germplasm and Geographical Indications (GI) for commercialization.
12. Build awareness among scientists of industry needs so they may orient their research around development of commercially viable technologies.
13. Produce more refined products that have more commercial value, such as alkaloid level products from commercially viable medicinal and aromatic plants, nano-products for bio-fertilizers, seed conditioning technology for seed storage and long term viability during transportation of seed, etc.
14. Develop technologies and equipment for increasing shelf life of horticulture produce in rural areas.
15. Develop nutrition-rich extruded products.
16. Provide agri-advisory services in rural areas through service providers.
17. Establish an agri-call center.
18. Establish an agri-health center.
19. Prepare agribusiness projects suitable for micro and small-scale enterprises and communicate to entrepreneurs in rural areas through the network of KVKs (Krishi Vigyan Kendras) in the university. This will help promote grassroots-level enterprises in the state of Madhya Pradesh.
20. Promote entrepreneurship in rural areas in both agricultural and non-agricultural sectors, focusing on youth. Develop structured certification programs such as 'Agri Service Providers.'

Web links

www.jnkvv.nic.in, www.bpd-jnkvv.org, www.niabi.in, www.naip.icar.org.in

References

1. Anonymous (2012) JNKVV At A Glance. An official publication, Jawaharlal Nehru Agriculture University, Jabalpur, Madhya Pradesh, India.
2. Rao, S.K.; Bhale, M.S.; Khare, D (2011) Quality Seed Production in JNKVV A Success Story Jawahar Seed. An emerging brand. Business Planning and Development Unit, Jawaharlal Nehru Agriculture University, Madhya Pradesh, India.
3. Rao, S.K. (2012) A profile of Business Planning and Development (BPD) Unit, NAIP-I, Jawaharlal Nehru Agriculture University, Madhya Pradesh, India.
4. Rao, S.K. (2012) Directorate of Farms At A Glance. An official publication, Jawaharlal Nehru Agriculture University, Jabalpur (M.P.) India.
5. Rao, S.K. (2011) Opportunities for Seed Industry Business Planning and Development Unit, National Agricultural Innovation Project, Jawaharlal Nehru Agriculture University, Jabalpur Madhya Pradesh, India.
6. Rao, S.K. (2011) Opportunities for Bio-fertilizer Industry. An official publication, Business Planning and Development Unit, Jawaharlal Nehru Agriculture University, Jabalpur, Madhya Pradesh.
7. Rao, S.K. (2012) Business opportunities for Herbal Industry. An official publication, Business Planning and Development Unit, Jawaharlal Nehru Agriculture University, Jabalpur, Madhya Pradesh.
8. Rai, A.K. (2007) A multi-channel electronic choke indicator for tractor driven seed drill. An official publication of Instrumentation Jawaharlal Nehru Agriculture University, Madhya Pradesh, India.

Chapter 4. Promoting Agri-Business through Technology Transfer and Public-Private Partnerships for Second Green Revolution- Anand Agricultural University's Approach

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Significance of improved technology for productivity enhancement, especially in agriculture is well acknowledged world over. Universities and research institutions have traditionally been recognized as the primary sources of such technical interventions that assured crop/animal productivity enhancement. However, such innovative technology often tends to be at a 'proof of concept' stage and may need refinements prior to being commercially viable. Research institutions and universities may lack the necessary infrastructure or financial support for scaling up a number of technologies that emerged out of their research labs. Technology transfer to small and large entrepreneurs through commercial licensing is one way of ensuring scale up and commercial production. Though nascent, this concept has been gaining popularity in a number of agricultural universities and research institutions based in India. This chapter provides in detail the experiences of Anand Agricultural University, Gujarat, which has adopted technology transfer mechanism for commercialization to benefit producers from Gujarat state.

Brief background about the University

The Institute of Agriculture, Anand, was established in 1940 by Sardar Vallabh bhai Patel to serve the cause of rural education, research and training needs of the farm families. It has been nurtured by well-respected men and has since become a full-fledged university offering post-graduate programs in agriculture, veterinary and dairy sciences since 1947. In 2004, it was renamed Anand Agricultural University (AAU). It houses colleges of agriculture, veterinary sciences and dairy, five polytechnic colleges; College of Agricultural Engineering and Technology, Godhra; College of Food Processing Technology and Bio Energy, Anand; International Agribusiness Management Institute, Anand; and College of Agricultural Information Technology, Anand. The university also supports 17 research stations, one extension education institute and 22 extension education centers in Gujarat.

AAU has been actively involved in crop improvement in many crops and has successfully released several improved cultivars and has released promising hybrids in several crops over the past several decades (Annex1), which have been popularly grown in Gujarat.

IP and tech transfer policy of the University

The University has actively been involved in developing and disseminating innovative technologies for crop productivity enhancement in the past. Very recently the university established an IP management cell and adopted an IP policy. The Intellectual Property Management and Technology transfer policy of the University largely follows the guidelines of the Indian Council of Agricultural Research, New Delhi, (Ref 2, 28) the apex organization in the country dedicated to agricultural research, education, extension and commercialization. The establishment of the IPR cell has enabled the university to protect its innovations through patenting. The University has developed agriculture technologies like tissue culture and bio-fertilizer; veterinary technologies like Area Specific Mineral Mixtures for livestock; dairy technologies like Batch Type Halwasan (a local sweet savoury) Making Machine, Twin Cylinder Scrapped Surface Heat Exchanger, and probiotic lactic cultures for dairy products. The university also has developed and is in the process of commercializing food processing and bio-energy technologies like bio-diesel plant intermediate oil recovery equipment.

Following the guidelines provided by the ICAR, the University adopts a policy of licensing its technologies on 'non-exclusive' bases to entrepreneurs for a fixed period for commercial scale production thus, catering to the technological needs of Gujarat state.

Geographical Indication (GI) obtained for bhalia wheat

The University also has obtained Geographical Indication (GI) for a special type of wheat, called, *bhalia* wheat, from the Government of India to safeguard the interest of farmers. The durum wheat *Triticum durum* Desf cultivated in the Bhal tract of Gujarat under conserved soil moisture conditions is popularly called the *bhalia* wheat and is recognized for its quality parameters like long grain, protein rich, high in gluten, high carotene, and low water absorption and is in high demand/

Plant variety protection and farmers' rights obtained for crops

In Gujarat, AAU was the first to receive Plant Variety Protection and Farmers' Rights (PVP and FR) registration for four maize varieties in 2010-11, which have been awarded certificates of Registration under Plant Protection Variety and Farmer's Right Act - 2001 by the Registry, Government of India, New Delhi.

Establishment of Business Planning and Development Unit at AAU

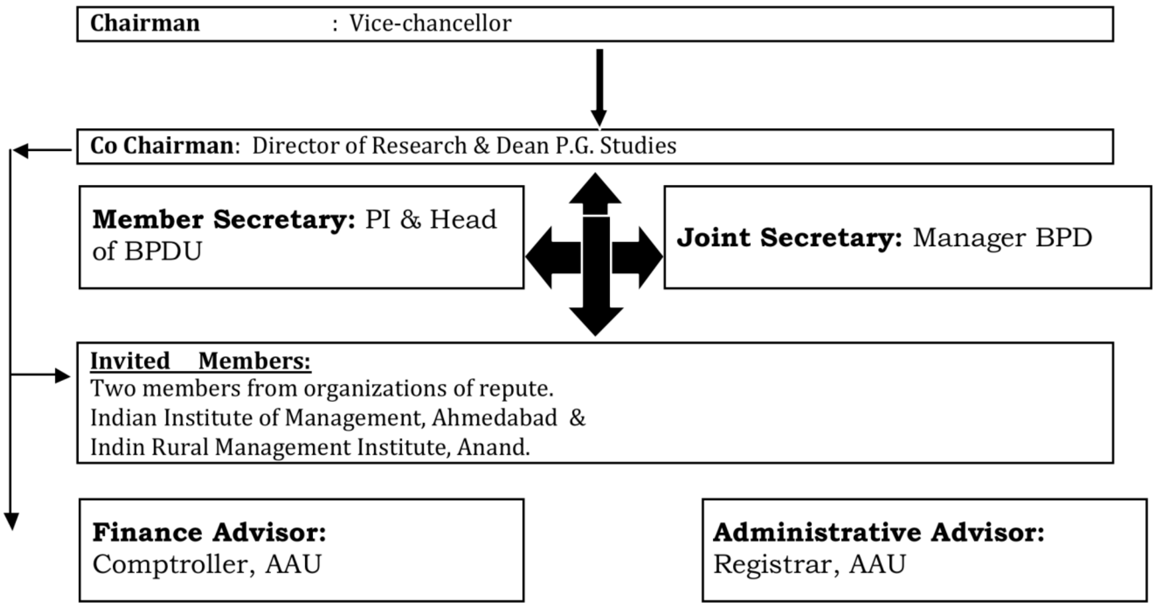
The University's IPR Cell was established in 2006 with the primary objectives to: 1) encourage the university scientists to engage in basic, applied and innovative research; 2) provide guidelines for the protection of university's innovations in accordance with Indian Right to Information Act, 2005; 3) enable faster transfer of these innovations to application for public benefit and commercial use; and 4) provide assistance to the scientific faculty and staff in filing patents and protecting intellectual property preferably before commercializing their innovations. Further, the university, under the aegis of ICAR and the National Agricultural Innovation Project funded by the World Bank (Ref 6) (NAIP-I, ICAR) also started an incubation facility termed as Business Planning and development Unit.

AAU Business Planning and Development Unit (BPDU)

Public-Private Partnership (PPP) plays a key role in the advancement of agricultural research under the IPR regime. The BPD unit was established at AAU in 2010. This agri-business incubator is working to create public awareness about opportunities for innovators (Ref 10) and entrepreneurs and serves as the center for transfer of technologies and encourage Public-Private Partnership (PPP). It provides an opportunity to the innovators who want to start new agri-businesses in the agricultural sector (animal husbandry, dairy, veterinary, fisheries, agriculture and horticulture) with access to a national network, under the Government of India scheme of "Support for Entrepreneurial and Managerial Development of SMEs" through business incubators.

Organizational structure of AAU BPDU governing board

The AAU BPDU is the primary arm of the University for technology transfer and commercialization. It has been established to enhance the visibility of the University and works under the direct leadership of the University's vice-chancellor. The organizational structure of the BPD is as follows:



Mandate and services provided by AAU BPDU

The primary objectives of the BPDU are to:

- Accelerate development of agri-business technologies and canvassing to private organizations under PPP to create an agribusiness environment.
- Provide research and development (R&D) services to potential and existing entrepreneurs for setting up their own units through consulting, training and advisory services and contract farming,
- Promote new and near-ready technologies, new varieties and hybrids of crops developed at AAU for commercialization.

BPDU provides services such as technology-specific training programs, collaborations/ partnership with industries, identification of potential entrepreneurs for specific technologies, market assessment, sensitization and networking with industries. The BPDU also disseminates technology-related literature through various communication media, including videos, CDs, leaflets and brochures. The BPDU also assists potential entrepreneurs in making detailed project reports and techno-economic feasibility analyses.

Technology transfer

The purpose of the BPDU is technology transfer and commercialization of technologies generated from Anand Agricultural University (AAU). BPDU therefore, pools the technologies from various scientists working in colleges and research stations that are viable in terms of market potential, demand by the farmers and other end-users, assesses their potential using different techniques such as the Analytical Hierarchy Process (AHP) and Strategic Assessment Method. The BPDU also estimates return on investment and arrives at a breakeven point of each technology prior to commercialization.

Costing. Costing of technologies is done by the BPD Unit in association with the scientists and with the approval of the governing board. An economic feasibility or viability report, along with business plans, is then developed by the BPD Unit in association with the scientists who have developed the technology.

Marketing. Agribusiness camps are held at the institute campus to give publicity to the technologies following news releases in local daily and agricultural media outlets. Literature on the technologies is distributed at farmer fairs, technology shows, road shows and other relevant forums. The incubator manager and the scientists visit the market to meet industry members and showcase the technologies along with their business plans. These meetings require the presence of the decision-maker (business owner or entrepreneur) and not only technology and R&D staff of the company so that the process of technology commercialization will not be unnecessarily delayed. The participation of the inventors is integral to these activities.

Process of technology transfer at the BPDU:

1. Once an entrepreneur or business is interested in licensing a technology, he enrolls as member of the incubator by registering and paying the requisite one-time membership fee and then an annual renewal charge for technological updates.
2. After registration, the client signs a non-disclosure agreement (Ref 20).
3. After signing the agreement, a meeting between the client and the scientist is arranged for imparting technical details of the technology and the technology is demonstrated.
4. The scientist and the incubator manager visit the client's site, where he intends to set up/install the technology. They check for location feasibility and that legal aspects (such as environmental and safety regulations) for establishing the technology are in place and adhered to the by client. The client is guided if any changes are needed in the existing infrastructure.
5. Once it is determined that the client is in a position to take up the technology and would be able to operate it successfully, the client and BPD Unit come together to sign the officially authorized Memorandum of Understanding (MoU) with the university-authorized signatory in concurrence or presence of AAU BPDU Governing Board. This MoU specifically highlights the roles and responsibilities of both the participating agencies for technology commercialization. It also contains the number of visits of the consulting scientist or his authorized representative to the site and period of stay, and shows the phase-wise breakdown of the entire technology commercialization project.

In most cases the process of technology commercialization does not take more than one year, barring some specific cases where certain protocols take longer time (e.g., tissue culture protocol in date palms takes up to three and a half years). Once the technology is licensed, sub-licensing is not allowed. The first installment of payment is usually due upon signing of the MoU.

In most of the technology licensing agreements from agricultural business incubators, there is a provision that two to three technical experts of the licensee will be trained in the facilities of the incubator or in laboratories on the university campus. At the same time the client is advised by university experts to initiate the process of procurement of instruments and machinery and for the commencement of construction work at the company site.

Inter BPDU linkages and transfer of technologies (Ref 21)

The BPDU, AAU is one among the 11 that have been initiated by ICAR in the last five years. All 11 BPD units funded by NAIP/ICAR are linked through a common platform: Network of Agri-Business Incubators of India (NIABI). AAU BPDU has collaborated with Haryana Agricultural University's (HAU) BPDU for commercialization of technologies in their respective jurisdiction, which is a winning model. Anand is a milk capital in India, and a detection kit for milk adulteration developed by HAU, Hissar has practical utility in Gujarat state, so AAU BPDU is marketing HAU's milk urea detection kit.

Capacity building

An expansion in the capacities and incentives for protecting innovation followed by licensing would expectedly trigger the improvement in research quality and hastening the technology transfer at AAU. The BPD Unit obtains and conveys market feedback from the industry (Agribusiness sector) on its technological requirements to the scientific community at AAU so that the further research efforts can be aligned in the market-led direction. The BPD unit regularly organizes technology awareness and commercialization programs in various subsectors of agribusiness, such as agricultural industry, dairy and food processing, veterinary industry, etc. It also participates in IP capacity building and awareness for the scientists by organizing seminars on IP management in agriculture and educating them in the patent filing procedure, including the prior art search. The technologies devised by the scientists are submitted to the BPD Unit for commercialization by the concerned faculty.

Other services

The BPDU at AAU provides consultancy services, rental services and contract research besides PPP and TOT, described as follows.

Consultancy. The BPD Unit facilitates the offering of private consultancy services by University scientists to private companies as per AAU consultancy guidelines. Scientists are given a share of the consultancy fees. So far, the scientists have served as consultants for the establishment of the Animal Biotech Research Centre at Nasik for Marshall Breeders Private Limited (Ref 7), and for making paneer (a form of cheese) from cow milk (Ref 22).

Rental services. High-value instruments and facilities, such as the genome sequencer (Department of Animal Genetics and Biotechnology), fermentor (Department of Agricultural Microbiology), and Real Time PCR (Plant Tissue Culture Laboratory), are available for rent to the entrepreneurs at an affordable rate. For example, the 200-liter capacity fermentor is engaged for Liquid Biofertilizer manufacturing.

Contract research. The University also performs short-term contract research projects for private companies such as product testing and trials, development of new product formulations and solutions to specific technical problems of the industry. The private partner provides the funding for the entire project funding, including applicable government taxes.

Pesticide residue testing. AAU's All India Coordinated Research Project (AICRP) pesticide residue laboratory has world-class facilities and is accredited by the National Animal Biotechnology Laboratory (NABL). It has the requisite quality standards as per the government prescribed guidelines to analyze a wide range of pesticide residues (160) in agricultural commodities, including food, feed, seed spices, oil, soil and water. (ISO/IEC 17025:2005 specifies the general requirements for the competence to carry out tests and/or calibrations, including sampling. It covers testing and calibration performed using standard methods, non-standard methods, and laboratory-developed methods.) The residue data that are generated are utilized to fix the permissible residue standards for different animal feeds, plant based products etc. by Indian Council of Agriculture Research- National Agriculture Research System (ICAR-NARS). The analytical services rendered by the lab are of great importance for certification of residue-free produce in the international market and for organic food certification.

Other Services. The BPD Unit also facilitates soil and water testing analysis for agricultural entrepreneurs, guidance for contract farming and organic farming, and other technical requirements of small companies and farmers.

Success story of technology transfer and public-private partnerships

Liquid biofertilizers technology

The liquid bio-fertilizers (LBF) are suspensions having useful microorganisms, which fix atmospheric nitrogen and solubilise insoluble phosphates and make it available for the plants. Liquid bio-fertilizers have a distinct advantage in terms of cost saving over chemical fertilizers in addition to yield advantage. Chemical fertilizers otherwise may have negative effects on soil as well as human health, change the soil chemistry and make the soils unsuitable for plant growth in the long run. The products of bio-fertilizers that were in use earlier were carrier (solid) based with 'lignite' used as a carrier material. Lignite is hazardous to the production workers. Also, the shelf life of carrier based bio-fertilizers is only 6 months and is difficult to transport. LBFs on the other hand have a shelf life of minimum one year, with no health hazards to production workers and are easy to transport. Additionally, LBF can be used in drip irrigation and as a component of organic farming.

The LBF developed by the Anand Agricultural University (AAU), Anand is based on native cultures of bacteria viz.,*Azotobacter chroococcum*, *Azospirillum lipoferum* and *Bacillus coagulans* and is safe and also eco-friendly alternative to chemical fertilizers. The LBFs, are being supplied to the producers and other commercial entrepreneurs under the brand name "Anubhav liquid Bio-fertilizers" by the University. AAU has supplied LBFs over 50,000 litres to the Government of Gujarat for distribution to farmers as a part of Krishi kit during *Krishi Mahotsav,* a mass agricultural technology dissemination programme of the Department of Agriculture, Government of Gujarat. The response of Gujarat farmers on use of LBF in different crops, such as cotton, banana, potato, rose, turmeric, papaya, etc., reported better yield and quality.

To extend its reach to the farmers, the AAU has licensed the technology of LBF for commercialization to three companies in Gujarat through its Business Planning and Development Unit (BPDU) under Public Private Partnership (PPP) mode.

The liquid Biofertilizers technology has been successfully commercialized to three companies, i.e., Kemrock Agritech Private Limited, Gujarat State Fertilizers and Chemicals Limited and Gujarat Agro Industries Corporation Limited.

Kemrock Agritech Private Limited (Ref 12)

Kemrock Agritech Pvt. Ltd. (KAPL) is an ISO 9001:2008 Certified Tissue Culture Laboratory (Ref 3) registered with Agricultural and Processed Food Products Export Development Authority (APEDA) as a merchant exporter. It has a modern facility spread over 20 acres with a state-of-the-art laboratory (11,000 sq. ft.), fully automated greenhouses (25,000 sq. ft.) and net houses (75,000 sq. ft.) with the latest equipment such as foggers, irrigation systems, etc. The facility is installed with state of the art laboratory facilities, growth rooms with movable racks, and over 200 trained operators who can produce over 10 million plants per annum.

Until early 2010, KAPL was only involved in the plant tissue culture business, and mostly worked with bananas, which generated most of the revenue. However, KAPL found that relying on one narrow business so heavily was risky. KAPL had these three options.

1. Integrate forward with its customers, having some buyback arrangements with them, which would involve procuring the banana produce at an agreed upon price and then selling it either in the local market or export it;
2. Integrate backward with the company itself entering into banana farming so that hassles of procuring elite banana suckers from progressive farmers would be avoided; or
3. Enter into a related business.

Forward integration was not possible because banana farmers are spread across India with a major share in Maharashtra and Tamil Nadu. Banana procurement from pan India would put Kemrock at a logistical disadvantage. Backward integration would have required huge chunks of fertile land. KAPL found that the best option was to enter into a related business with low investments.

AAU was advertising technology commercialization options through its Agribusiness Incubation Centre, the Business Planning and Development (BPD) Unit, in a local agricultural magazine. KAPL was interested in the Liquid Biofertilizer Technology (LBF) and Date Palm Tissue Culture protocol. Since the Date Palm tissue Culture Protocol had a long gestation period of three to four years compared to one year for Liquid Biofertilizers, KAPL decided to license Liquid Biofertilizer Technology from AAU(Ref 14). KAPL staff lacked experience and expertise in microbiology and biofertilizers as it was a new technology for them. The assistance of the AAU BPD Unit was vital for KAPL as it assured that the technology package included the incubation of the company for a period of one year and the training of three technical staff in the bio-fertilizer mass production laboratories of AAU for a period of three weeks. During the entire incubation period, the company had access to the guidance of AAU microbiologists on- and off-site. Within a period of six months after the agreement was signed, the company launched its product in the market under the brand name Tapak Bund® in three variants: *Azotobacter*, *Azospirillum* and phosphate culture.

Gujarat State Fertilizers and Chemicals (GSFC) Limited (Ref 19)

BPD Unit also licensed its Liquid Biofertilizer Technology to Gujarat State Fertilizers and Chemicals (GSFC) Limited, Vadoadara. GSFC had traditionally been a chemical fertilizers and specialty chemicals business. A small portion of its product portfolio was in powdered Biofertilizers packets, which need lignite as a carrier material. Lignite prices fluctuate highly, and demand for other uses of lignite is high, so it became very difficult for GSFC to maintain bio-fertilizers production. In addition, powdered biofertilizers cannot be used in drip irrigation systems, which were increasing rapidly in most of GSFC's potential biofertilizers markets. The availability of liquid bio-fertilizer technology at AAU (within 40 km radius) was an advantage. GSFC will launch the product under brand name "Sardar"(Ref 23).

Farmers have observed several benefits from the use of LBFs.

1. The savings from not spending money on chemical fertilizers and carrier based bio-fertilizers can be used for other purposes by the farmer.
2. Yield increases of 7 to 8 percent in crops have been observed.
3. Liquid bio-fertilizers find wide application in drip irrigation and greenhouses, an area under which is increasing by leaps and bounds particularly in Gujarat. In addition, the operators in the production process, most of whom become asthmatic when producing carrier based bio-fertilizers, have observed health benefits, as the liquid bio-fertlizer is a harmless liquid.

Award of Excellence" by Federation of Gujarat Industry for Best work in Agricultural Development was received by Dr. R. V. Vyas, Res Scientist (Micro) and CPI, AAU BPDU and his associates on Liquid biofertilizer Technology at FGi Business Centre, Vadoadara on September 10, 2012. The Award was given away by Chief Minister of Gujarat State Mr Narendra Modi in esteemed presence of Mrs. Gitaben Goradia, President FGi and Mr. Vinod Rao, Collector of Vadodara.

Indian Council of Agricultural Research has recognized the efforts of developing and commercializing the efforts of Dr. R. V. Vyas and Mrs. H. N. Shelat and honored them with a certificate of Appreciation during 6th Regional Committee Meeting of ICAR held at Central Arid Zone Research Institute (CAZRI) Jodhpur, Rajasthan on 16th Nov. 2012 (Ref 24, 25)

Efforts in enhancing visibility and awareness building

Regional Industry meet

In its efforts to augment its relationship with the Agricultural Industry, AAU's BPD organized the first Regional Industry Meet (Western zone) at Ahmedabad Management Association, Ahmedabad in April 2012 in collaboration with Confederation of Indian Industry (CII). The purpose of the meet was to foster and strengthen linkages between public sector organizations in agriculture, especially State Agricultural Universities (SAUs) and Indian Council for Agricultural Research (ICAR) Institutes, and the agribusiness industries of the Western zone of the country. These linkages would support faster technology commercialization, boost agribusiness, and develop a permanent platform for industry to effectively and efficiently share knowledge, skills and resources available in the SAUs and ICAR Research Institutes, particularly in the Western Region.

The meet was organized around four major themes: 1) Crops and Horticulture; 2) Farm Tools/Equipment and Machinery; 3) Dairy and Veterinary; and 4) Fisheries and Food Technology. Over 270 stakeholders from industry, NGO, university and ICAR institutions of western India participated in the meet. An exhibition displayed various technologies of three Agricultural Universities of Gujarat and prominent centers of ICAR Research Institutes across the country in 15 stalls (see Appendix for a detailed list).

Inaugural function of SAU-ICAR-CII Regional Industry meet

Exhibition Inauguration of SAU-ICAR-CII Regional Industry meet(Ref 9)

Table: Promotional activities of AAU BPDU for PPP and TOT with industry sector

Date	Seminar/ Workshop	No. of Participants
07.10.10	Prospective Entrepreneurs and Stakeholders Meet (AAU, Anand)(Ref 8)	75
14.03.11	Technology Awareness and Commercialization Program in Dairy and Food Industry (AMA, Ahmedabad)	41
15.06.11	Technology Awareness and Commercialization Program in Veterinary Industry (AMA, Ahmedabad) (Ref 16)	40
09.12.11	Intellectual Property Rights meet	46
29.02.12	SFAC Agribusiness Camp (AMA, Ahmedabad)	90
29.06.12	AAU NGO Partnership Meet (Ref 5)	45

Impact

Farmer communities of Gujurat became aware of Anubhav liquid Biofertilizerby distributing liquid Biofertilizer amounting to 50,000 liters in 18,000 villages in Krishi Mahotsav (per farmers meet) during 2010-2012. This is a unique step that boosted the awareness of liquid bio-fertilizer among the farmers, decreased cost of cultivation by curtailing chemical fertilizer input cost, and generated awareness regarding environmental safeguarding. BPD clients have also done a very good business with our technology. First client M/s Kemrock licensed the Liquid Bio-fertilizer Technology from the subproject in 2011. The company has graduated and has launched the product in the market. The first year sale of the company was 13360 bottles @ Rs. 180 per bottle and hence total revenue accrued to the company in the first year was Rs. 2404800. In the second year the company has already sold 15046 bottles @ Rs. 180 per bottle and hence revenue in the second year is Rs. 2708280. Total Revenue= Rs.5113080. Second client, Gujarat Agro Industries Corporation (GAIC) has supplied 50,000 bottles to Krishi Mahotsav program apart from regular sale from its depots.

The tissue culture in date palm technology awareness, advertising and promotion has been done on large scale, not only in Gujarat but also in other states. This has led to extensive inquiries from Gujarat and elsewhere including those from Karnataka and Andhra Pradesh. Finally AAU BPDU has been able to strike a deal with a company from Secundrabad (southern part of the country) to transfer the technology in a phased manner.

The consultancy service offered by the BPD Unit has made a great impact. Our first consultancy assignment with Marshall Breeders for establishment of Animal Biotech Research Centre (for poultry breeding at Nasik) has apart from generating employment, led to the expansion of the company’s business in foreign markets. Another consultancy assignment has been completed successfully with Shree Nijanand Dairy Farm, Simarda, Petlad (Anand). The entrepreneur is making *paneer* from cow milk with a high recovery percentage using improved AAU know how and supplying to hotels in Petlad and Anand. It had become a new delicacy for people in the area.

Another major area of BPD impact has been awareness creation about the BPD Unit itself as well the technologies and services of AAU. Until now, the BPD Unit has attended more than 200 walk-in inquiries and has catered to 37 who have become our registered members. On the innovation nurturing front, AAU BPD Unit has organized three innovators meetings and forwarded six agri-innovations for funding support to Ministry of Micro, Small and Medium Enterprises after final screening to commercialize these innovations. There has been an increase in entrepreneurship and employment through startup ventures and MoUs with industry for AAU technologies (Ref 27). Readers can learn about the AAU BPD Unit online at: http://www.aaubpd.com and the AAU at: http://www.aau.in

References and further reading

1. Baljeet Singh, R. V. Vyas, Saiyad M. Iqbal and Rachana M. Shukla (2011) Agribusiness Incubation and Agro-technology Commercialization, *Enhancing Organizational Growth Through Innovation and Creativity-Issues, Opportunities and Challenges,* Excel Publishers, New Delhi.
2. Project Implementation Plan for NAIP (2006), Indian Council of Agricultural Research (ICAR) PIU-NAIP, Krishi Anusandhan Bhavan-II, Pusa Campus, New Delhi.
3. Nushad P., Baljeet S., Iqbal M., Vyas R. V (2010) Business Planning and Development : A Flagship Unit for Agri Business Growth in Western India, Readers Shelf Volume No. 6, Issue No. 10, July 2010
4. Baljeet Singh (2012) Business Incubation in Agricultural Biotechnology, Readers Shelf, December 2012, pp 5-6
5. R. V. Vyas (2012) BPD activity-AAU NGOs Meet, AAU Newsletter April-June 2012 pp 7
6. R. V. Vyas (2010) World Bank and NAIP team visits Anand: Short term Review of NAIP Sub Projects, AAU Newsletter, April-June 2010 pp
7. R. V. Vyas (2010) MoU between AAU and Marshall Breeders: A success story of BPD, AAU Newsletter April-June 2010
8. R. V. Vyas, H N. Shelat (2010) Perspective Entrepreneurs Meet, AAU Newsletter Oct-Dec 2010
9. R. V. Vyas, HN shelat(2010) AAU participates in ICAR Industry Meet, AAU Newsletter, April-June 2010
10. R. V. Vyas, HN Shelat (2010) Got an Agribusiness Idea: AAU to help, Times of India 21.10.10
11. Sunil Patel, R. V. Vyas, HN Shelat (2010) Automated Halwasan Making Machine, Times of Anand 23.10.10
12. R. V. Vyas, HN Shelat (2011) AAU Inks Pact with Anand's Kemrock Agritech Times of India 20.1.11
13. Sunil Patel, R V Vyas, HN Shelat (2009) AAU for Patent of Mechanised Basundi, Indian Express 26.5.09
14. R. V. Vyas, HN Shelat: (2010) AAU Signs MoU with Kemrock for Liquid Biofertilizer Technology Comercialization, Ahritech India, April 2011 pp9
15. Subhash N, R. V. Vyas, HN Shelat (2011) Tissue Culture for Date Palm Developed, Sunday Times of India 8.5.11
16. R. V. Vyas, HN Shelat (2011) AAU Organizes Awarness Program for Veterinary Industry, Indian Express, 22.6.11
17. R. V. Vyas, HN Shelat (2011) AAU commercializes Liquid Biofertilizer Technology, Intellectual Property Writes: IP News Bulletin 5, CIFE Mumbai March 2011 pp3
18. R. V. Vyas, HN Shelat (2011) AAU GSFC Launch Liquid Biofertilizer, Business Standard 29.6.11
19. R. V. Vyas, HN Shelat (2011) AAU and GSFC Joined Hands for Liquid Biofertilizer Technology for Gujarat Farmers, Indian Express 29.6.11
20. R. V. Vyas, HN Shelat (2011) GSFC, AAU Sign Agreement, Times of India 28.6.11
21. R. V. Vyas, HN Shelat (2011) Gujarat Haryana Varsities to Exchange Agri Technology, Times of India 15.10.11
22. R. V. Vyas, HN Shelat (2011) Nijanand Dairy and AAU, Times of Anand 25.8.11
23. R. V. Vyas, HN shelat (2011) GSFC to Set Up Bio Complex for Liquid Biofertilizers, Business Standard 7/8 January 2012
24. R. V. Vyas, H N Shelat (2012) Indian Council of Agricultural Research Honors Anand Agricultural University Scientists for Liquid Biofertilizer Tech, Times of India 20.11.11
25. R. V. Vyas, HN Shelat (2012) AAU Scientists Honored for Liquid Biofertilizer Tech, Times of India 21.11.11

26. Baljeet Singh, Sunil Patel (2012) Viable Dairy Technologies for Commercialization from AAU BPD Unit, Seminar Proceedings (Abstracts), National Seminar on IT Mediated and Technology Driven Agricultural Development June 20-21, 2012
27. Baljeet Singh (2012) Agri Preneurship: the Role of Agri Business Incubators-Emerging Paradigms in Business Ethics(book) pp 155-158
28. M C Varshenya (2009) From the Vice Chancellor's Desk, AAU Newsletter, Oct-Dec,2009 pp-1

Appendices

Table 1. Hybrids/varieties of crops released from AAU for Gujarat state

Name of the Crop	Name of Variety	Year of release	IC No.	Notification no.
Potato	JH 222	1991		
Okra	GOH 1	1992		
Eggplant	AHB 1	1993		115(E) 10-2-96
Amaranths	GA1	1994		527(E) 16-08-1991
Eggplant	GBH-2 (ABH-2)	1995		
Chili	GC-2	1996		
Eggplant	AB 1	1997		
Okra	GO 2	1999		1135(E) 15-11-2001
Garlic	GG 3	2000		
Onion	GWO	2000		
Indian Bean	GIB 1	2000		
Eggplant	GBH 2	2001	296412	642(E)31-5-04
Eggplant	GBL 1	2001	296049	448(E) 21-4-03
Tomato	GT 1	2002	298411	
Chili	GVC 111	2003	471191	597 (E) 25-4-06
Eggplant	GOB 1	2004	471186	597 (E) 25-4-06
Tomato	GT 2	2004	471187	597 (E) 25-4-06
Musk melon	GMM 3	2004	471188	597 (E) 25-4-06
Cucumber	GCU 1	2004	471189	597 (E) 25-4-06
Chili	GVC 101	2004	471190	597 (E) 25-4-06
Chili	GVC 121	2004	471192	597 (E) 25-4-06
Sponge Gourd	GSG 1	2005	566555	597 (E) 25-4-06
Bottle Gourd	ABG 1	2005	546535	
Chili (NP)	AVNPC 131	2007	553034	
Cowpea	AVCP 1	2007	553035	
Pigeon Pea	AVPP 1	2007	553036	
Musk melon	GMM 3	2008	471188	
Tomato	AT 3	2008	573504	
Pumpkin	AP 1	2009	573503	
Ridge gourd	GARG 1	2010	587023	
Chili	GAVC 112	2011	590084	
Okra	GAO 5	2011	590085	
Chili	GAVCH 1	2011	590127	
Chili	GAVC 112	2012		
Tomato	AT 4	2012		

Between 1991-2012, 35 vegetable crop varieties have been released: 1 Amaranth, 1 Bottle Gourd, 8 Chili, 1 Cowpea, 1 Cucumber, 6 Eggplant, 1 Garlic, 1 Indian Bean, 2 Musk melon, 3 Okra, 1 Onion, 1 Pigeon Pea, 1 Potato, 1 Pumpkin, 1 Ridge Gourd, 1 Sponge Gourd, and 4 Tomato.

Table 2. Registration obtained under PPVFR for the following hybrids/varieties of crops

Crops	Varieties/Hybrids	Submitted Through
Maize	GM-1, GM-3, GM-4, GM-6, Narmada Moti	Project Director (Maize), ICAR
Rice	GR 103 (Mini Mussouri), Gurjari, GR-7	Director of Research, AAU

Table 3. AAU Technology Basket for Agri-Entrepreneurs:ble 3a. AAU Technologies - Commercialized

Sr No.	Name of the Technology	Commercialized to company / firm/ progressive farmers
1.	Liquid Bio- Fertilizers (Ref 18)	Kemrock Agritech Private Ltd., Asoj, Vadodara, Gujarat
		Gujarat State Fertilizer and Chemicals Ltd., Vadodara, Gujarat
		Gujarat Agro Industries Corporation Ltd. Ahmedabad, Gujarat
2.	Probiotic Lassi	MILMA, Calicut, Kerala
3.	Dietetic / diabetic frozen dessert	Sudha Dairy, Patna, Bihar
4.	Technology for production of dehydrated Spinach / Fenugreek / Coriander leaves	Shri Rajnibhai C Shah, Vallabh Vidhyanagar, Gujarat
5.	Production of Biogas by addition of castor cake	Muni Seva Ashram, P.O. Goraj, Ta. Waghodia-391760,Vadodara,Gujarat
6.	Water Recovery Technology from Spent Gobergas Slurry	R C Jain, Agromen Herbals, Dugli, Dist- Dhamtri, Chhattisgarh
7.	Brinjal Seed Extractor	Dogma Industries, Vitthal Udyognagar, Gujarat
8.	Instant Tur Dal Powder	Many beneficiaries
9.	Roughage Block Making Machine	
10.	Mechanized Roughage Baler	
11.	Tomato / Lime seed Extractor	
12.	Chilly Seed Extractor	
13.	Seed Pelleting Machine	
14.	Vanspati Ghee Biogas plant / Compact Model of Biogas plant	
15.	Multi Utility Elevator Platform	
16.	Aonla Shredding- cum-stone Extracting machine	
17.	Low cost Evaporative Cooled Storage for Perishables	
18.	Technology for production of dehydrated Aonla Flakes	

Table 3b: Technologies Ready for Commercialization

Sr no.	Name of the technologies
1.	Anubhav Liquid Bio Fertilizer (Ref 17)
2.	Tissue Culture protocols for Date Palm (*Phoenix dactylifera*) , Pointed Gourd (*Trchisanthes dioca*) , Spine Gourd (*Momordica dioca*), Stevia etc.; Potato Micro tuber Protocol (Ref 15)
3.	Anubhav Seeds and seedlings (Horticultural and Medicinal Crops etc.)
4.	Biodiesel production line
5.	Continuous Basundi (sweetened dense milk dessert) Making Machine (Ref 13)
6.	Batch Type *Halwasan* Making Machine (Ref 11)
7.	Probiotic lactic cultures for dairy products (human health) (Ref 26)
8.	Twin Cylinder Scrapped Surface Heat Exchangerfor making Traditional Indian Sweets (Ref 26)
9.	Anubhav Area Specific Mineral Mixtures for Animals
10.	Microwave puffing of Rice for instant *Mamara (locally popular snack made from rice)* production
11.	Technology for production of dehydrated Ginger flakes / basil powder
12.	Technology for production of carotene rich pumpkin powder

13.	Production technology for ready to serve unripe mango beverages (Panna)
14.	Evaporative cooled transportation system for fruits/vegetables and other perishable commodities
15.	Pre-cooling protocols for fruits & vegetables for delaying ripening and extending their shelf life
16	On farm post-harvest activity hut for easy handling, sorting, grading and intermediate storage of fruits and vegetables

Table 3c: Technologies in the pipeline

Sr no.	Name of the technology
1.	Consortium of PGPR for N and P augmentation having additional biological control potential
2.	Anubhav Bio-degradation consortium for fortification of organic manure/ agricultural wastes
3.	Safed musli (a medicinal plant), Bamboo and Sandal Wood Tissue Culture Protocols
4.	Medicinal and aromatic plants based products
5.	Improved hybrids and varieties of field and vegetable crops
6.	Characterization of genes involved in disease resistance
7.	Shrikhand (a locally popular savoury preparation from curd and sugar) Making Machine
8.	Improved Animals (Goat) having more meat content through RNAi technology
9.	Whole genome sequencing method- Pyrosequencer
10.	Identification of species of meat samples by molecular genetics techniques
11.	Development of DNA based diagnostic test for livestock diseases.
12.	Screening of breeding bulls for chromosomal aberrations karyotyping
13.	Pumpkin powder based carotene enriched nutritional food products
14.	Mechanized line for raw mango pickle production
15.	Production technology for nutritive fruit bars
16.	Production technology for bottled / canned fruit juices / drinks
17.	New nutritional rich food products for different target groups
18.	Production technology for dried fruits, vegetables and spices powder
19.	Production technology for bottle-gourd juice
20.	Production technology for wheat grass juice
21.	Mechanized production line for *kaju khatri (locally popular savoury prepared from Cashewnut , milk and sugar* type of sweet

Showcase of technologies in the SAU-ICAR-CII Regional Industry meet

1. **Anand Agricultural University**: Liquid Biofertilizers, Area Specific Mineral Mixture for livestock, Dairy Technologies, Tissue Culture Plants etc.
2. **Navsari Agricultural University**: Composting from banana waste, Fruit processed products, Low Cost Farm Machinery, etc.
3. **Junagadh Agricultural University**: Promising Groundnut, Pearl Millet, Castor, Wheat, Chickpea, Custard Apple, Soy Bean, Sponge Gourd.
4. **National Research Centre for Groundnut**, **Junagadh**: IPM in Groundnut, PGPR a new Biofertilizer for higher productivity, Castor cake- a boon to farmers for managing soil borne diseases, combating yellowing in rain-fed groundnut, low cost and non-monetary input technology for groundnut, Production of amylases from de-oiled groundnut cakes, Cellulase from groundnut shell, Proteases from De-oiled Groundnut Cakes, Paired Row Planting for Rain-fed Groundnut, Criss Cross Method of Sowing for Post Rainy season, Enhancing Water Productivity through Efficient Irrigation Scheduling and Bird Paradox.
5. **Directorate of Medicinal and Aromatic Plants Research**, **Boriavi**: Aonla juice, *Aloe vera* juice, Medicinal Plants, Fruits, Seeds, Roots, Essential oils, etc.
6. **Indian Agricultural Research Institute, New Delhi** (Crops): Pusa Fruit Drinks, Nano formulations of Bioactive Compounds, Promising Wheat and Rice Varieties, Azadirachtin Bio-formulations, Dehydrated Mango Slices, Nutraceutical Based Products.
7. **Indian Institute of Horticultural Research, Bangalore** (Horticulture): Fruit beverages, Osmo air dried fruits, Dry flowers, Arka Swadesh Rose Variety, Arka Anand and BLPH-1 Brinjal, Arka Sphoorti and Arka Vimal Cauliflower, Production technology of Arka Fermented Coco Peat, Fruit Fly Pheromone Trap, Arka Tejas

Carnation, Nursery machinery, Arka Bheem Onion, Sowing and Transplanting Machinery, Mushroom Spawn Production Machinery, Osmotically Dehydrated Fruit Slices, Crushed Tomato, Individual Shrink Wrapping of Pomegranate and Sweet Oranges.

8. **Indian Veterinary Research Institute, Izatnagar, UP** (Dairy and Veterinary): Value added dairy and meat products, diagnostic kits, etc.
9. **Central Institute of Fishery Research Institute, Cochin** (Fisheries and Food Technology): Wooden Fishing Vessel, Turtle Extruder Device, Retort Pouch Packed Fish Products, Chitin/Chitosan from Prawn Shell Waste, Glucoseamine Hydrochloride, Fishkure etc. Area Specific Mineral Mixtures for Livestock.
10. **Central Institute of Cotton Research & Technology, Mumbai** (Farm Implements and Machinery): Variable Speed Double Roller Gin, Kraft Pulp from Cotton Stalk, Biogas from textile Mill Waste, Compost from Cotton Willow dust, Oyster Mushroom from Cotton Stalk, Microbial Cellulose.
11. **Feedback and channel desk** of BPDU, AAU, Anand.

Private organizations participated:

12. **CII:** Recent Programs done and Focus Areas.
13. **Essen**: Mulch films, Green House Drainage Sheets, Suncool Multilayer Agri Films
14. **CIAE** (Farm Implements and Machinery).
15. **Mahyco Monsanto Biotech** (India) Limited: Bollgard and Bollgard II

Chapter 5. Enabling Public Private Partnership through technology Licensing in Horticultural Crops

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Innovative scientific knowledge, packaged as 'improved technology' has well been acknowledged as a critical input for efficiency and productivity enhancement and an important attribute to a country's economic growth (6,7). Protecting such innovative knowledge, through Intellectual Property Rights (IPR), especially as patents, copyrights, and industrial designs has also been accepted by research institutes and universities world over as a powerful tool that helps improvise and commercialize research results (World Bank 2009). Promoting creativity and innovation through intellectual property policies have been emphasized in several forums, including the World Intellectual Property Organization's (WIPO's) development agenda (8).

Though innovation, technology transfer, and linkage with industry have been practiced in a number of high income countries for long, it is the passing of the Bayh-Dole Act in the USA in 1980 that triggered a paradigm shift in innovations across countries world over, the results visibly amplified by 2000. Emulating the USA's Bayh-Dole Act and other similar Intellectual Property (IP) policies, a number of middle and low income countries, have been compelled to initiate policies to strengthen their Intellectual Property Rights (IPR) under the WTO-led new world order. Globally, technology transfer policies have been recognized to provide publicly funded research organizations the power to accelerate transformation of scientific discoveries into industrial applications. Operationalizing initiatives such as assigning IPR to research institutions or universities and creating technology transfer offices, incubation facilities, technology parks, collaborative research facilities or consortia etc., involve modifying the exiting legislature and creating a whole new system of governance (9), which has been accepted and intitutionalised by a number of countries including India by early 2000.

The Indian council of Agricultural Research (ICAR), the apex body for all agricultural R&D in the country adopted its Intellectual Property Rights policy by 2006, there by initiating a paradigm shift in technology transfer and commercialisation efforts of over the 96 R&D institutions under its purview.
Horticulture being the most important sector of Indian economy offers wide scope and exhibits huge potential for technology commercialisation. Closely following the guidelines provided by ICAR, the Indian Institute of Horticulture Research (IIHR), a premier horticultural research institute in India also has initiated technology transfer through licensing since 2007-08 and a Horticulture Technology Management, Business Planning and Development (HTM-BPD) facility since June 2013. The models adopted in technology licensing, experiences and the lessons learnt by IIHR form the focus of this chapter.

Brief background of the Institute

Indian Institute of Horticulture Research (IIHR), Bangalore, a premier research institute under the aegis of Indian Council of Agricultural Research (ICAR), New Delhi, was established in 1968. At present, the institute with its 11 divisions, 4 sections, three sub-stations and two Krishi Vigyan Kendras (Farmer Knowledge centres), is the home for around 131 dedicated researchers contributing for the upliftment of small and marginal producers and entrepreneurs of fruits, vegetables, ornamental, medicinal and aromatic crops and mushrooms. The mission of the institute is achieving sustainable development of horticulture while providing livelihood security, economic growth and nutritional security through research efforts in fruits, vegetables, ornamentals, medicinal and aromatic plants and mushrooms.

The institute's Mandate is to undertake basic and applied research for developing strategies to enhance productivity and utilization of tropical and sub-tropical horticulture crops, serve as a repository of scientific information relevant to horticulture, act as a centre for training for up gradation of scientific manpower in modern technologies for horticulture production and Collaborate with national and international agencies in achieving the above objectives (4).

The institute addresses the research, education and extension issues of major horticultural crops aiming at enhanced productivity, profitability and sustainability for all horticultural crop stakeholders. In the last four decades of its existence, the institute has developed sound infrastructure and human resources capable of addressing the emerging challenges in horticulture. The technological contributions of the institute include: over 210 improved varieties and hybrids , biotic and abiotic stress tolerance packages, improved crop nutrition packages, post-harvest technologies, biotechnology and engineering solutions . The institute received 'the Best' research institute award twice, in 1999 and 2011.

Technology Transfer Policy

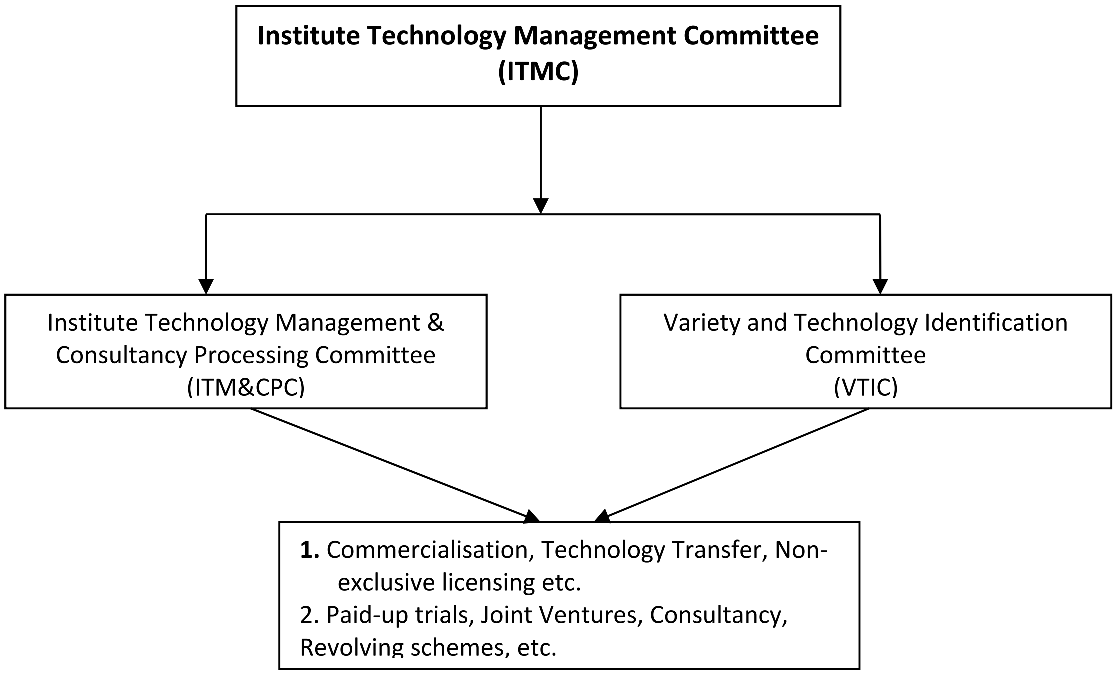
Pre-IPR Policy Period

Prior to adoption of Intellectual Property Rights (IPR) policy, research institutes under National Agricultural Research System (NARS) supplied breeders' seed to public and private sector seed multiplication centres and nursery men at pre-determined (nominal) prices according to their requirement. The public sector state agencies multiplied the 'breeders seeds' on their own facility or on selected farmers' fields for a fixed price and obtained the certified seed, which was then distributed to different states according to their pre requested indents. The private seed companies and few large nurseries purchased vegetable varieties and hybrid seeds from public sector research stations and multiplied them for commercial sale. This model ensured the primary objective of adequate supply of seeds, while the system did not provide quality assurance or the breeders any claim or right over the intellectual property or innovations of their research. The system thus does not address the issue of sustainability or quality assurance. Germplasm collection, conservation and utilization form an important mandate of research for a number of ICAR institutions. It is beyond doubt that such collections made by ICAR researchers provide valuable base material for crop improvement, which gets into the main stream of breeding programme and to the private sector research through various research programmes, through the All India Coordinated Research Programmes (AICRPs). Germplasm collection, evaluation, characterization, screening for biotic and a biotic stress factors and utilization have been major contributors of the crop improvement and disease resistance breeding programmes of the publicly funded research institutions under the NARS (2).

The value of the germplasm, thus collected or the actual costs involved in the process of evaluation and selection have not been assessed and quantified. Research publications in refereed journals and citation indices have been the major source of recognition for the researchers' intellectual contribution. Further, the adoption pattern, research impact due to direct or indirect adoption of technologies could not be assessed by the publicly funded research institutions under the above discussed model, leading to grave under valuation of the contributions of public sector R&D efforts. Barring few cases of wide spread adoption and associated visible monetary gains as has been documented, viz., 'Dogridge' root stock technology adoption' in grapes, adoption and impact of variety 'Arka Manik' in watermelons, adoption of a specific variety in tomatoes, to name a few, much of the effort by the public research went either undervalued or unnoticed. Unlike the West, which adopted stringent intellectual property regimes for both sexually and asexually propagated plant material and gained IP revenue from commercialization of their research efforts as early as the 1930s, India, similar to its other developing country counterparts did not have clearly defined IP policy until 2006. ICAR's decision to adopt its Intellectual property guidelines w.e.f 2nd October 2006 earmarked the beginning of a new era in the history of ICAR and India's agricultural R&D scenario.

Post-IPR Policy

In the post IPR policy regime, adopting the ICAR's intellectual property guidelines, research institutes under its purview are eligible to initiate commercialisation of technologies through licensing. A total of 25 research institutes representing different crops have been identified by the Intellectual Property and O management (IP and OM) section of the ICAR for setting up institute level Intellectual Property Management offices.



At IIHR, the Institute Technology Management Committee (ITMC) is the appellate authority of the technology commercialization processes, while the Institute Technology Management Unit (ITMU) is the functional arm that identifies the technology suitable for commercialisation; provides guidance to the innovators in all matters concerning intellectual property protection and commercialization activities (5). The IP management structure under ICAR and that of IIHR is represented as shown in Figure 1.

Stringent guidelines are applied for identifying technology for commercialization by the ITMU, as has been outlined in Figure 1. All technical know-how, including the improved varieties, hybrids, post-harvest technologies, biotechnology processes or products, etc., get screened by the institute's Variety and Technology Identification Committee (VTIC). VTIC, after approval, forwards all those which hold potential for commercialization to ITMU. The ITMU then assesses the strength and potential of all such technologies, deliberates with the innovator and his team arrives at the possible offer price, and the possible strategy for commercialization and IP protection. The technology profile, details of the innovation and the team, provided in a 'technology disclosure form,' is maintained under strict confidentiality by ITMU. The technology commercialization is then arrived at adopting different strategies.

Given the complexity of the diverse crop groups and their seed or planting material, IPR cell of ICAR also set in motion different models for commercialisation of technologies through licensing. Sub-licensing of technologies or technical know-how would help ICAR institutions to ensure adequate supply of the technology with assured quality, yet retain the institute's identity and ownership rights over the disseminated technology and technical know-how.

ICAR and research institutes under its purview strictly adhere to the policy of non-exclusiveness and allow equal opportunity for all interested parties irrespective of size or volume of business handled.

Technology commercialization process as per the guidelines spelt out under the ICAR's IP policy, comprises:

- Transfer of physical or material component of the technical know-how in the form of seed, planting material or any other input, all of it or a part of it be provided in quantity required for a standard unit (one acre).
- The technical knowledge or package of practices for its cultivation and production provided as training for the licensee.
- An upfront payment of fixed amount as the technology license fee.
- An annual royalty component, which varies from 2 to 5 percent of the gross/net realization from the sale of the technology by the licensee.

In most cases, the license is for a period of three years, renewable after a review. Depending on the technology in question, the licensee needs to approach the institute or innovator for fresh seed lot or part of the technical know-how every year so as to ensure quality of the technology disseminated. The sole proprietary right over the technology or the IPR lies with ICAR/ Institute.

It is mandatory for the parties involved to sign a Memorandum of Understanding (MOU) that specifies the terms and conditions of the license agreement on ownership of the intellectual property, non-transferability of the agreement, indemnity and dispute settlement procedures. The licensee agrees to use the name and logo of the institute in all sales of the licensed produce.

IPR Cell and BPD Unit and technology transfer mechanism

Though the potential and uniqueness of the horticultural crop technologies has well been recognized, an exclusive Business Process Development facility for horticulture is under active consideration and will be accorded in 2013 with a proposed budget of over Rs. 4.00 crores. The HTM-BPD at IIHR would primarily focus on:

- Identifying innovations with potential for commercial application and facilitate technology innovations and protection process.
- Facilitating business process development and market potential of technologies.
- Facilitate the process of technology up-scaling and incubation until take-off.

The main objectives of the HTM-BPD would be:

- Technology commercialisation through incubation for horticultural production systems.
- Enterprise and entrepreneurship development in horticultural production systems.
- Capacity building and imparting consultancy skills for horticultural crop-based entrepreneurs.

HTM - BPD Unit at IIHR will be a gateway to the huge scientific, technological and infrastructural resources of horticulture. The incubation facility promises easy and quick access to the huge potential of technologies with low transaction costs through the BPD's pre-negotiated standard contracts, confidentiality and intellectual property agreements. The BPD also would provide incubation services for individual entrepreneurs, start-ups and companies seeking reliable advice, consultancy on all verticals of horticulture, access to infrastructure facilities, business development, market access, financial services, mentoring, networking and partnerships with the institute.

The IIHR - BPD proposes to offer exciting opportunities for horti-business across the value chains from technology transfer, training, access to infrastructure, business development service, financial assistance through production and processing to marketing assistance in five thrust areas which have attractive business prospects namely;

- Seed and planting material
- Plant health management

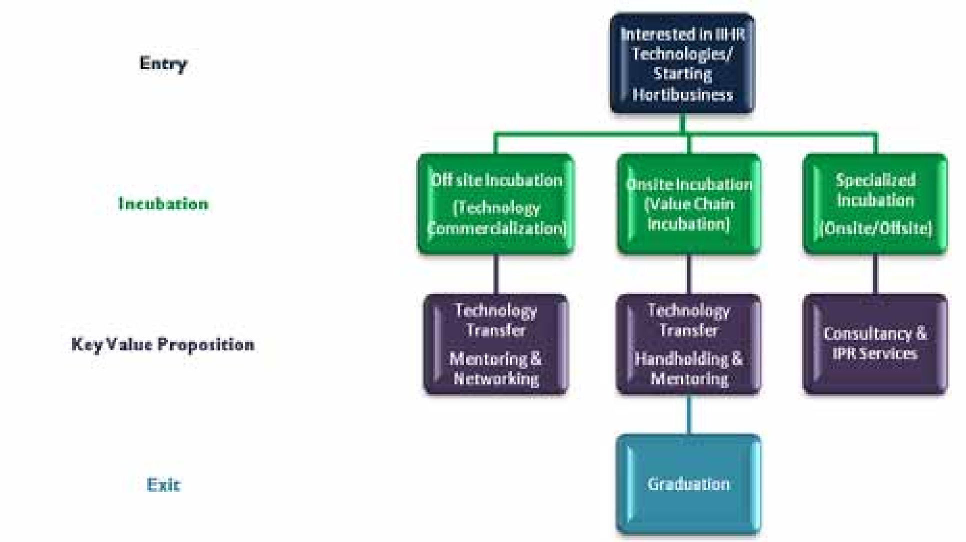
- Post-harvest technologies
- Farm machinery and implements
- Biotechnology

Incubation model
The HTM-BPD would have a three-pronged incubation model for enthusiastic entrepreneurs. These include the off-site incubation, the on-site incubation and specialized incubation facilities.

Off - site incubation. Off site incubation facility includes Technology Commercialization through licensing along with professional hand-holding till the entrepreneur stabilizes his or her business. The services offered under this model include scientific support for production and testing, mentoring and advisory on financial and socio economic feasibility study, scientific support and technical consultancy, marketing assistance and business facilitation, etc., at the site where the incubatee proposes his or her enterprise.

On – site incubation (value chain incubation). This would provide access to business-ready innovative technologies and processes for horticulture-based businesses. This form of incubation proposes to provide scientific support for production and testing, infrastructure facilities such as office space, production facility on the institute's premises, besides the usual business promotion activities, mentoring and advisory services, scientific support and technical consultancy, marketing assistance and business facilitation. These facilities would be provided at a pre-fixed rate.

Specialized incubation. The HTM-BPD also would service other forms of incubation that are specialized in nature, such as technology and product validation and development, research collaboration and field trials. The BPD also would facilitate **IPR Services** that include Patent Search and Patent filling.



Membership
Entrepreneurs and companies enroll themselves as members categorized under five categories to avail horti-business Incubation services depending on their specific needs and their status as individual growers or entrepreneurs; group of farmers and self-help groups, Non-Government organizations, small scale companies or large national companies and international institutions.

Focus sectors
The HTM-BPD's Technology or technical know-how focus for licensing and incubation from IIHR falls under the following categories.

Seed and planting material. Includes the seeds of improved varieties, hybrids of all horticultural crops; 'advanced breeding lines' a rich source of special characteristics in purified and non-segregating form.

Plant health management. Technologies specializing in protecting crops from pests and diseases are being commercialized. This includes mass production and supply of mother cultures of microbial bio-control agents like *Pseudomonas fluorescens. Trichoderma harzianum, Trichoderma viridae Paecilomyces lilacinus and Pochoniachlamydosporia.* Cost-effective, eco-friendly pheromone traps for monitoring fruit flies as a part of Integrated Pest Management (IPM) in mangoes also falls under this category. Apart from this an alternative to synthetic chemical insecticides, a botanical formulation called Neem soap and Pongamia Soap, that are effective on DBM in cabbage and cauliflower, serpentine leafminer, red spider mites, etc., have been included under this category.

New microbial plant growth promoter-Seed Pro and Sealer cum healer for mango trunk borer management have recently been introduced under this theme area and is in the process of commercialization.

Four types of crop specific micronutrient supplements that include Banana Micronutrient Formulation, Vegetable Micronutrient Formulation, Mango Micronutrient Formulation and Citrus Micronutrient Formulation are also included under this category. These micronutrient formulations enhance fruit quality in terms of fruit appearance, fruit keeping quality and taste.

Agricultural engineering. Machineries which reduce manpower and saves time are included. The section of agricultural engineering has developed machine designs for nursery, transplantation, picking industry, mushroom spawn production and fruit harvesting.

Biotechnology. Seedless watermelon, micropropagation protocols for ornamental plants like Anthurium, Gerbera, Orchids, Tuberose, Hippeastrum, and Chrysanthemum. Micropropagation protocols for horticultural plants like male sterile line in cauliflower, pointed gourd, tissue culture protocols and gene constructs have been developed by the division of biotechnology. Technologies like Sachet techniques for the low scale acclimatization of micropropogated plants, Endomycorrhizae also known as Vesicular ArbuscularMycorhizae (VAM) are also included in this group. Recently SSR Markers for Okra has been commercialized under this theme area.

Post-harvest technologies. IIHR does not focus only on increasing the yield and disease management, but has innovations in preventing post-harvest loss and value addition to harvested produce. The division of PHT has enhanced the quality of products and know-how of many readily usable technologies to increase marketability of the produce have been developed thereby reducing the post-harvest loss in horticultural products that perish easily. These include Osmotic dehydration (OD) technology for amla, mango, pineapple and papaya. Ready to Serve (RTS) fruit beverages and squashes, watermelon rind candy, watermelon rind pickle and crushed tomato are some of the technologies also included. Besides these, a unique technique for drying of flowers for increasing shelf life is also available at the institute.

Besides the technologies and technical know-how, the institute also provides the following support services for all stakeholders involved in horticultural crop production, marketing and processing.

Public private partnership models adopted by IIHR while commercialization

Technology commercialization through licensing is one way of strengthening public private sector partnership. Since public sector is not equipped with mandate or infrastructure to undertake mass multiplication of seeds and planting material, it could be licensed to private sector institutions that are equipped to carry out the same, creating thereby a win-win situation for both. Few public sector organizations also could undertake the mass multiplication and ensure the quality supply of planting material in requisite quantity, adding value to the efforts put forth by scientists. As a premier research organization, holding a mandate of service to the resource poor, IIHR has been evolving Public Private Partnership (PPP) models befitting the basic mandate of the institute. As a policy, the institute's ITMU permits licenses operational within Indian Territory only at present. The following section provides a description of various such models and the problems and prospects associated with them **(10**).

Technology licensing directly to private seed / other product companies

IIHR has been successful in licensing some of the advanced breeding lines and specific traits such as 'male sterility' in vegetables that help reduce the breeding time, to a number of private seed companies. IIHR being a premier research institute having long-standing in the field has been a repository of acquired rare and valuable germplasm in a number of horticultural crops. The research efforts of the eminent scientists has also helped in developing advanced breeding lines in specific crops having 'male sterility' associated with specific disease resistance characteristics. The pure line selection and standardization of such advanced breeding lines are of immense value for the private sector seed industry for reducing the time taken for production of hybrids and high yielding types. The institute has licensed such technologies in capsicum, okra, tomato to name a few and has earned to the tune of Rs. 4.5 million from the non- exclusive licenses it has granted to over 15 private seed companies in the last two years. ITMU ensures appropriate MoU, upfront payments, royalty and other essential features for safe guarding the interest of the scientists. IIHR also has assigned licenses to private product manufacturers, such technologies that can be directly produced on commercial scale. These include the products such as post-harvest technology products, agricultural engineering designs/circuits, etc.

Technology licensing to private sector organizations through a public sector mediator

Technology innovations that solicit stringent IP protection, such as patents, demand financial back up. Some of the technologies or technical interventions could be simple but may not have easy access to the interested entrepreneurs for immediate commercial production. IIHR adopted the strategy to assign such technologies to a public sector agency that acts as a 'mediator' in identifying potential partners for patenting and mass multiplication and commercialization. The National Research Development Corporation (NRDC), New Delhi, India has been an effective mediator for number of technologies for commercialization. IIHR has an MOA with NRDC valid for five years. ITMU in consultation with the innovator assigns technologies to NRDC on individual case by case basis either for filing for appropriate IP protection or for commercialization. NRDC assists the institute in tracking down the entrepreneurs' sales, turn over and royalty collections, etc., the total emoluments so collected are then shared in the ratio of 70:30 between the Institute and NRDC. IIHR has been able to commercialize more than 7 technologies through NRDC in the last two years. The fact that NRDC has been able to obtain patents for specific innovations and also identify firms that have commercialized products has helped IIHR improve its visibility in the market.

Technology licensing directly to other public sector organizations

Keeping in view the primary mandate of the institute to ensure adequate supply of seed and planting material and other technologies at affordable prices, IIHR adopts a policy of licensing its technologies directly to other public sector organizations like the National Seeds Corporation (NSC) and KrishiVigyanKendras (KVKs). ITMU also has developed appropriate memorandum of understanding to be executed between two public sector organizations while sharing technical knowledge or collaborative research that could involve intellectual property rights.

Other partnership models

Technology commercialization being a continuous process evolving over a period of time, institution need to keep up abreast with innovative means of arriving at partnership models. Some of the technologies warrant generation of authentication data sets, regulatory and bio safety data sets that require technical skills as well as financial support, the partnership models would need special case specific clauses that safe guard the interest of the parties involved. Though standard formats are available, case specific changes need to be made while entering into such agreements.

Criteria and considerations adopted in technology commercialization

The Institute's Technology Management Unit ensures stringent criteria and considerations while entertaining any technology commercialization processes. Technologies are thoroughly discussed and deliberated at the variety and technology identification committee prior to being considered for commercialization.

- Varieties, hybrids and other seed material are ensured to meet the Distinctiveness, Unique and stable (DUS) criteria prescribed and are registered at an appropriate appellate body such as PVP and FR or NBPGR.
- Technology licensing is complete only when the parties concerned have entered into an MoU which is thoroughly deliberated, scrutinized and tailor made for individual cases and agreed upon by both the parties; the relevant seed or material is supplied in adequate quantity.
- All technology licenses are granted for individuals or companies of Indian origin or have offices in India and the license granted is permissible only within the Indian Territory.
- The Institute holds all rights on the technology generated and licensed by its scientists.
- ITMU in consultation with the innovator arrives at the 'price' chargeable for a specific technology or technical know-how. The ITMU/ ITMC however holds the power to charge differential prices under different models of PPP keeping in view the institute's primary mandate.

Success stories of technology commercialization

IIHR in the last three years has licensed more than 44 technologies on non-exclusive basis to several private seed companies, public, private sector organizations and small scale entrepreneurs. The commercial productions of some of these products by the licensees has not only enhanced the supply and availability of these products to all stakeholders, but have also enhanced the visibility of the institute.

Case study 1: Arka Banana Special

A crop specific foliar nutrient formulation, 'Arka banana special' is one of the pioneer technology emerged out of research from the Division of Soil Science and Agricultural Chemistry of IIHR during 2005. The foliar formulation is a nutritional supplement, designed using a specific combination of micronutrients to boost the banana crop yield. As the term suggests, it has to be sprayed onto the leaves at specific plant growth period in prescribed dose. Experience of the farmers who have used the product indicates a definite 20 % yield (in terms of bunch weight) enhancement along with improved quality. This has resulted in the banana farmers realise up to 24% overall gain (higher net returns) from the adoption of this technology. Since, IIHR has not been able to meet the growing demand for the produce; the technology was licensed to small scale private entrepreneurs through another public sector organisation called the National Research Development Corporation (NRDC) in the year 2009 under a MoA. NRDC helps IIHR identify prospective clients for licensing the technology, file the patent and also ensure continuous flow of royalty payments for the technology. NRDC shares all the emoluments so collected with IIHR in 70: 30 ratio. NRDC thus identified six clients for this technology.

Subsequently, keeping in view the need to ensure easy access of technology to farmers, the technology transfer office of IIHR also licensed the technology to about 8 public and private sector Krishi Vigyan Kendras (Agriculture Knowledge Centres run either by Non- government organisations, private sector or public sector) for commercial scale production of Arka banana special at village or block level across banana growing regions. Technology transfer included signing of a MoU with an up front technology fee, one day training on the technology preparation and usage; a fixed rate royalty payable annually on the gross sales undertaken by the entrepreneur.

Evaluation of the technology impact

In an attempt to evaluate the technology dissemination, adoption and the impact there off, IIHR also undertook an ex post evaluation of four KVKs and one private entrepreneur who licensed the technology from IIHR. Within a period of a year and half since obtaining the license, the four KVKs reported a cumulative production cum sale of over 6.5 tonnes of the produce, while the private entrepreneur produced and sold over 25 tonnes. The aggregate earnings from the sale of Arka banana special by the licensees worked out to be around Rs 0.8million for the KVKs to Rs. 1.92 million for the private entrepreneur fetching the institute a royalty of around Rs. 0.05 million.

The KVKs helped spread the technology across 645 ha, while the private company spread it on 1,600 ha within a year of licensing the technology, indicating the success of technology licensing efforts undertaken by IIHR. Further, personal interviews of the beneficiaries revealed a definite 10 to 15% increase in banana bunch weight due to the use of foliar resulting in a 24 to 26 % increase in net income.

The economic impact was assessed based on a sample of over 80 growers distributed across three states covering a total of over 12 districts during the two year study period. The technology dissemination and commercialization efforts through licensing to Krishi Vigyan Kendras (5) and private entrepreneurs (1) has resulted a cumulative yield enhancement to the tune of nearly 5,000 to 12,400t earning an additional return of Rs 122.5 million. The adoption of a simple technology like use of foliar nutrient formulation appears to have released a total of 233 ha from banana cultivation for other uses.

Case study 2: Use of pheromone trap for control of mango fruit fly infestation

Fruit fly infestation in mangoes has been reported to reduce crop yields during severe infestation by 80%. Through simple, yet timely adoption of integrated pest management practices, mango growers can save their losses. The technology is based on the male annihilation technique, which is well known across the world. Scientists from IIHR, made an innovative method of impregnation of the para-pheromone into wood blocks and designed a simple yet easy-to-use trap for the mango fruit flies. While the process of impregnation has been applied for 'patent,' the technology has been licensed to several private small scale entrepreneurs for mass production and supplies the traps to mango growers across the mango growing regions in Karnataka, Andhra Pradesh and Tamil Nadu states.

The Karnataka state Department of Horticulture has provided a grant for demonstrating and supplying the technology to mango growers at subsidized rates. IIHR utilized this opportunity to involve the licensees for supplying the traps to the growers, thereby creating a win-win public private partnership effort. This has resulted in widespread adoption of the technology, reduction in the mango crop loss due to fruit fly infestation besides increasing the availability of quality mango fruits for consumption in the market.

Case study 3: Mass production of bio-pesticides by on-site incubatee

Use of bio-control agents like *Pseudomonas fluorescens, Trichoderma harzianum, Trichoderma viridae* have proven to be highly useful for controlling nematodes and other soil borne pathogens. The demand for these formulations is ever increasing. Through the efforts of scientists, more than 800,000 hactares have been brought under these useful bio-control measures. The mass multiplication and supply of these bio-control agents has been undertaken by an 'on-site' incubation process under BPD. The incubatee gets charged for the facilities provided and is permitted sales from the institute as well. The incubatee in turn pays 3 percent as royalty for the BPD. Such an incubation facilitation extended would prove to be beneficial both for the incubatee and for the innovator in up-scaling the technology and also to meet the growing demand for the product.

Revenue generation and distribution

Technology transfer efforts by ITMU at IIHR over the last two and half year since 2009-10 has generated a total of over Rs. 25 million through upfront and royalty payments from technology licensing. IIHR has transferred around 44 technologies to over 170 clients. The revenue generated are distributed between the scientist innovators and their team, ICAR and ITMU, as per the format provided by ICAR.

Other activities of technology transfer and commercialization at IIHR

IIHR actively participates, organizes and promotes technology transfer and commercialization efforts all over the country.

Participation in ICAR-Industry meet

IIHR's ITMU participated in the ICAR – Industry meet in 2010 and 2011 at Delhi. Innovative technologies from IIHR, such as foliar nutrient formulations, pheromone traps, post harvest management products, improved seeds, biopesticides and others were displayed at the exhibition held during this meet. Honourable guests, reputed seed company representatives visited the stalls and showed keen interest in the products.

ICAR-Industry meet 2010 and 2011 at New Delhi.

Regional meet

During the ICAR-CII Industry Meet 2011 in New Delhi many stakeholders emphasised the need for showcasing technologies developed by ICAR institutes at regional level. As a result, four regional industry meet was organised viz., Western region organized by Anand Agricultural University at Ahmedabad on April 16, 2012, Southern region organized by Tamil Nadu Agricultural University, at Coimbatore on April 25, 2012, Eastern region organized by Central Agricultural University at Agartala on July 3, 2012 and Northern region at CCS Haryana Agricultural University at Hissar on September 4, 2012.

Organizing Horti-Industry meet

IIHR also organized a horticulture –industry meet on two occasions, the First one in November 2010 and the second in March 2012. All the horticultural institutes under the aegis of ICAR participated and displayed their technologies at this meet held at IIHR Campus, Bangalore. Besides the wide coverage for the technologies available, the meet also brought together the industry and public research organizations to discuss the technology requirement and joint collaborations. Theme based group meetings for seed and planting material, pest management, biotechnology, post-harvest technology and engineering were organized. The institute also managed to get a number of license agreements initiated during the meet.

Participation in Food 360 – 2011 at Hyderabad
ITMU participated in a meet entitled, Food 360 – 2011 held at Hyderabad, which was organized by the Federation of Indian Chambers of Commerce and Industry (FICCI) Hyderabad Chapter in partnership with Govt. of Andhra Pradesh, during November 21-22, 2011. Overwhelming response was received for the exhibition of technologies displayed by IIHR.

Sensitization and IP awareness programmes for scientists involved in horticultural research
ITMU, IIHR organizes awareness programmes for scientists and other technical persons time and again on Intellectual Property Rights, technology generation, protection and commercialization. Two training programmes, one national and one International were organized by ITMU, IIHR.

Key constraints and areas where capacity building is needed

- Decentralising the functioning of technology transfer and business planning and development offices from that of the main research institute for governance; operationalising a full-time working team has been recognised as the most constraining aspect impeding the exploring full potential of technology commercialization in horticulture.
- Skill sets for negotiating prices and royalties with private sector, creating and enhancing awareness about the technology licensing and incubation facilities need to be enhanced for the team involved in technology transfer.
- Seed capital/ angel funding sources need to be identified and sufficient money flow needs to be ensured.
- Skill sets for royalty collection need to be enhanced.

Requirement of capacity building:

- The team needs to undergo periodic training through visits to other organisations to enrich knowledge on IPR and technology transfer facilitation and implementation.
- Team needs to be strengthened to undertake impact of technologies; strategic Marketing avenues for the technologies, and check and balances of the licensees.

Lessons learned and way forward

- **Huge untapped potential of the horticultural crop-based technologies.** The technology transfer and commercialisation efforts undertaken by IIHR so far have brought forth the unexploited potential of horticultural technologies developed by the institute and the demand for the same. The institute has been very successful in initiating new Public Private Partnership (PPP) models, thereby enhancing the visibility and accessibility of the institutes' scientific mandate.
- **Need-based technology.** 'Technology' that meets a specific requirement of the client or industry gets accepted and adopted quickly. There is thus a need to identify specific needs of the industry and prospective client through the process of technology innovation.
- Technology transfer strategy. Adopting a policy of non- exclusiveness and dual pricing provide the public research institutions the power of technology deployment keeping both commercial and non-commercial goals.
- **Building competitiveness.** Technology transfer and commercialisation efforts at IIHR in the last few years have increased awareness and competitiveness among the scientist innovators. The IP polices have helped research institutions in advancing institutional goals towards creativity and innovation.
- **Encouraging entrepreneurial skills.** Adopting IP policies also promote entrepreneurial skill sets both for their scientists and clients.
- **Value addition through commercialisation.** Though IIHR succeeded in creating few Public Private Partnership models through technology transfer and commercialisation efforts, it has not been yet able to enhance the value of its contribution with its partners.

References

1. Sidhu, A.S., Sudha Mysore, A. Krishnamoorthy, S. Ganeshan, M. Kavitha and S. Vinay, 2012. Valorization and licensing of intellectual property: A case study of Indian Institute of Horticultural Research (IIHR), Bangalore, Seed Times, 5(3):39-43
2. Amrik Singh Sidhu, N.K.Krishna Kumar, M.R. Hegde, A. Krishna Moorthy, S. Ganeshan and Sudha Mysore, 2011, Ensuring commercial production of quality planting material in Horticulture, Public Private Partnership Models and success stories, National Seed Association
3. Krishna Moorthy, A., M.R. Hegde, N.K.Krishna Kumar, S. Ganeshan, Sudha Mysore, Kavitha and Vinay, 2011. Visibility, accessibility and Licensing of horticultural technologies: A step forward, IIHR, Bangalore
4. Prabhakar, M., RejuKurian, T.M.Gajanana, Sudha Mysore and R.Venugopalan, 2011, Vision 2030, IIHR, Bangalore
5. N.K.Krishna Kumar, S. Ganeshan,,Sudha Mysore, P.B.Gaddagimatt, S. Vinay and Kavitha. M2010, Commercailsation of Horticultural technologies, a step forward., Brouchure of ITMU, IIHR, Bangalore
6. Cohen, W., Florida, R., Randazzese, L. and Walsh, J., 1998. Industry and the academy: uneasy partners in the cause of technological advance. In: R. Noll, ed. Challenges to Research Universities. s.l.:s.n., p. 171–199.
7. Jaffe, A., 1998. Measurement Issues. In: L. Branscomb, ed. Investing in Innovation. Cambridge, MA, USA: MIT Press.
8. Sampat, B. N., 2009. The Bayh-Dole Model in Developing Countries: Reflections on the Indian Bill on Publicly Funded Intellectual Property, Washington, D.C., USA: United Nations Conference on Trade and Development and International Centre for Trade and Sustainable Development.
9. Zuniga, P., 2011. The State of Patenting at Research Institutions in Developing Countries, Geneva, Switzerland: World Intellectual Property Organization
10. Krishnamoorthy, A, Hegde, M.R., Krishna Kumar, N.K., Ganeshan.S., Sudha Mysore, S. Vinay and M. Kavitha, 2012, Visibility, Accessibility and Licensing of Horticultural Technologies, A Step Forward

Web links

www.iihr.ernet.in
www.icar.org

Chapter 6. Technology Commercialization through Zonal Technology Management - Business Planning and Development (ZTM-BPD) Unit at Indian Veterinary Research Institute, India

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Brief background of Indian Veterinary Research Institute

The Indian Veterinary Research Institute (IVRI), Izatnagar, is a premier research institution and deemed university of India, widely known for its pioneering contributions to various areas of veterinary and animal sciences. The institute, which was established in 1889, has created a niche during its more than 120 years of history in immuno-biologicals, patents, processes, consultancy and other veterinary services. The institute places great importance on its mandate of research, teaching, consultancy and technology transfer activities. The institute imparts quality post-graduate education to students not only from various parts of the country, but also from overseas. Today, the institute contributes immensely to human resource development in the discipline of veterinary sciences, providing students with skills and knowledge necessary for the challenges of the new millennium. The institute has more than 275 faculty members, and it awards degrees to master and doctoral programs in more than 20 disciplines of veterinary and animal sciences, livestock products technology, basic sciences and extension education. To impart continuing education to field veterinarians, the institute also conducts diploma courses in veterinary preventive medicine, animal husbandry, veterinary biological products, animal reproduction, poultry husbandry, medicine and surgery, zoo and wild animal health care and management, meat and meat products technology.

The institute undertakes basic, advanced and applied research through 85 externally funded projects. A number of national and international research projects on animal health and production systems are addressed by the institute. In total, the institute has 157 research and 44 service projects with clear deliverables. Besides extramurally funded programs, the institute has international collaborative projects with organizations from the USA, UK, and Australia.

The institute continues to play an important role in quality control and potency testing of immuno-biologicals for various stakeholders, and maintains a good relationship with industry. Organization and participation in farmers' fairs, animal science exhibitions and other extension activities, such as Krishi Vigyan Kendra (a farmers knowledge centre, the extension wing attached to a research institute, a university or a private institution), Agricultural Technology Information Center (ATIC), Farmers' Call Center (Kisan Call Center), and Institute's Helpline, play a key role in the technology transfer mission of the institute. Recently, the Institute has been approved to operate one FM radio station, which will be used to provide farmers with expert advice on livestock production and health.

The mandate of the Institute is two-fold:

- To conduct research, post-graduate education and transfer of technologies in the areas of animal health and production; and
- To act as national referral centre for veterinary type cultures, disease diagnosis, biologicals and immunodiagnostics, etc.

The objectives of the Institute include:

- To conduct basic, strategic and applied research in animal health, production and technology.
- Development of technological know-how for immuno biologicals, diagnostics, vaccines, drugs and surgical devices.
- Generation of disease database.
- Technology integration for improving livestock production through agro-ecosystems.
- To impart post-graduate education in different disciplines of veterinary science, training and consultancy.

The institute also has six regional campuses located at Mukteshwar (Uttarakhand state), Palampur (Himachal Pradesh), Eastern Region Station (West Bengal), Srinagar Station (Jammu and Kashmir State), Bangalore (Karnataka) and Bhopal (Madhya Pradesh). They were established over the last three decades and cater to the specific local needs of animal health care, nutrition and other veterinary and animal science related aspects.

Dr. M.C. Sharma, Director Indian Veterinary Research Institute, and Dr. Puneet Kumar, Consortium Principal Investigator (CPI) of ZTM-BPD Unit, IVRI received the Best National Agri-Business Incubator Award from the Former President of India Dr. A.P.J. Abdul Kalam during the Annual Conference of Network of Indian Agri-Business Incubators, February 6-8, 2012.

Mr. Sukhjinder Singh, an incubatee of ZTM-BPD Unit of IVRI Izatnagar, received the Best National Agri-Business Incubatee Award from the Former President of India Dr. A.P.J. Abdul Kalam at 2nd Global Agribusiness Development Conference 2012 of NIABI, February 6-8, 2012.

Intellectual property and technology transfer policy of the Institute

Our internal policy and institutional support in the early phase was mainly guided by the ICAR Rules and bylaws and the Rules and Guidelines based on the 'Johl Committee Report' of ICAR. A case-by-case approach guided the protection of IPRs and transfer of IPR enabled technologies by ICAR. However, it was felt appropriate to elaborate upon the IPR policy framework and working guidelines for the management of technologies in the set up with the help of a committee of administrators, professionals and law experts. The outcome is expected to create IPR awareness and literacy, enhance the work environment for higher innovativeness, ensure that the scientists and innovators are duly rewarded with their share of benefits accrued, and guide the manner of technology transfer which would be competitive and better serve the interests of agriculture and farmers. Thus the IPR Cells were established to fulfill these objectives and to benefit all stakeholders.

Technology commercialization process at IVRI

The Indian Council of Agricultural Research (ICAR), New Delhi recently approved 10 Business Planning and Development (BPD) units in East, West, North, South and Central Zones of India, half in ICAR Institutes and half in State Agricultural Universities (SAUs). In ICAR institutes, these were named “Zonal Technology Management–Business Planning and Development (ZTM-BPD) Units” as each ZTM-BPD Unit has to coordinate the activities of Intellectual Property Rights and Technology Management of about 19 to 20 more ICAR institutes in their own zone. The Indian Veterinary Research Institute (IVRI), Izatnagar, also is one of the five ZTMUs set up in 2009.

The prime objectives of the ZTM- BPD Unit of IVRI are:

- To stimulate technology development and transfer between ZTM-BPD and entrepreneurs for commercialization of technologies.
- To act as a catalyst in conversion of original innovative research ideas into commercial ventures.
- To refine and up-scale technologies.
- To promote public private partnerships and start-up companies for technology-led venture creation.

Services provided by the ZTM-BPD Unit, IVRI:

- Promoting, developing and up-scaling of new and solution based technologies of ICAR Institutes located in North Zone-II.
- Commercializing these technologies on non-exclusive basis to the competent firms, so that these technologies may become easily available to their end users (farmers) relatively inexpensively.
- Fostering entrepreneurial spirit among scientists, youth farmers, grass root innovators and start-up companies.
- Providing support in setting up new enterprises using value-added products and services.
- Creating a support system for these entrepreneurs through the process of business incubation.
- Creating awareness on Intellectual Property issues among scientists of ICAR North Zone.

As per the guidelines of Intellectual Property and Technology Management (IP&TM) Cell of ICAR (2006), the institute has setup an Institute Technology Management Unit (ITMU) that caters to the process of technology licensing and commercialization. Technology Commercialization is the process of moving research from a research place to a successful marketable product (Jolly, 1997). Commercialization is often thought of as an orderly series of steps; building a prototype, testing its feasibility, and progress to completing product development and design (Kremic, 2003). The ability to move a technology to market quickly and efficiently is crucial in transferring technologies from public laboratories (NRC, 2010). The development and commercialization of a new technology or product starts with the steps as shown in Figure 1 (next page) and described below.

1. **Applied or basic research generates a new technology or product.**
2. **Recognition of potential commercial applicability**: ITMU assists researchers in this stage of the process.
3. **Disclosure**: Commercialization starts with a full and complete written description of the technology submitted to the ITMU.
4. **Technology assessment**: The technology assessment process is an overall examination of the commercial viability of the product or technology. ITMU examines the need and potential for Intellectual property protection and the market for the product such as:
    - An existing need for the product.
    - Other products that are currently serving this market.
    - Whether the new product has significant advantages over existing products.
    - Can the new product compete on a cost basis.
    - The technology assessment should provide sufficient information to make a preliminary decision on the commercial potential of the product and whether it merits further investment of time and money to pursue the next stages of commercialization (Pellegrins, M., 2008).

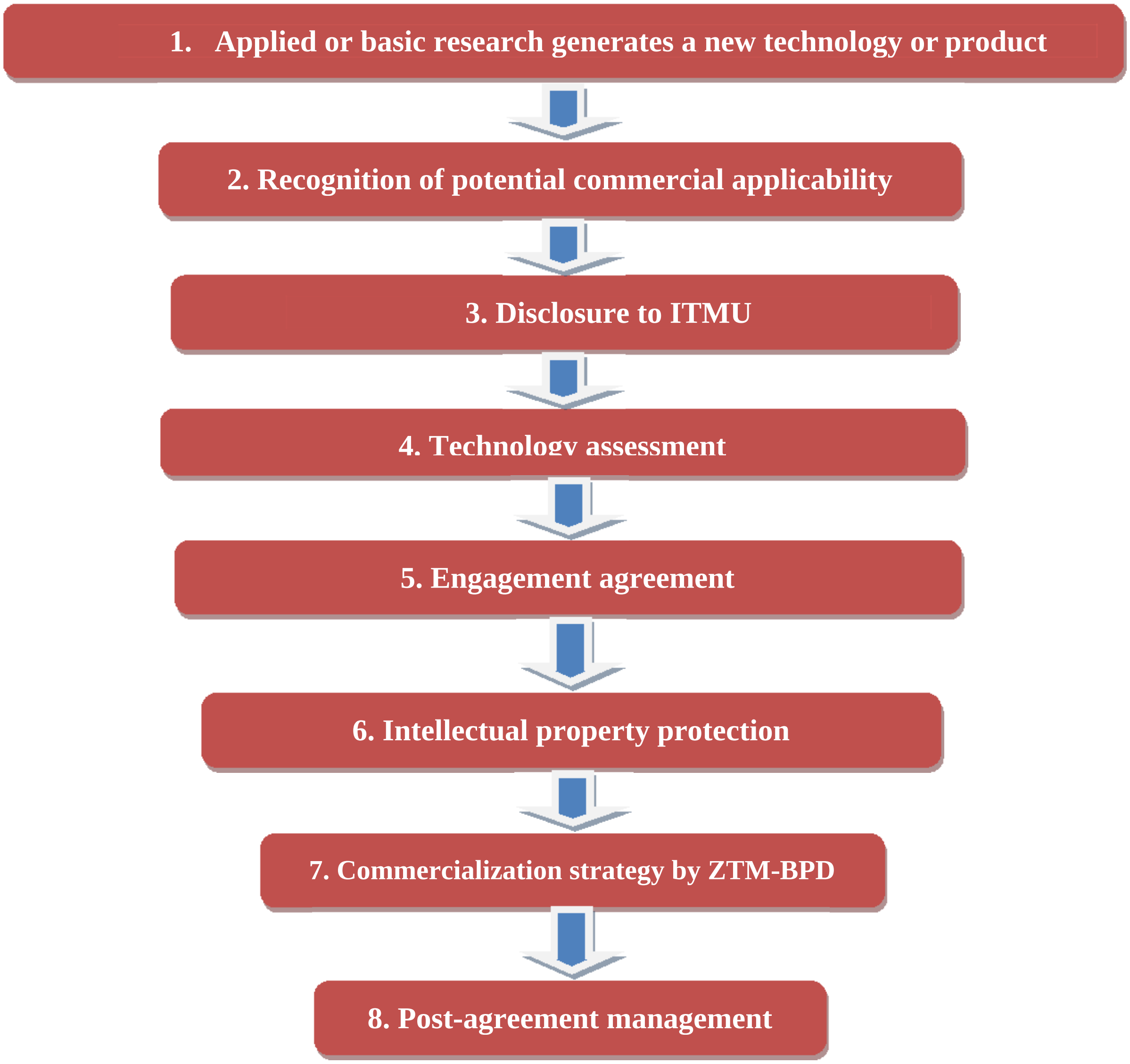


Figure 1: Technology Commercialization process adopted at IVRI

5. **Engagement agreement**: The Engagement Agreement outlines the terms, conditions, obligations and interaction between ITMU and the researcher.
6. **Intellectual property protection**: A decision is made on the necessity, eligibility and extent of legal protection and the most appropriate method of protecting it (i.e. patent, copyright, trademark, or keeping know-how a trade secret). The aid of a patent lawyer may be sought in this regard.
7. **Commercialization strategy**: By this point, both BPD/ ZTM-BPD and the researcher have a feel for the market(s), some preliminary information about the nature of the market and the commercial potential of the product (its advantages and shortcomings), as well as ball park economics for producing and marketing it. On the basis of this information, the commercialization strategy is determined. Depending on the characteristics of the product and market, the concept can be:

a) Sold outright to an interested individual or company,
b) Licensed to a suitable company for fees and royalties (WIPO/ITC, 2005), or
c) A new business can be formed explicitly to capitalize on the technology (start-up).

Licensing (option 'b') is the most common commercialization strategy.

- In a licensing situation, a company is granted certain rights for utilizing the patented technology and/or know-how in exchange for providing monetary returns to the owner.

- Potential license candidates are sought based on their ability to market and sell as well as manufacture the product. The best candidates are approached to determine their interest.
- Interested candidates are asked to sign Confidential Disclosure Agreements to bind the company to confidentiality concerning the technology.
- The License Agreement is drawn up and signed by both parties (the licensing company and the Institute).
- Final product development and test marketing by the licensee (if required) commence, often while finalization of the license is underway.
- The license is monitored to ensure that the licensee and the Institute or inventor is fulfilling their responsibilities as outlined in the license.

8. **Post-agreement management** - Our skilled project managers and technology analysts provide on-going, post-agreement management and administration of intellectual property transactions.

Business strategies for technology commercialization

The ZTM-BPD Unit promotes technology-based enterprises, assists to bring in creativeness in agri-business development by providing value-added services, transfers technology and fosters entrepreneurial spirit in the field of agriculture and allied activities. The Unit has 20 linked institutions that its members can draw upon for technical solutions to their problems. The ZTM-BPD Unit offers unique opportunities for creating entrepreneurial opportunities and building strong partnerships with entrepreneurs, start-up companies, and small, medium and elite industrial houses for technology-based viable business ventures. The unit also provides an attractive platform for nurturing new innovative ideas into viable commercial ventures, paving the way to further innovations and faster technological progress. State of the art technology incubators provide all initial facilities to entrepreneurs to develop confidence and success in the business. Facilitating process development and technology validation is yet another important goal of this initiative.

The ICAR institutions, including IVRI, were associated with National Research and Development Corporation (NRDC), New Delhi for commercialization activities, which in the last decade helped in commercializing around five technologies. The need for an in-house facility that specializes in technology transfer and commercialization was felt, which lead to the establishment of ZTM-BPD Unit at IVRI, since 2009. This unit would encompass even more broadly Intellectual Property Management, Business Incubation, Technology Lifecycle Management and Entrepreneurship Development along with Technology Commercialization with a view to promote technology-based new enterprises, value-added services, transferring of technology and fostering the entrepreneurial spirit and eventually greater creativity in the research system (Processer, 1995; Sheft, 2008). After the establishment of the ZTM-BPD Unit in IVRI, 13 technologies have been commercialized to 17 commercial houses and about 20 technologies are in the final stage of commercialization.

Technology management

For effective technology management, a complete database of promising technologies from ICAR North Zone-II has been prepared. The evaluations and critical examination of the potential technologies revealed significant differences in the competitive advantage, market demand and revenue generation potential of these technologies (Rogers *et al*., 2001).

Classification of technologies of the Institute

Indian Veterinary Research Institute (IVRI) has prepared a diverse portfolio of technologies, encompassing vaccines, diagnostics, and animal nutrition; value-added products, farm implements and machinery. The institute has segregated the technologies developed as well as which are in pipeline into following heads:

- Vaccine technologies
- Diagnostics and biotechnology product technologies
- Herbal drug formulation technologies for livestock

- Animal feed technologies
- Machinery or equipment (surgical) and reproductive technologies
- Value-added livestock product technologies
- Machinery or equipment (farm-based) technologies

The unit analyzed the potential technologies and categorized them according to their commercial potential. The commercially viable technologies were evaluated and a list of most promising technologies was prepared. The revenue generation potential of technologies directly depends on their innovativeness, competitive advantage, degree of sophistication, entry barriers and cost effective value proposition (Ramakrishnan *et al*., 2005). On the basis of two parameters, level of competitive advantage and revenue generation potential, the technologies have been categorized into four broad categories. These are as follows (Figure 2):

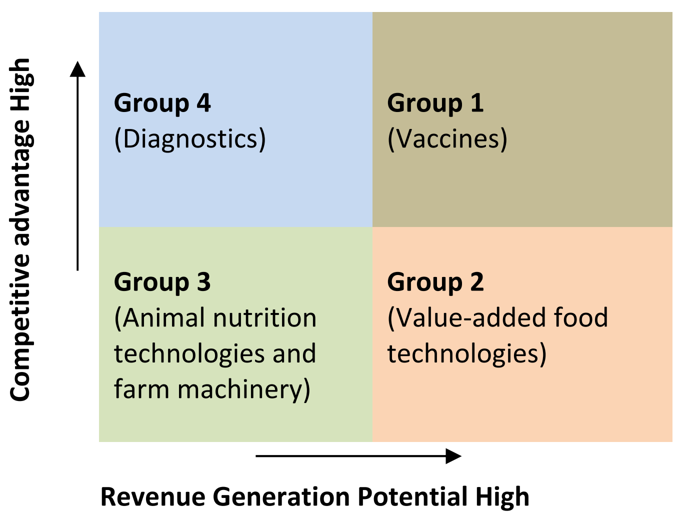


Figure 2: Technology Classification at IVRI

The ZTM-BPD Unit has recognized significant differences between groups of technologies and segmented technologies on the bases of the following criteria:

- Revenue generation potential
- Entrepreneurship development potential
- Level of technical sophistication

The unit has commercialized the technologies from all the segments from the High Entrepreneurial Potential (Value-Added Meat Product Technologies) to High Revenue Generation (Vaccine Technologies) along with Nutritional Technologies, which have both entrepreneurial as well as revenue potential characteristics.

Following is the list of technologies which have been commercialized through ZTM-BPD Unit of IVRI, Izatnagar in last two years:

- Classical swine fever virus cell culture vaccine
- Vero cell based Goat Pox vaccine
- Vero cell based Sheep Pox vaccine
- Attenuated homologous *peste des petits* ruminants (PPR) vaccine
- *Peste des Petits Ruminants (PPR) Hybridoma clone 4b11*
- Recombinant antigen (VP7 protein) based indirect ELISA Blue Tongue antibody detection kit
- Emulsion based Chicken Products
- Hurdle Technology Based Meat Pickle

- Vegetable Incorporated Meat Products
- Jai Gopal Vermiculture Technology
- Functional Chicken Nuggets (A value-added meat product)
- Area Specific Mineral Mixture (ASMM) (Animal Nutrition Technology)
- Urea Molasses Mineral Block (UMMB) (Animal Nutrition Technology)

Entrepreneurship development

The Zonal Technology Business Planning and Development Unit mission is to assist entrepreneurs in planning, creating prototypes, marketing and commercializing innovative technologies and therein building successful companies. The ZTM-BPD Unit functions as a venture creation engine in addition to being a resource center and incubator for high-tech startups and early stage companies; it helps translate lab research into consumer products and provides an infrastructure and network to support entrepreneurs. The ZTM-BPD Unit operates a series of incubating clusters that help entrepreneurs reduce their costs, exposes them to a network of industry and academic contacts, and provides advisory support and a structured business growth roadmap. The ZTM-BPD Unit has built its core competencies in supporting prospective entrepreneurs.

At present ZTM-BPD unit has 24 registered entrepreneurs, 18 as annual members and 06 corporate houses as life members. The area of interest of registered entrepreneurs has been given in the following tables.

Annual Members

Sl. No.	Name	Area of Interest	Location
1.	Mr. Manujendra Singh	Commercial Dairy Farming and Processing Unit	Pilibhit (U.P.)
2.	Mr. Brijesh Mishra	Dairy Farming	Deoria (U.P.)
3.	Mr. Lalit Sharma	Commercial Goat Farming	Bareilly(U.P)
4.	Mr. Sumit Saraswat	Commercial Dairy Farming and Processing Unit	Bareilly(U.P)
5.	Society for Technology & Development (NGO)	Animal Husbandry	Shimla (H.P.)
6.	Mr. Mansoor Azam	Value-added Meat Products	Bareilly (U.P.)
7.	Mr. Mohd. Farhan	Commercial Goat Farming	Badaun (U.P.)
8.	Dr. Laxmikant	Commercial Goat Farming & Quail Farming	Faizabad (U.P.)
9.	Mr. Gurbhag Singh (AIDT)	Turmeric Processing Plant, Agricultural Technologies of Indian Institute of Sugarcane Research (IISR), Lucknow	Pilibhit (U.P.)
10.	Mr. Aslam Javed	Commercial Goat Farming and Value-added Meat Product Technologies	Bareilly (U.P.)
11.	Mohammad. Kashif	Commercial Goat Farming a, Value-added Meat Product Technologies, Piggery, Fishery and Poultry	Bareilly (U.P.)
12.	M/s B.K. Pharmaceuticals	Manufacture of Veterinary feed supplements	Kolkata (W.B.)
13.	Mr. Sukhjinder Singh,	Turmeric Processing Plant, Agricultural Technologies of Indian Institute of Sugarcane Research (IISR), Lucknow	Puranpur (U.P.)
14.	M/s Dream advantage breeding & research farm Pvt. Ltd.,	Value-added Meat Products	Allahabad (U.P.)
15.	Mr. Ajay Raghav	Value-added Meat/pork Products	Meerut (U.P.)
16.	Mr. Iqbal Sandhu	Commercial Dairy farming	Baheri (U.P.)
17.	Abinav Sharma	Milk pasteurization and milk products	Bareilly U.P.)
18.	Mr.P.D.Singh	Commercial Dairy Farming and Processing Unit.	Bareilly (U.P.)

Life Time Members

Sl. No.	Name	Area of Interest	Location
1.	M/s Rakesh Pharmaceuticals	Contract Research for Clinical Validation of Herbal Galactogogue and Ethno-Veterinary Medicine	Ahmedabad (Gujarat)
2.	M/s Vinayak Ingredients	Animal Nutrition Technologies	Mumbai (Maharashtra)
3.	M/s Margdarshak Community Development and Consulting Services Ltd.	Nutritional Technologies, Agricultural Technologies, Value-added Meat and Milk Products	Lucknow (U.P.)
4.	M/s Sainath Avian Specialties	Commercial Quail Farming	Hyderabad (A.P.)
5.	M/s Guru Soya Foods Pvt. Ltd.	Soya Products for Animal Nutrition	Bareilly (U.P.)
6.	Mr. Krishna Dev	Commercial Diary farming	Lucknow (U.P.)

Successful case studies of IVRI technologies

The ZTM-BPD Unit, IVRI has remarkably commercialized 13 technologies to 17 companies in the last two years from all the segments from the High Entrepreneurial Potential (Value-added Meat Product Technologies) to High Revenue Generation (Vaccine Technologies) along with nutritional technologies, which have both entrepreneurial as well as revenue potential characteristics. Further; the technologies that are in the process of commercialization are also following a similar pattern. The details are in the following table.

Segment	Characteristics	Commercialized
Segment I Technologies	• High entrepreneurship development potential • Low revenue generation potential • Low technical sophistication. (e.g. Value-Added Meat Products Technologies)	• Functional Chicken Nuggets and Technology In process: • Chicken, Chevon and Mutton Nuggets, • Chicken, Chevon and Mutton Patties, • Chicken Meat Chips
Segment II Technologies	• Medium entrepreneurship development potential • Medium revenue generation potential • Medium technical sophistication	• Area Specific Mineral Mixture (ASMM) • Urea Molasses Mineral Block (UMMB)
Segment III Technologies	• Low entrepreneurship development potential • High revenue generation potential • High technical sophistication	• PPR and Goat Pox Vaccines • Vero cell based Sheep Pox vaccine • Classical swine fever virus cell culture vaccine • Recombinant antigen (VP7 protein) based indirect ELISA blue tongue antibody detection kit

Case study: PPR and goat pox vaccines

A major success in technology commercialization for the unit was a High Revenue potential technology (Segment III). The ZTM-BPD Unit organized a Business Opportunity Workshop that included a technology showcase. Hester Biosciences, India, became interested in some of the technologies and after a series of discussions and visits; an MoU was signed in 2011. The company licensed the technologies of *Peste des petitis ruminants* (PPR) and Goat Pox Vaccines for commercialization, and IVRI received a lump sum and will continue to receive royalties over the next 15 years.

MoU signed between IVRI Izatnagar and Hester Biosciences, Ahmedabad, India, for Commercialization of technologies of PPR and Goat Pox on March 08, 2011.

Way forward

Future strategies for commercialization of technologies

Group	Existing strategy	New possible strategy
Group 1 **Vaccines**	Lump sum premium (Rs 10-50 lakhs in three installments) and royalty @3-5% on sale plus Service Tax **3 installments** 50%: At the time of commencement / MoU Signing 25%: at the time of transfer of knowhow documents and demonstration of technology 25%: Within a month after the start of Production	The technologies of this group are usually of high end and ONLY few players are in the business environment. Thus an emerging need of collaboration of some leading corporate organizations and research institutions must be addressed.
Group 2 **Value-added food technologies**	One time payment for the technology with less competitive advantage	Generally value-added meat technologies are less competitive and the existing mode of technology commercialization with lump sum technology fees plus royalty is not lucrative offering. Customized training programmes on charge basis [{**proposed technology fee/ members/ batch/year} X 3-5 years**) may be another ways of technology commercialization.
Group 3 **Animal Nutrition Technologies**	Lump sum premium at the time of MoU signing(Rs 1-5 lakhs) and royalty @3-5% on sale plus Service Tax	Entrepreneurs/ start-up organization should be facilitated for less competitive animal nutrition technologies. Microfinance organizations and leading NGOs may be the critical unit of a new model of technology commercialization.
Group 4 **Diagnostics**	Lump sum premium and royalty (**Serious concern in unorganized business environment**, push strategy failed)	(FOCUS AREA)

Current strategies have been critically analyzed and some innovative models have been proposed hereunder to capture untapped business potential with optimum utilization of resources.
Group 1: Vaccine - business proposal for cell culture vaccine: strategic approach
Group 2: Value-added technologies
Group 3: Animal nutrition technologies and farm machinery
Group 4: Veterinary diagnostics

Group 1 technologies: Vaccine

In the dynamic business environment, the IVRI might need to revise its product portfolio to match demands in more attractive market sector or increase the value-added features of existing products and services. This designed business proposal for group of cell culture vaccine (PPR, goat pox vaccine, sheep pox vaccine and swine fever vaccine in one premises i.e. GLP-GMP lab) considered the following critical steps:

1. Situation analysis and competitive assessment
2. Evaluation of strategic options
3. Dynamic allocation of resources

Situation analysis and competitive assessment

- PPR vaccine has been successfully commercialized to national and international leading commercial houses e.g. Hester Biosciences, Ahmedabad, Gujarat; Indian Immunologicals Ltd. and Intervet Pvt. Ltd.
- No complaint from commercial houses for IVRI technology.
- Brand building of IVRI technology through IIL and Intervet.
- Not a single buyer has been turned up for PPR diagnostic kits.
- Goat pox has gained some appreciation from corporate organizations.
- Cell culture swine fever vaccine is in demand in India.
- No buyer for sheep pox vaccine.

PPR Vaccine: No other competitive technology in domestic market. Although the vaccine is available in France, it has not been imported yet and uneconomical.
PPR Diagnostic kit: Only one manufacturer BDSL, UK-based organization.
Goat pox vaccine: Only IVRI technology is in the domestic market.
Sheep pox vaccine: Only IVRI technology is in the domestic market.
Cell culture swine fever vaccine: Only IVRI technology is in the domestic market.

Evaluation of strategic options

Strategic Option 1: Innovative product offerings in domestic and global market

a. Vaccine + diagnostics

- PPR vaccine + cELISA Kit
- PPR vaccine + sELISA kit
- PPR vaccine + cELISA kit+ s ELISA kit

b. Combined vaccine

- Goat pox vaccine + PPR vaccine
- Sheep pox vaccine+ PPR vaccine

Strategic Option 2: Global Market exploration

- Middle East
- Africa
- SAARC countries

Strategic Option 3: Group of cell culture vaccine from the same premises

- All the promising immune-biological technologies in cell culture based category may be efficiently produced in the same premises.
- Optimum utilization of resources of IVRI.
- Good scope of PPP project which is in the alignment of ICAR guidelines for promotion of PPP in NARS.
- Up-scaling of some technologies may be done through this mode.
- Veterinary Business Incubator laboratory (VBIL) for viral vaccine and semi-construct GLP laboratory through BP division can be effectively and optimally utilized.

Dynamic allocation of resources

Activities for strategic option 1

Combined package of vaccine and diagnostics: Communications may be made to all the interested commercial houses in the arena of immune-biologics.

Multiple vaccines: Up-scaling and refinement of these combinations may be performed at VBIL either at IVRI Mukteswar campus or BP division, Izatnagar.

Activities for strategic option 2

Untapped lucrative market in neighbouring countries, Middle East or Africa may be captured by creating linkage with national laboratories or biological production units

Internet marketing may be done for global reach.

Innovative cyberspace advertisement agencies like Google Adword, LinkedIn may be contacted for cyber marketing of advanced immune-biologics technologies across the globe.

Activities for strategic option 3

For optimum utilization of physical and scientific resources from various sources may be aligned to achieve super ordinate goals of IVRI in particular and ICAR-NAIP in general.

Proposed package of cell culture vaccines: PPR vaccine, Goat pox vaccine, sheep pox vaccine and swine fever vaccine in the same premises

Modus operandi: This strategic option has ample scope of PPP project in immune-biologics.

Expected outcome:

IVRI

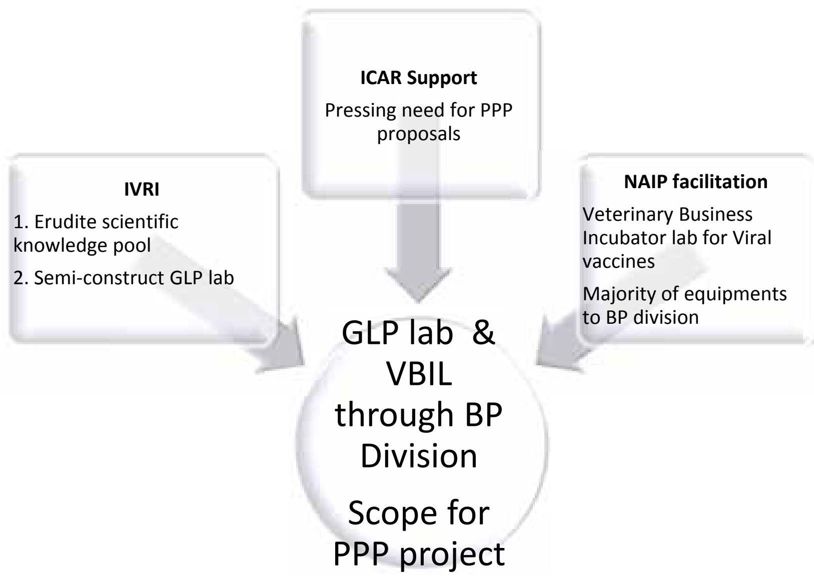
- Revenue generation will be significantly increased
- Confidance building inside ICAR system and Brand building outside business arena
- Positioning of IVRI as premier R&D organization in global business platform

ICAR

- No extra financial burden for complition of the GLP assignment
- Paradigm shift in ICAR system will be facilitated by IVRI's move in technology commercialization and PPP project.

NAIP

- Veterinary Business Incubator laboratory (VBIL) established through NAIP project will be justified as successful Incubator Lab establishement in NARS
- It will be innovative landmark in the creation of business incubator lab movement



Public Private Partnership (PPP) Proposal for Cell Culture Vaccine at IVRI, Izatnagar

The era of globalization has opened a plethora of opportunities in developed and developing nations. The macro- and micro- economic environment in a nation like India has emerged as a lucrative destination to explore the untapped market potential in all the sectors which attract the international and national corporate houses. Being an agrarian economy, Indian agriculture is also one of the major thrust potential areas for the corporate houses. Indian Council of Agricultural Research, the apex organization in India has realized these business dynamics at global and domestic arena and proactively initiated numerous activities especially establishment of Zonal Technology Management- Business Planning and Development Units (ZTM-BPD Unit) in five zones of ICAR, in the alignment of emerging changes to fulfill the social and commercial need profitably. In this direction ICAR has been successfully organized first ICAR-Industry meet at NASC, New Delhi in July 2010 and second in May 2011.

Animal husbandry, the major contributor in agriculture GDP poses immense business opportunities. Besides livestock and livestock products based enterprises, immune-biologics emerged as lucrative business avenue for international and national corporate houses. In the area of veterinary immune-biologic, Indian Veterinary Research Institute, Izatnagar, the premier institution in Southeast Asia in Veterinary Science is the single stop destination. The need of PPP proposals in the field of immune-biologics have been realized at all the business platforms, which is in the alignment of the suggestions of the Honourable Agriculture Minister Shri Sharad Pawar Ji and ICAR higher management.

The present PPP proposal envisage the immense business opportunity in cell culture immune-biologics i.e. vaccine and diagnostics by efficiently utilizing the Veterinary Business Incubator laboratory of ZTM-BPD unit and semi-construct GLP-GMP laboratory. All stakeholders of value chain starting from the producer to end-users will be benefited with this project. The focus of this PPP project is on service delivery to cost effective-technologically superior quality vaccine and diagnostics to farmers and infrastructure needs (semi-construct GLP-GMP Lab) rather than asset creation or investments.

Some of the interested organizations like Intervet, Merial, Pfizer, Eli Lily and Seasons Healthcare Pvt Ltd. have given clear indications at ICAR Industry Meet and Business Opportunity Workshop for the sufficient potential of the PPP project in immune-biologics at Indian Veterinary Research Institute, Izatnagar.

No administrable indigenous homologous vaccine is currently available in India to prevent goat pox and sheep pox virus infection in the 200 million sheep and goat population in the country. Even though PPR vaccine technology have been successful commercialized from IVRI, Izatnagar to Indian Immunologicals and Intervet Pvt. Ltd., there is significant demand-supply gap at the grass root level. The PPR vaccine is in great demand. Therefore, animals have to be vaccinated against PPR using a homologous vaccine.

Regarding swine fever vaccine, there is a felt need of cost effective technology from the leading commercial houses. Presently, lapinized swine fever vaccine is used which is available at Rs 25 per dose. The cell culture vaccine may satisfactory replace these lapinized vaccine in a cost effective manner. The emergence of an organized sector in pig farming demanded a cost effective, superior quality vaccine and cell culture swine fever vaccine may profitably fulfill this burgeoning need.

The Government of India is giving emphasis on the disease control and eradication program through National Disease Control Program in systematic manner. Small ruminants are not an untouched part of the program which may create immense market potential for PPR, goat pox and sheep pox vaccines. Reports and data suggest that more than 28 to 56 million doses of vaccines may be required per year throughout the country.

Group 2 technologies: Value-added food technologies

Value-added food technologies have been divided into two major segments (i) dairy products and (ii) processed meat products. These two play the major role in food and nutritional security and fulfill the demand of the Indian food industry to a greater extent. With the increasing income level and awareness on nutritional prospects, the demand for products of animal origin has increased manifolds. The Ministry of Food Processing has finalized Vision 2015 on food processing industries, which envisages tripling the size of the processed food sector by increasing the level of processing of perishables from 6 to 20 percent, value addition from 20 to 35 percent and share in global food trade from 1.5 to 3 percent by 2015. The sector is mainly geared towards the domestic market.

Being the world's largest producer and consumer of dairy products, India represents one of most lucrative dairy markets. In "Indian Dairy Market Report and Forecasts 2011-2016", it is estimated that the sales of dairy products in India will nearly double its size from INR 2.6 Trillion (US$ 60 Billion) to around INR 5.1 Trillion (US$ 115 Billion) by 2016. Similarly, According to the Confederation of Indian Industry (CII) report, 21 percent of meat and 6 percent of poultry are currently processed and by 2015, this is expected to go up to 45 percent and 25 percent respectively. According to Ministry of Food Processing's Annual Report, there are around 170 meat-processing units around the country.

Strategy
Value-added food technologies have a large market in terms of consumption but it is very unorganized. Therefore it is suggested that it is better to transfer them through customized training programmes for each technology, where potential entrepreneurs will be encouraged to take the training and start their own production house and in this way technology will fetch greater amount of money in place of transferring it to a single person for lesser amount. Otherwise these technologies can also be transferred to the potential commercial houses on low cost basis and high royalty on soled units.

Group 3 technologies: Animal nutrition technologies

Animal nutrition technologies have large impact on animal husbandry practices through improving the productivity and health of lactating and growing farm animals. These are low cost technologies and hence require less investment for their production. Therefore, these technologies have large potential for entrepreneurship development too. This sector forms the major portion of the Indian animal husbandry market. The present scenario has the paradigm shift from use of therapeutics to prophylactics and nutrition. Under current conditions, more stress has been given on improvement of animal nutrition in place of developing antibiotics for them. These technologies have a good market for their consumption and are area specific in nature. These technologies are comprised of mineral mixtures for different areas and other nutritional feed supplements for animals of economic importance. As this sector has lot of potential and good prospects for future growth with a larger size of market, there is need to have more and more investment for research and development in this sector. Animal nutrition industry has grown to a large extent in the last decade and lot of investment have been made in research and development, but as industry people don't have infrastructure and facilities to conduct the research and development trials, it is suggested that there is need to strengthen the links in between research institutions and industry. Here, industries and research institution can work in close collaboration and market research-based sponsored /trailer made contract research projects for technological research and development can be undertaken by the research institutes. *In place of selling the technology to one commercial house for a high price, it is better to transfer the technology to a large number of commercial houses on a low cost basis and fetch more money.*

Proposed model-I. According to the present proposed business model, there is need to identify the dynamic non- governmental organizations, farmers and dairy cooperatives and other micro-finance institutions that are mutually benefited through farmers' development. Technology can be transferred to these institutions or organizations on a low cost basis (e.g. Rs. 1 lakh) and they are encouraged to add more number of franchises of the same field and from different areas. They produce and distribute these technologies with other forms of assistance to the farmers.

Proposed model-II. Identify the one potential interested commercial house and encourage it to take all the nutrition technologies and produce them for different geographical areas of their interest. The commercial house will also be assured to provide the know-how and technical data related to soil profile.

Proposed model-III. These technologies can also be used for entrepreneurship development, through different self-employment group schemes under which financial assistance will be provided by the financial institutions and technical know-how by the institute.

Group 4 technologies: Diagnostics

Diagnostics are the specialized technologies with high level of sophistication and have a greater importance in surveillance and monitoring of diseases of economic importance. Although, these are very specialized and useful technologies for disease prevention, there is no direct market available for their consumption. The farming sector is very unorganized, and most of the livestock keepers are small, marginal farmers and landless laborers. Their economic condition is not good and they have no interest in paying money for disease diagnosis of their animals. Due to unavailability of direct market for their consumption, no company is showing the willingness in producing these technologies. Major buyers for these technologies are B. P. Divisions of State Animal Husbandry Departments, which produces some of the technologies but doesn't have technical expertise on all.

In the absence of manufacturers for these diagnostics, the scientific fraternity of research institutions is engaged in production of these diagnostics which takes away them from their important research and development activities and it is unjustifiable. To overcome the situation and fulfill the demand, it is necessary to create the networking in between the Research and Development Institutions and State Animal Husbandry Departments and need to synchronize cumulative demand for these products. These technologies cannot be handled as a single commodity, so it is good to offer them in a package, for example: (i) large ruminant disease diagnostics package, (ii) small ruminant disease diagnostics package, (iii) diagnostics package for equines, and (iv) diagnostics package for poultry.

Strategic models for commercialization of diagnostic kits

Model-1. Under this model a cumulative demand for different diagnostic kits will be placed by the B.P. Division of State Animal Husbandry Departments for their disease diagnosis, control and eradication programmes. Here, IVRI may play the role of manufacturer and supplier for these kits to the state animal husbandry departments or these technologies may be produced under public private partnership mode with these departments.

Model-2. Here is need to Identify the potential entrepreneur or start-up companies with good management skills and risk-taking ability for production of these diagnostics, where capital investment will be made by the entrepreneur and space and infrastructure will be provided by the host institute.
The technology cost and fee for the business incubator may be charged in the form of installment as the business grows in due course of time. The biggest advantage of this model is in promoting the entrepreneurship among youth and helps the new start-up companies to grow. Under this model scientists will be free to devote their valuable time in research and development activities in place of production.

Model-3. This model works on the principal of public private partnership mode, where the diagnostic kits may be offered in the form of composite package. Here, a potential company may undertake production of these diagnostics using the space and infrastructure of business incubation laboratories of ZTM-BPD Unit under public private partnership mode.

Technologies marketing plan

Under the marketing concept, the IVRI must find a way to discover unfulfilled customer needs and bring to market technologies and products that satisfy those needs. The process of doing so can be modeled in a sequence of steps: the situation is analyzed to identify opportunities, the strategy is formulated for a value proposition, tactical decisions are made, the plan is implemented and the results are monitored. Consider these three components: **situation analysis, marketing strategy** and **marketing mix decisions**.

Situation analysis (5C analysis and PEST analysis)

In order to profitably satisfy customer needs, there is need of analysis of IVRI technologies and capabilities, its external and internal situation, including the customer, the market environment. A useful framework for performing a situation analysis is the 5C Analysis. The 5C analysis is an environmental scan on five key areas especially applicable to marketing decisions. It covers the internal, the micro-environmental, and the macro-environmental situation. The 5C analysis is an extension of the 3C analysis (company, customers, and competitors), to which some marketers added the 4th C of collaborators. The further addition of a macro-environmental analysis (climate) results in a 5C analysis, some aspects of which are outlined below.

1C. Company/organization
Indian Veterinary Research Institute has a rich experience from 120 years in the field of immune-biologicals and has developed various vaccines against animal diseases. The dedicated scientific human resource at various campuses are relentlessly involve in research and development (R&D). IVRI has been established as a brand in the field of livestock vaccine at national and international level. Under the dynamic leadership of ICAR and NAIP, ZTM-BPD unit is proactively involved in the technology commercialization process in biological products.

2C. Collaborators
IVRI has a network with various private and government organizations in the field of R&D, animal health care. Strong linkages with various national and international corporate organizations in the field of biological products viz. Indian Immunological, Intervet, Panacea Biotech, Brilliant etc clearly reveal the potential of IVRI in the field of immune-biologicals.

3C. Customers
Out of approximately 200 organizations in Indian animal healthcare market, only 30 are in the biological products. Industry has clearly recognized the potential in livestock biological products which is growing at the rate of 15 percent against animal healthcare market of seven percent. Though the animal biological market is relatively small but the huge livestock population is making this segment as a lucrative option for various national and international players. In a constantly changing business environment with advancement in technology, IVRI offers various new technologies to its existing and potential customers at reasonable price. The networking with IVRI through the ZTM-BPD unit will provide various value-added services of consultancy and contract research in due course of time.

4C. Competitors
IVRI has a glorious history in the field of immune-biologicals and with its magnificent infrastructure and erudite scientific human resource, the institute is *numero uno* in this field. In the era of globalization, various global R&D institutions are the potential competitors.

In competitive business environment, IVRI has to adopt a positioning strategy. Although IVRI has first mover advantage in India and Asia in the field of immunobiologicals, there is still much more to do. There is need to position IVRI as the single stop destination in the field of animal biological product research and development at global platform. Database marketing and customer relationship marketing is the effective tool.

5C. Climate (or context)
The climate or macro-environmental factors are:

Political and regulatory environment. With recognition that the animal husbandry sector plays a major role in the contribution of the agriculture sector to the economy, the Indian government has ambitious plans to significantly increase outlays for control of animal diseases. Diseases such as Foot and Mouth (FMD), HS and Pest Des Petits Ruminants (PPR) which have high economic impact are considered in the national control programs. This itself will expand the markets and enlarge its size from the present level of $40 million by an equal share in the next few years. Post WTO changes also offer various global business opportunities and attract various national and international players.

Economic environment. Agrarian economies like India and other developing countries are realizing huge economic losses due to livestock diseases. These losses are provoking governments to create a conducive economic environment of business development in animal biologicals.

Social/Cultural environment. A paradigm shift has been realized in the Indian research system from conventional research and technology transfer to the industry-driven research and technology commercialization and Indian Council of Agricultural Research is not an exception. ZTM-BPD unit at IVRI is the interactive interface between industry and 20 ICAR institutes in North II zone for technology commercialization.

Technological environment. In the knowledge economy IVRI has competitive advantage over other R&D organizations by having huge scientific human resources which are relentlessly involved in R&D of biological products. In rapidly changing environment of technology advancement, IVRI offers the latest technology in animal biological product research and development.

SWOT analysis of IVRI in animal vaccines. A SWOT analysis (strengths, weaknesses, opportunities, and threats for the internal and external situation) can be used to condense the situation analysis into a listing of the most relevant problems and opportunities and to assess how well the IVRI is equipped to deal with them.

Assessment

Strengths. The institute is a forerunner in R&D on immuno-biologicals of veterinary importance. The institute has excellent infrastructure in terms of GMP and GLP compliant labs, experimental animal sheds including challenge sheds with BSL grade II facilities, polyclinics, livestock and fodder farms, germplasm bank, repository of organisms, challenge and field strains, cell lines, hybridoma clones, small lab animal resources, specialized labs for residue analysis, specific pathogen-free lab animal facility, etc. IVRI Mukteswer has core competencies in viral disease research and IVRI Bangalore campus is equipped with sophisticated infrastructure for FMD vaccine R&D, production and quality control.

Weaknesses. Though many technologies have been generated, the major focus area is the time duration in development. In the competitive environment, market-driven and cost-effective technologies are the need of hour. Many technologies are in process of development up to lab-scale analysis.

Opportunities. In the boundary-less global business environment various promising opportunities are emerging in the field of animal biological products. Various global players are focusing in developing countries for research and development in animal vaccines and Indian R&D institutions are a lucrative destination. Being an apex institute in veterinary and animal science and a significant contributor to Indian animal husbandry segment, IVRI has potential to be a single stop destination for animal vaccine R&D.

Threats. Emerging trend of private R&D organizations and innovative multi-institutional collaborations are the potential treat for the public-funded research institution. The quick responses and flexible *modus operandii* put these corporate institutions in a better position.

Marketing strategy (STP analysis)

Market segmentation is the identification of portions of the market that are different from one another. Segmentation allows the IVRI to better satisfy the needs of its potential customers. The marketing concept calls for understanding customers and satisfying their needs better than the competition. But different customers have different needs, and it is rarely possible to satisfy all customers by treating them alike. Industrial customers in the animal healthcare industry tend to be fewer in number and purchase larger quantities. Among various characteristics of segmentation in industrial customers, on the basis of company type, segment of companies in biological market out of total ambit animal healthcare is selected as a target segment for animal vaccine technologies of IVRI. There is a need to optimally position the offering (technologies in vaccine production) within this segment. Latest technology updates, new vaccine technology, technical know-how, clinical trials, technology business incubator lab facilities and value-added services are value proposition to the customers in target market.

Marketing mix decisions

Marketing mix decisions control on the four P's subject to the internal and external constraints of the marketing environment. The goal is to make decisions that center the four P's on the customers in the target market in order to create perceived value and generate a positive response.

1. Product

IVRI has developed numerous technologies in the field of bacterial and viral biological products viz. vaccine and diagnostic kits. The biological product technology R&D is in alignment with the demand of livestock farmers but because of low purchasing power and less number of production unit there is huge gap in the demand-supply of the biological products. Now various national and international organizations are looking forward to fill this gap in collaboration with IVRI.

2. Price

Although precise technology valuation is a difficult and time taking task but proper consideration is being taken by ITMU at IVRI. Undervaluation and overvaluation should be evaluated by taking feedback on the commercialized technology by market survey and expert panel of industry personnel.

3. Place

IVRI with its widespread network of regional campuses and research stations across India provides excellent business accessibility to the commercial houses. ICAR, New Delhi, being the apex organization, can also be a excellent platform as central point for technology commercialization and industry interface for various national and international organizations.

4. Promotion

In the competitive business environment, integrated marketing communication mix must be considered. The communication of ICAR technologies at national and international level can be done by the following points.

Database marketing. IVRI and ICAR have glorious history of technology development and transfers. Indian economy has realized a positive impact due to these technologies and numerous business houses have been established. These institutions can prepare a database of such success stories, successful commercial ventures, private organizations. Such databases can be regularly utilized by the assessing the industry need and developing the technology accordingly to meet the customers demand profitably.

E-marketing. In the era of communication revolution and globalization the marketing has been modified with newer approaches of e-marketing. The value prepositions are delivered to the target market segment through e-communication. This mode is cost effective and quick in functioning. The targeted market segment should be regularly contacted with informative mail with glimpse of superior advantages of developed advanced technology in ICAR system (promotional tools). Newsletter and business bulletins can also be periodically circulated among all the stakeholders. In biological products various global market spaces are providing excellent opportunities and in such cases e-marketing is the best way to communicate our offering and value prepositions.

Industry interface. In the field of technology commercialization especially in the field of agri and allied business, ***industry-institute interface is a very effective platform for showcasing technology and understanding the market demand*** which will be input to the scientific human resource to develop technology in alignment with the industry demand.

References

ICAR, 2006. Indian Council for Agricultural Research guidelines for Intellectual Property Management and Technology Transfer and Commercialization at www.iasri.res.in

Jolly, Vijay K. 1997 : Commercializing New Technologies: Getting from Mind to Market; Harvard Business School Press.

Kremic, T. 2003. Technology transfer: a contextual approach. The Journal of Technology Transfer 28 (2):149-158.

NRC. 2010. Managing University Intellectual Property in the Public Interest. Edited by S. A. M. a. A.-M. Mazza. Washington, D.C., The National Academies Press.

Pellegrino 2008. About IP validation. Chapter 3.in: guide to valuing Intellectual property. PP. 13-30.
Prosser, G.A. 1995. "The Role of Incentives in the Deployment of Technologies from Cooperative R&D." *The Journal of Technology Transfer* 20 (2):13-17.

Ramakrishnan, V., Jiwen C., and Krishna B. 2005. Effective Strategies for Marketing Biomedical Inventions: Lessons Learnt from NIH License Leads. Journal of Medical Marketing 5 (4):342-52.

Rogers, E. M., Takegami, S., and Yin, L. 2001. Lessons Learned About Technology Transfer. Technovation 21:253-261.

Sheft, J. 2008. Technology Transfer and Idea Commercialization. Nature Biotechnology 26:711-712.

WIPO/ ITC, 2005. Exchanging Value-negotiating Technology Licences, A training manual published jointly by the World Intellectual Property Organization (WIPO) and the International Trade Centre (ITC). P 14. At: http//www,wipo.int/sme/en/documents/guides/technology-licencing.html

Chapter 7: Changing Landscape of Technology Transfer and Intellectual Property Management at CCS Haryana Agricultural University

R.B. Srivastava, R.C. Yadav, S.K. Sethi, N.K. Kakker, Manisha Mani, Mohan Gautam, Nikhil Khurana, Abhender Singh, and Purnima Raina

Background of CCS Haryana Agricultural University

Agriculture scenario in Haryana

Haryana is one of the small states of India. It is only 44,000 km^2 which accounts for 1.4% of the total geographical area of the country. Agriculture contributes about 18% to the GDP of the state, whereas at the national level, the average contribution of agriculture to GDP is 14%. This sector also provides employment to nearly 56% of the population of the state. Due to the farmer-friendly policies of the Government of Haryana; technological support from Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar, India and farmers' willingness to adopt the latest farm technologies, the state has realized not only a Green Revolution, but also White, Blue and Yellow revolutions. In fact, Haryana agriculture has grown steadily from deficit to subsistence to surplus production. The food grains production increased remarkably approximately 8 times from 2.59 million tonnes (1966-67) to 17.21 million tonnes in 2011-12.

Haryana is second largest contributor of food grains to national food reserves. This is only possible because of favorable government policies like National Agriculture Policy (NAP), Crop Loan and Kisan Credit Card, Ground Water Cell Scheme, National Agricultural Insurance Scheme, etc., and the adoption of farm-worthy technologies and the hard work of farmers. The agriculture sector continues to play a major role in the state economy. Therefore, development of this sector is a priority of state government. Accordingly, technology generation and extension programs are being strengthened.

During the last 40 years, the achievements in research and development of state agriculture have been highly satisfactory. Although agricultural revolution in the state has brought economic gains to farmers, second-generation problems in this sector have brought new challenges to farmers, scientists and other stakeholders. The major challenges are over-exploitation of natural resources, quality issues and market competition. Therefore, it has become essential to re-examine research and development pursuits.

Efforts are being made to educate the farmers on national and global needs so that they can plan to cope with new emerging situations. Under the World Trade Organization (WTO) regime, the strong technical support to farmers and agro-industries is to be provided to meet the new challenges. Diversification and entrepreneurship development in agriculture have been recognized as core areas in strengthening of agriculture to bring both sustainability and competitiveness to the state's agricultural sector. Since the geographical situation and agro-climatic conditions of the state are suitable for commercial agriculture in Haryana, the government is creating a world-class infrastructure for agricultural processing, packaging, transportation and technology generation.

Further, efforts have been made to support small and marginal farmers through new cost-effective technologies, organizational structures, institutional responses and, above all, a renewed relationship among farmers, technologists, scientists, administrators, industries, funding agencies and consumers. In this way, the establishment of State Agricultural University named as CCSHAU, by the state government established has greatly benefitted farmers and agricultural industries in the state.

Profile of CCS Haryana Agricultural University

Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Hisar, India was established on February 2, 1970, under the Haryana and Punjab Agricultural Universities' Act 1970 to provide technological support to farmers and farm-related industries. The University has an excellent infrastructure to achieve its academic obligations, including teaching, research and extension education to meet the social and national objectives. Today, the University is well recognized for its contribution to agricultural development in the state as well as in the country.

The Indian Council of Agricultural Research (ICAR) recognized it as the best SAU in India in 1996. At present, there are four constituent colleges of the university. Before the establishment of separate Veterinary University, it also had a College of Animal Sciences and Veterinary Sciences. The programs/courses offered by the University are:

1. **College of Agriculture** - forestry, agricultural economics, agronomy, entomology, extension education, horticulture, nematology, genetics and plant breeding, plant pathology, seed science and technology, soil science, vegetable science, and agricultural meteorology.
2. **College of Agricultural Engineering and Technology** - agricultural engineering, farm machinery and power engineering, soil and water engineering, professing and food engineering.
3. **College of Basic Sciences and Humanities** - chemistry, biochemistry, molecular biology and biotechnology, bioinformatics, plant physiology, botany, microbiology, sociology, statistics and zoology, communication skills in English, and English-Hindi translation.
4. **College of Home Science** - extension education and communication management, foods and nutrition, human development and family studies, family resource management, textile and apparel designing, and school counseling.

Apart from the various colleges, the University has a library and Students' Welfare and Activities Centre, a hospital, a farmers' hostel, community center, and furnished hostels for students.

Research and Extension

CCSHAU has created a well-equipped infrastructure comparable to any institution in any advanced country. There are seven research stations in different agro-climatic zones of Haryana. CCSHAU has a very strong seed production program to meet the needs of farmers.

The university has developed over 260 varieties and hybrids of various food and horticultural crops, as well as soil and water management technologies, bio-fertilizers, bio-tech products, food products, bio-degradable plastic, farm machinery and tools, diagnostic kits, vaccines, and pest control technologies. Centers of excellence in food and nutrition, and entomology had been established.

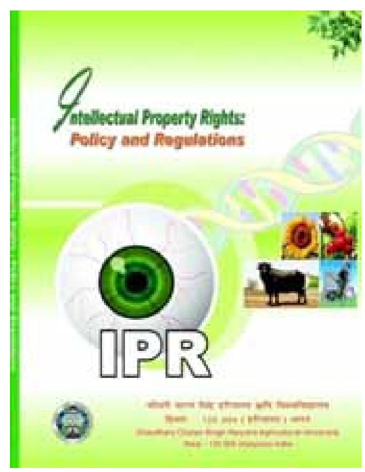
For technology transfer, the university has established 19 centers in different districts of the state, which are known as Krishi Vigyan Kendras (KVKs). These centers have been successful in extension activities; however, to speed up the process, the technology transfer system may need to be revamped. Further, for the growth of farm sector, employment generation and related industries, the development of entrepreneurship among the farmers must be triggered. Therefore, the university established its IP Management and Commercialization office to further support technology transfer programs.

Collaboration with Michigan State University (MSU), USA, for capacity building in IP management

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS agreement) has necessitated legal protection of the innovations and creative work of scientists working in universities and institutions. This encourages competition among the scientists for the development of high quality, market-competitive technologies leading to technology licensing and entrepreneurship development. Accordingly, CCSHAU established its IPR Cell in 2005. In order to build the capacity of this cell, CCSHAU signed an MOU with Michigan State University, USA. This collaboration culminated into the organization of several awareness programs, including winter schools, brainstorming sessions, trainings, workshops and industry meets for faculty members, entrepreneurs, industries, planners and students of the university, which facilitated patent filing and commercialization activities. This also helped in generating awareness for plant variety protection and farmers' rights. Under the US Agriculture Knowledge Initiative (AKI) program, the Cell, in collaboration with MSU and ICAR, also organized awareness programs at CCSHAU, Hisar; National Academy of Agricultural Research Management (NAARM), Hyderabad; and Kerela Agricultural University, Thrisure, and became instrumental in creating nationwide awareness among the agricultural scientists working in different SAUs and ICAR institutes in the country. Under the collaboration with MSU, a senior scientist of the University was trained at MSU and various places in the US for technology management and commercialization. The vice-chancellor and the director of research also visited the US under this capacity building program. In addition, in recognition of the efforts of this unit, the scientist heading this unit was invited to deliver lectures in Sri Lanka universities.

Establishment of Business Planning and Development Unit

In its efforts to generate financial resources, the IPR Cell submitted projects to ICAR and Department of Biotechnology (DBT), and was awarded a prestigious mega-project to establish a business planning and development unit under the National Agricultural Innovation Project (NAIP) to strengthen the commercialization and IP protection program. This has given further stimulus to the commercialization and intellectual property management activities at the university. The IPR Cell is now known as IPR-cum-BPD Unit. It has organized several programs to sensitize scientists and attract industries and entrepreneurs in order to meet its objectives of technology licensing, capacity building and intellectual property management.



Accomplishments of IPR-cum-BPD Unit in IP management

IP and Technology Transfer Policy

The university adopted the Guidelines of Indian Council of Agricultural Research (ICAR) for Intellectual Property protection and commercialization. Accordingly, the unit prepared a document called "Intellectual Property Rights: Policy and Regulations" that has been implemented by the university. Under these policies and regulations, there is provision to give incentives and recognition to creativity, technology licensing, sharing of resources and encouragement of Public-Private-Partnerships. As a part of this policy, an e-course was introduced on "IP and its management in agriculture," which is a compulsory course for all the post graduate students. An information compendium "IPR: An Introduction" has also been published for students and faculty members. These guidelines, awareness programs, and post graduate course on IPR helped scientists and students to come forward from across the colleges of the university to file applications and commercialize the technologies. The university has so far submitted 45 patent/protection applications for its intellectual properties and signed 38 MoUs with private and public sector for technology commercialization.

Potential technologies identified for commercialization

Concerted efforts were made by the IPR Cell-cum-BPD Unit to identify commercializable potential crop hybrids or varieties and technologies like agricultural processing machines, Poly Hydroxy butyrate, biotechnologies, liquid bio-fertilizers, pest management technologies, food products, animal products, diagnostic kits after the discussion with the concerned Department heads, scientists and inventors. Two editions of this comprehensive document were brought out. The process of valuation of technology has been initiated. All the documents have also been placed on our website: http://hau.ernet.in/hrm/bpd/bpd.htm

Development of entrepreneurship and agri-business enterprise

Employment generation for agricultural graduates or rural unemployed youth is a challenge. This unit has taken initiatives in developing entrepreneurship through training and incubation facilities for young, small and medium level entrepreneurs to promote the technologies developed by the University. The training programs have been organized for the prospective entrepreneurs in the fields of vegetable seed production, liquid bio-fertilizers, biotechnologies, food products, dairy products, bio-degradable plastic, etc.

Incubations facilities developed

Organizational structure and various services provided by your BPD

This unit's main office is in the Directorate of Human Resource Management and it has three sub-units for incubation of registered entrepreneurs.

1. **Crop Display Unit (CDU) -** promotes commercialization activities and serves as an incubator for the entrepreneurs in the College of Agriculture and College of Agricultural Engineering, specifically in the field of seed business and other technologies related to crop production and agricultural engineering.
2. **Biotech and Microbiology Unit (B&MU)** - promotes commercialization activities and serves as an incubator for the entrepreneurs in the College of Basic Sciences and Humanities, and College of Home Sciences, specifically in the field of bio-technology, bio-fertilizers, food processing, etc.
3. **Veterinary Products Unit (VPU) -** promotes commercialization activities and serves as an incubator for the entrepreneurs in the College of Veterinary Sciences and Animal Sciences, specifically in the area of production of diagnostic kits, vaccines and animal products.

These sub-units support entrepreneurship development and also take part in accelerating technology licensing.

Promotion of partnership with institutions in public and private sectors

The IPR Cell-cum-BPD Unit is constantly organizing various promotional programs including University-Industry Linkage workshops, brainstorming sessions, road shows, trainings, contact visits and other means of communication for partnership development and commercialization of technologies. In this endeavor, the following programs described below were organized.

Awareness workshop/market sensitization and publicity programs organized

Industry university interaction	: 14
Business opportunity workshops	: 13
Entrepreneurship development programs	: 14
Tech. exhibitions and market sensitization programs	: 48
Contact to industry	: more than 500

The Unit organizes various activities regularly to mobilize and sensitize scientists, industries, entrepreneurs and other stakeholders to participation in the commercialization and enterprise establishment process. The efforts have given highly encouraging results in bringing the university and entrepreneurs closer.

Technology exhibitions

Demonstrations of all the commercializable technologies developed by different departments of the university were made during the promotional programs organized at the main campus of the university, outreach stations and KVKs. These exhibitions were also organized at farmers' fair, ICRISAT Hyderabad, National Dairy Research Institute Karnal, Chandigarh, Amul Dairy Gujarat, Kiloi village, Rohtak, Regional Research Station Kaul, Kaithal, ICAR Complex New Delhi, and other venues in order to attract the stakeholders. This unit at Hisar also organized the State Agricultural Universities - ICAR Institutes - Confederation of Indian Industry Regional (SAU-ICAR-CII) Meet, where about 300 participants from universities, ICAR Institutes and industries participated and a large exhibition to display the commercialized technologies was organized. This event helped in bringing together various small and big industries for collaboration.

Documentary (video) on "commercializable technologies" released

A documentary has been prepared to support the ongoing popularization/awareness activities on CCSHAU's technologies. It carries information regarding commercializable crop hybrids of maize, pearl millet and rice; crop varieties of wheat and sesbenia; liquid biofertilizers; plant tissue culture technologies; biodegradable plastic; value added food products; a milk urea detection kit and other veterinary diagnostic kits; meat and milk products. The documentary is available on YouTube here:
http://www.youtube.com/watch?v=clHnZMTRbmo

Advertisements

Advertisements are also made in various daily newspapers, both national and regional, and English and Hindi, along with the concerned journals and magazines. Electronic media is also invited to cover the various activities of the Unit. This has also helped in partnership development.

Bulletins and manuals for entrepreneurs

Manuals

- Vegetable seed production
- Microbiology in the service of farmers
- Biotechnologies in commercialization
- Dairy products technologies for commercialization
- Veterinary products and technologies for commercialization
- Training compendium on hybrid seed production in vegetable crops
- Training manual on Entrepreneurship development in bio-technology, liquid biofertilizer and food products
- Incubation training manual for entrepreneurs for biotechnologies
- Information compendium for students on Intellectual Property Rights and its management in agriculture

Folder/Leaflet/Handouts for Public Awareness

- Value Added Pearl-Millet Based Products
- Value Added Quality Protein Maize Based Products
- Sugarcane Varieties (Ready for commercialization)
- Single Cross Maize Hybrids (Ready for commercialization)
- Sugarcane Entomology Commercializable Technologies

Campaigns

This Unit has organized awareness campaigns to inform stakeholders about the prospective technologies for entrepreneurs and industries at RRS *Uchani Karnal*, KVK Sonepat, KVK Kurukshetra, HAMETI Jind, "*Rajya Stariya Panchayati Raj Sashaktikaran Sammelan"* at Jind, Sonepat Sugar Mill, Shahbad Sugar Mill, Aterna, Murthal, Indri. The technology road shows were also organized to attract entrepreneurs and agro-industries.

The BPD Team also visited Anand Agricultural University, Gujarat; Amul Dairy, Anand; Nijanand Dairy (Simardha Village), Gujarat State Fertilizers Corporation (GSFC) Baroda, and Indian Agricultural Research Institute (IARI) New Delhi, to promote technologies such as milk urea detection kit, maize and pearl millet hybrids, and animal products. As a result of continuous campaigning, a scientist from the University of Adelaide, Australia also visited CCSHAU to see the compost making technology developed by the department of Microbiology.

Impact of IPR-cum-BPD Unit activities

Initiatives taken by CCSHAU to establish the IPR Cell-cum-BPD Unit to promote IP management and commercialization activities have started yielding results. Faculty members and students are coming forward to protect their technologies and creativity. The unit has been able to attract the seed, fertilizers, public health, food, biotechnology, and agricultural engineering industries located not only in Haryana but also all over India covering almost all of its states. Many companies have signed MoUs with the University for commercialization of technologies and the number is steadily increasing. This Unit has been instrumental in getting 117 MoUs signed with prominent private sector companies and accelerating patent filing activities. The result has been realized as follows:

Status of intellectual property protection

The initiatives taken by the IPR Cell-cum-BPD Unit have resulted in momentum in filing of patent/ protection applications from across the departments of the University. The inventors are faculty members and students. So far, 45 applications have been filed for getting patent/protection of intellectual property, out of which the following (nine) patents/protection have been granted:

- A Statistical Package for Mating Designs, Inventor(s)- L.S. Kaushik, D.R. Aneja, O.P. Sheoran, Deptt. of Mathematics and Statistics; Copyright No. **L-23301/2005**
- A Process of development of Anti- theileriosis vaccine, Inventor(s)- R.D. Sharma, Anil Kumar Nichani, Deptt. of VEPM; Sri Lanka- Patent No. **WO 2005/109991 A3**, Morocco- Patent No. **28656** and OAPI- Patent No. **13625**
- A process for Preparation of Diagnostics Reagent for testing of HS, Inventor(s)- Parul Sharma, R. S. Khokhar, Deptt. of VEPM; Patent No. - **233446**
- Indian Gooseberry Pricking Machine, Inventor(s)- M.K. Garg, Dinesh Kumar Malik, Deptt. of Processing and Food Engineering; Design No. **194255**
- A new laboratory method for production of *Pasteuria penetrans*, Inventor(s)- Raman K. Walia, Anil Kumar, Satish Kumar Mehta, Deptt. of Nematology; Patent No. - **243958**
- A Process of preparation of Tissue Culture Medium for enhancing *in-vitro* Plantlet Regeneration in Air Yam Plant using Bacterial Culture Supernatant, Inventor(s)- Pushpa Kharb, K. Dahiya, V. Yadav, P. Batra, N. Narula, S. Dhillon, V.K. Chowdhry, Deptt. of MBB; Patent No. **248511**
- A process of testing urea in Milk and Solutions thereof, Inventor(s)- Gulshan Narang, R.S. Khokhar, Deptt. of VPHE; Patent No. **250500**
- A Novel Process of Genetic Transformation in Chickpea using *Agrobacterium*, Inventor(s)- Pushpa Kharb and Team, Deptt. of MBB; Patent No. **252590**
- Development of low cost liquid formulation of native strains of *Bascillus thuringenesis* against *Helicoperva armigera*, Inventor(s)- Kamla Chaudhary, Harish Dhingra, K.S. Boora; Patent No. **253532**

Status of commercialization of technologies

CCSHAU has so far signed 38 MoUs/MoA with both public and private sector institutions for commercialization of 26 technologies. The private sector includes multinational and national companies/ventures as well. The details are described below.

MoUs signed with private sector

Maize/corn hybrids. CCSHAU has developed 14 prominent Maize/Corn hybrids for corn, baby corn and sweet corn that have become so popular across the country that companies from other states like have come forward and signed non-exclusive MoUs. So far 12 companies have signed MoU for the production and marketing of maize/corn hybrids.

Pearl millet hybrids. The pearl millet hybrids developed by the University have been released and are becoming popular and widely accepted by farmers. The hybrids can give more yield than the conventional varieties and are tolerant to drought and highly resistant to downy mildew. The long bristles also help prevent attacks from birds in the field. The farmer can earn more profit by using these hybrids. Non-exclusive licenses for Pearl millet Hybrids developed by the University have been signed with three seed companies from Haryana and Rajasthan for the production and marketing of pearl millet hybrids.

Rice hybrid. A new and improved rice hybrid that is comparatively better than earlier hybrids developed by the University in yield and resistance against insects and diseases and was released by the University for general cultivation in the state. It was the first non-basmati rice hybrid developed by the University and it outperformed the earlier rice hybrids. With the efforts of this unit, it came into the focus of private seed companies and was licensed to a company from Chhattisgarh State for production and marketing.

Wheat varieties. The wheat varieties developed by the University namely WH 1080, WHD 943, WH 1021, etc. have great market potential because of their quality and yield. They have been licensed to the two seed companies from Andhra Pradesh and Haryana, namely J.K. Agri Genetics Ltd., Hyderabad and Supreme Seeds, Fatehabad (Haryana).

Sesbania (Dhaincha) variety. The University developed *Sesbania* variety DH-1 about ten years ago. This crop is used for green manure. It remained unnoticed by the seed companies. With the concerted efforts of IPR Cell-cum-BPD Unit, the variety was licensed to a company from Uttrakhand State.

Liquid biofertilizers. Liquid biofertilizers increase the yield of crops by 5-10% in addition to saving the cost of chemical fertilizer (about 25%). So far, there is no other organization except CCSHAU to supply quality biofertilizers on a large scale to meet the demand. The liquid biofertilizers technology was licensed to companies from several states.

Other MoUs have been signed with the private sector for Milk Urea Detection Kit/Technology (2), Aonla Pricking Machine (1), R&D Agreements (3), Schizont Cell Culture Vaccine against bovine topical Theileriosis (1) and Incubation in PHB and Milk Urea Detection (2).

MoUs/MoA signed with public sector

CCSHAU has also taken initiatives to collaborate with public sector organizations. The following six MoUs/MoA have been signed to strengthen the ongoing activities in IP management and commercialization:

- University has signed MoU with National Research Development Corporation (NRDC) to get its support in patent filing and commercialization of technologies
- Haryana Seeds Development Corporation (HSDC) for seed marketing
- Anand Agricultural University (AAU) Gujarat to help in commercialization of technologies
- National Seeds Corporation (NSC) Delhi, for the production and marketing of pearl millet, maize and other crop hybrids/varieties
- MoA with National Bureau of Plant Genetics Resources (NBPGR) for germplasm evaluation.
- MoU with Punjab Agricultural University (PAU), Ludhiana, Punjab for collaboration in the areas of teaching and research

Revenue generated. The licensing of the technologies has gained momentum after the establishment of this unit. As a result, more than Rs. 11.5 million INR ($213,497 USD) in revenue has been generated.

Entrepreneurs/Companies/NGOs registered. Total numbers of entrepreneurs and companies registered:

Companies/Industries:	**20**
Prospective Entrepreneurs:	**42**
NGOs:	**2**

Success stories of the IPR-cum-BPD Unit

The establishment of IPR Cell-cum-BPD Unit proved very useful in technology transfer to the stakeholders. Several technologies that have market potential were not visible for a long period. After the establishment of this unit, the technologies/hybrids/varieties have been brought to the attention of stakeholders all over the country. The following have become the success stories.

Crop varieties and hybrids

Fourteen maize hybrids (baby corn and sweet corn) developed by the University have been licensed to national and multinational seed companies situated in various states. A large number of farmers of these states have benefited as the licensee companies have multi-fold production units. Similarly, three pearl millet hybrids have been licensed to seed companies located in Haryana and Rajasthan. The commercialization of Rice Hybrid developed by the University has also benefitted the farmers of Chhattisgarh state besides the farmers of Haryana and Punjab. The *sesbania* variety that was released about ten years ago has been licensed to a prominent seed company located in Uttarakhand. Because of licensing of this variety, huge demand has been created. This variety will help in the improvement of soil health as it is used as green manure.

Milk urea detection kit

This kit developed in 2004, has been brought to the attention of the dairy sector and the public and is in heavy demand. It can be used for instant testing of milk to detect the urea contamination in the milk.

Liquid biofertilizers technology

The liquid biofertilizers technology developed by the University has reached the states of West Bengal, Chhattisgarh and Himachal Pradesh through licensing. Earlier, this technology was limited to Haryana only. It is becoming popular in other states too because of its cost-effectiveness and ease in application.

Conclusion

Agriculture is the backbone of India, particularly in the state of Haryana, as it provides livelihood, employment and nutritional security to the larger sections of the society. Therefore, the government always supports strengthening human resource development, research and extension programs in agriculture. In this process, CCS Haryana Agricultural University, Hisar, has played a very crucial role since its establishment by supporting farmers and other stakeholders with time appropriate technologies. However, the agricultural extension system needed to be revamped. In this context, CCSHAU established the Intellectual Property Management and Commercialization office (IPR Cell-cum-BPD Unit). Financial support was also given by the Indian Council of Agricultural Research under NAIP for this purpose. The help provided by Michigan State University for capacity building in these areas also proved vital to promote commercialization of technologies and IP management at this University. All these efforts have culminated into accelerating the filing of patent/protection applications for intellectual property and commercialization of 26 technologies. This will benefit the end users, agricultural industries and will also create competition among the scientists for quality research and technology transfer.

Key constraints and areas where capacity building is needed

Agricultural research at national and international levels is strategically undertaken by both public and private sectors to develop quality products as per need of the consumer market. Inter-institutional collaborations and exchange of scientific knowledge have become part of the strategy to meet the new goals. CCS Haryana Agricultural University (CCSHAU) has well-trained human resource and well developed infrastructure with systematically developing a new scientific and business culture within the context of globalization which is its strength. The university has been the pioneer institution in Haryana as well as in the country to provide technological and commercialization support to the industries and also the farmers. Now the public sector organizations need to look beyond it as the open market economy has created fierce competition for agricultural products too. Obviously, another breakthrough for the development of new agricultural technologies development and their efficient and faster transfer to the farmers and industries have become utmost important to sustain and further boost the economy.

Lessons learned and a way forward

Agriculture is the backbone of Indian economy as it contributes quite visibly to the GDP of the country and provides employment to more than 50% of the population. Obviously, this sector will always be in focus of planners and scientists in order to generate better quality employment and also to develop technologies to meet the emerging challenges for food and nutritional security. Haryana has become a model state of India in agricultural progress. This could be possible because of farmers friendly polices of state government, technologies backup provided by CCS Haryana Agricultural University and ICAR and adoption of latest technologies by the farmers. Nevertheless, new impetus has to be given to Haryana agriculture in order to compete in WTO era and also to enhance the income of the farmers. In this era of globalization the market for horticultural and animal products is growing at faster rate. Therefore, the scientists must come out with a strategy which can help farmers to harvest such opportunities.

The worldwide focus of scientists and researchers is now shifting on the development of appropriate technologies, protection of inventions/technologies and real time technology transfer through licensing for industrial and agricultural growth leading to overall economic development. Therefore agriculture is also becoming knowledge-based industry. The university and industry have to exercise a more proactive and participatory role, initiating and facilitating mutually meaningful and equitable knowledge-based transactions amongst them.

Web links

http://hau.ernet.in/ and http://hau.ernet.in/hrm/bpd/bpd.htm

References

IPR Policy and Regulations, IPR Cell, Directorate of HRM, CCSHAU: June 4th, 2007

IPR and Introduction, IPR Cell, Directorate of HRM, CCSHAU: October 2007

CCSHAU's technologies for Commercialization- Vol. 1: 2008

CCSHAU's technologies for Commercialization- Vol. 2: May 2012

Chapter 8. Intellectual Property Management and Technology Commercialization in Agriculture: a new initiative in the Indian Fisheries Context

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Recognizing the importance of improved technical knowledge for improved efficiency in agricultural production systems and the WTO lead new global trade order, Indian agricultural research system has adopted the Intellectual Property Rights (IPR) policy in October 2006. Since then, the Indian agricultural research has been experimenting with a number of new, yet varied, concepts of technology transfer and commercialization policies in the research institutes under its purview. In view of the growing significance of 'fish based products' as protein supplements for assured nutritional benefits, the Central Institute of Fisheries Technology (CIFT), Cochin has been accorded a lead role in technology commercialization through licensing in the South Zone. This chapter presents a detailed account of the activities undertaken at the Zonal Technology Management and Business Planning and Development (ZTM-BPD) unit based in CIFT, Cochin.

Brief background about the Institute

The Central Institute of Fisheries Technology (CIFT), Cochin is the only national centre in India, where research in all disciplines relating to fishing and fish processing is undertaken. This institution has in fact proved its place as a source of technologies and knowledge in fisheries, generated by dedicated scientists over the past 56 years. This excellent track record in research and development (R&D) endeavours has twice earned the institute the best institute award of ICAR. The research work of the Institute is carried out in the seven Research Divisions viz. Fishing Technology, Fish Processing, Quality Assurance and Management, Biochemistry and Nutrition; Microbiology, Fermentation and Biotechnology, Engineering; and Extension, Information and Statistics. The institute maintains close liaison with the industries of Seafood and boat building, government agencies and NGOs. Its proximity to R&D organizations, academic institutions and its strategic location in the fisheries capital of the country are its advantages. The facilities and achievements of the Central Institute of Fisheries Technology offered scope and called for the setting up of agribusiness incubator in its premises for translation of research results into businesses of the future.

IP and technology policy of the Institute

The Institute secures Intellectual Property Rights as per the Indian law and in conformity with the international agreements to which India is a signatory. It promotes transfer of its IPR-enabled technologies, including finished processes, products, creations or works and other know-how, through commercial and public routes to farmers (*ICAR (2006)*). Systematic management of its IPR assets helps in promoting a commercial ethos in public sector research helping to transform agriculture from a predominantly subsistence mode to a globally competitive one. Commercialization of IPR-enabled technologies and other know-how, through public-private partnership has lead to accelerated rate of technology adoption among the users. This improvement has in turn lead to increase in productivity, production, farmers' incomes and employment. The process of technology transfer practiced by the Institute gives key considerations to the (i) national priorities relating to food security, (ii) sustainable use of natural resources, (iii) enhancing the incomes of small and marginal farmers, and (iv) employment generation.

Purpose for setting up the ZTM-BPD Unit

The Indian Council of Agricultural Research (ICAR), New Delhi, is an apex autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. It coordinates, guides and manages research and education under the National Agricultural Research System (NARS). With an objective of utilizing its research and development facilities and the knowledge generated by its researchers, ICAR adopted its Intellectual Property Rights (IPR) policy and IP management guidelines in October 2006. Accordingly, ICAR adopted a three tier system of IP management, with an Intellectual Property and Management Cell (IP&M) at New Delhi as the first tier; five Zonal Technology Management – Business Planning and Development (ZTM-BPD) units, representing different zones as the second tier, and 25 Institute Technology Management Units (ITMUs) at individual research institutes under its purview as the third tier. The ZTM-BPD units form a network of all those ICAR research institutions under that zone for the management of new and cutting edge technologies developed by these institutions. ICAR started this move with the aim of improving its R&D system by incorporating new ways of doing business in agriculture and related fields, to achieve the objectives of increased productivity, employment generation and building a strong national economy.

The ZTM-BPD Unit for the South Zone is established at Central Institute of Fisheries Technology (CIFT), Cochin, Kerala, that acts as the zonal hub for R&D information management, technology transfer and commercialization for ICAR Research Institutions situated in the states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. Since its establishment at CIFT in 2009, the Unit has been focusing on activities that accelerate technology commercialization in the fields of horticulture, crop science, fisheries, animal science and natural resource management.

The ZTM-BPD Unit receives necessary logistic and funding support partially through the World Bank-funded National Agricultural Innovation Project (NAIP) and partially through the ICAR XIth Plan Scheme.

Role of ZTM-BPD Units

The IP and technology management drive of ICAR has entrusted the ZTM-BPD Units of different zones to establish a mechanism that accedes to the conditions of international standards and also to find ways for stimulating research, enabling access to technology and promoting enterprise growth, all for the ultimate benefit of the Indian farming community (*Edwin Leela et. al. (2011)*).

The ZTM-BPD holds the twin responsibilities of coordinating the activities of the 21 institutes under the zone and of the business process incubation for fisheries technologies.

Coordinating the zone's ITMUs

The ZTM-BPD Units guide the member institutes under the zone to secure IPR protection of the research results, as per the Indian law and in conformity with the international agreements to which India is a signatory. It promotes transfer of these IPR-enabled technologies, including finished processes, products, creations or works and other know-how, through commercial and other public routes to farmers. The systematic management of IP assets have promoted commercial ethos in public sector research helping to transform agriculture from a predominantly subsistence mode to a globally competitive one (*NAAS (2003)*). The Unit has the power and flexibility to outsource for efficient execution of IP and commercialization matters.

The main activities of ZTM-BPD Unit are: 1) the development and use of a database system for management of intellectual assets; IPR protection, sensitization and capacity building; development of technology evaluation tools; formulation of model business plans/project reports; and technology transfer/commercialization through business incubation. The Unit aims to protect and translate the research results arising from the field of fisheries and other agricultural sectors into successful business ventures. It also helps identify new opportunities of business formation and link the prospective entrepreneurs, by providing pro-active and value-added support in terms of technical consultancy, IP protection, infrastructure facility, business support services and training to develop technology based business enterprises.

Development of an online database management system

The ZTM-BPD Unit, South Zone, has put in place an IP watch system in order to strengthen the interlinkages and information sharing among the member institutes in the Zone. The ZTM-BPD unit developed an Online Zonal Database Management System for facilitating cost effective, accurate, and timely information sharing among the member institutes in the Zone (*Razia Mohamed A. et. al. 2012)*. This system, named AGRI-TECHBASE, is a complete database management system that facilitates and provides active linkages with all member institutes through a facilitative environment for information processing and technology management. The 21-member institutes can access the database through the project website for updating, reviewing and monitoring complete information and the database relevant to the respective Institute, and thereby organize technology management. The system helps in understanding and evaluating potential technologies and scientific know-how developed, and the commercialization and revenue generation activities taken up by the member institutes.

Paulo Zawislak development of technology evaluation tools

A large number of useful technologies for different fields, including agriculture, animal husbandry, horticulture and fisheries are available for commercial use by the industry. The ZTM-BPD uses three evaluation criteria for shortlisting technologies for scaling up and commercialization. Technologies that are technically feasible, economically viable, hold potential for commercial application, have a market, and are socially acceptable are considered for commercialization purposes. All the technologies from the South Zone were subjected to such an evaluation prior to shortlisting them for commercial application.

Sensitization and capacity building

The ZTM-BPD Unit regularly conducts workshops, meetings and seminars for all its member institutes from the South Zone to create awareness, facilitate faster adoption and implement the new scheme of Intellectual Property Management and Technology Transfer/Commercialization within ICAR. This has helped in outlining the best-fit strategies and work plan for IP management by inculcating business ethos in transfer of both proprietary and public domain technologies. The scientific community was trained in handling technical information, finding solutions to technical problems, acquiring rights in the public domain, identifying the patentability potential of technologies at early stages of development, avoiding risk of R&D duplication and solving potential disputes involving patents.

The member institutes were given clear guidelines to convert their innovative ideas into business activities, to evaluate the commercial and economic viability of an invention, to formulate business plans and R&D contracts, to market and commercialize inventions, and to find potential business partners. Disputable areas regarding ownership of patents, acquiring trademarks in the name of the institutes, acknowledging the parent institution while selling the technologies etc. were sorted out during the meetings.

Collaboration with member institutes under the zone

Two monthly reports need to be generated and submitted to the ICAR headquarters: 1) summary highlights of research findings to be submitted to the Prime Minister's Office; and 2) input for the report for the Result Frame Document (RFD) of ICAR for information of Performance Monitoring and Evaluation Division of the Cabinet Secretariat. The IP protection and technology transfer/commercialization activities of the ITMUs are continuously monitored by the ZTM-BPD Unit for compilation and onward transfer to ICAR. A comprehensive assessment system was devised for research and technological affairs at the zonal level for improving the supervision of research programs and activities for aiding ICAR in decision-making and supervision processes. The ZTM-BPD Unit summarizes and reports the most important results that the member institutes have achieved during the period, such as product or process developed or commercialized, partnership development (including licensing of ICAR technologies), and IPR titles.

Business Incubation Centre at CIFT

The fisheries sector plays an important role in the socio-economic development of the country and has become a powerful income and employment generator. It stimulates the growth of a number of subsidiary small, medium and large-scale industries. In order to translate the research results arising from the field of fisheries and other agricultural sectors, ICAR has set up an innovation-based Business Incubation Centre (BIC) at CIFT, Cochin. The BIC is managed by the ZTM-BPD Unit and aims to establish fisheries enterprises through IPR-enabled ICAR technologies.

Incubatees signing MoU with BIC

The BIC supports operations on business projects as a measure of enhancing the foundation for new technology-based industries and establishing a knowledge-based economy. It focuses on finding new ways of doing business in fisheries and related agricultural fields by finding unexplored markets. The Centre helps prospective entrepreneurs by providing proactive and value-added business support in terms of technical consultancy, infrastructure facility, experts' guidance and training to develop technology-based business ideas, and establishment of sustainable enterprises. It acts as a platform for the rapid commercialization of ICAR technologies through an interfacing and networking mechanism among research institutions, industries and financial institutions. The Incubator at CIFT differs from traditional business incubators as it is tailored specifically for technology-based industries and is operational in an area with a high concentration of fish production. This industry-specific incubator also allows new firms to tap into local knowledge and business networks that are already in place. BIC offers their services to industries not only in Cochin, but also all over India through virtual incubation. Beyond promoting business growth, the Centre is also trying to bring its benefits to all the fisheries communities in India (*Ravishankar C.N. et. al. 2011*).

With the aim of transforming the incubator into a symbol of entrepreneurship and innovation, the ZTM-BPD Unit has created an environment for providing timely scientific and technical assistance and support required for establishment of technology based business ventures. The activities of the ZTM-BPD Unit focuses on finding creative and innovative ways for linking public sector resources and private sector initiatives within and across regional and national boundaries for promoting economic growth. The Centre uses the right expertise in relevant fields to identify and analyze the constraints and barriers hindering the growth of a business and devise appropriate strategies. It explores various structures and strategies to help small enterprises to grow and ensure a promising future in the global market. It fosters corporate and community collaborative efforts, while nurturing positive government-research-business relationships.

Process of business incubation

The Business Incubation Centre targets entrepreneurs, from fledgling start-ups in need of basic small-scale processing capacity, to sophisticated businesses in need of R&D back-up, office infrastructure, and pilot / test market processing facilities for the development of new products. The BIC at CIFT holds infrastructure for supporting up to 9 corporate level incubatees at a time. The BIC, apart from being a multi-tenant facility with on-site management that delivers an array of entrepreneurial services to clients operating with the facility, also serves clients that are not located in the facility through virtual incubation or incubation without walls.

The Centre regularly conducts industry interface and technology promotional programs for sensitization of entrepreneurs and to identify interested potential clients for physical and virtual incubation. The Clients at BIC have the opportunity to interact regularly with the scientists, business managers and business associates for developing ideas and formalizing business strategies. The BIC thus facilitates peer reviewing of business ideas, provides IP protection protocols, legal, financial and market oriented advices all at one place.

Client selection
The process of client selection starts with the review of applications submitted by the entrepreneurs for becoming a client with the Business Incubation centre. The applications need to provide a detailed technical and financial business plan and the anticipated socio-economic impact of its execution. The applications go through a two-fold review process, one by the individual peer review at the Centre, and the second by a Joint Evaluation Committee (JEC). The proposals are presented and discussed thoroughly at the JEC prior to being selected. The selection process is completed with the selected client signing a memorandum of Understanding (MoU) with the CIFT, as per mutually agreed terms and conditions for availing the facilities and services of BIC for a limited period of time on a stipulated payment basis.

The residency period for direct incubatees is normally two years, extendable by another year in special cases, depending on the progress of business development. As the business venture becomes mature enough, the concessions and the facilities provided to the incubatee companies will be gradually withdrawn. Incubatee mentoring will continue in a virtual mode after graduation on a case-by-case basis.

Services and facilities offered
The Incubation Centre provides shared physical workspace, management and technical assistance, access to financing, and other supporting services to the incubating entrepreneurial firms.

Incubation facilities under one roof are:

- Furnished office suites within the premises of CIFT, with shared facilities like secretarial assistance, computing, copying, conferencing, video conferencing, broadband internet and communication services
- Pilot level production lines
- Culinary facility
- Modern laboratory facilities for product testing and quality control
- Physical and digital libraries

Pilot level production lines
A state-of-the-art generic semi-commercial production facility is made available to incubating entrepreneurs for developing value added products from fish. The BIC provides access to these facilities along with support of manpower, and assists the entrepreneurs in production and testing of new product formulations. For the tenants, the pilot plant is an ideal testing arena to determine the commercial viability of new products. The plant also serves as a process laboratory: a place to see how processing equipment impacts food products under varying conditions.

Various lines available with the BIC for entrepreneurs are:

- Fish Pre-Processing Line
- Retort Pouch Processing Unit
- Fish Canning Line

- Fish Sausage Production Line
- Fish Extruded Product Line
- Fish Curing and Drying Line
- Fish Battering and Breading Line
- Fish Product Packing System Line
- Chitin and Chitosan Production Line

By providing access to these resources, the Centre effectively brings down the capital costs of intermediate and large scale processing equipment for small scale firms that attempt to scale up new technologies developed by the research institutes.

Business services
The business oriented services offered by the BIC include assistance in complying with business regulations, licensing procedures, financing, information services, marketing and tailor-made services designed for the various tenant enterprises. Incubator clients can also gain special advantage in terms of tax savings through

special regulations for business incubators. The BIC also offers a wide variety of services, with the help of strong associations throughout the Business Incubation Network. Currently the services being offered as part of business development assistance are as follows:

Facilitation for financial assistance
The ZTM-BPD Unit facilitates the availability of loans with the aid of State Bank of India (SBI), Agri-Commercial Wing. It provides direct access to financial schemes offered by Micro, Small and Medium Enterprises (MSME) for gathering capital investment, company expansion and new product development. It also helps entrepreneurs in developing linkages with various venture-funding agencies. The BIC is a registered member of Indian STEP and Business Incubators Association (ISBA); therefore, the privileged tenants of the incubator are entitled to tax exemption benefits as well as the opportunity to attend the ISBA Annual conference, workshops, training programs, etc.

Promotion of ICAR technologies
The ZTM-BPD Unit, since its establishment at CIFT, has been responsive to the rapid transformation of innovation processes and business needs, and has been continuously trying to enhance the visibility of ICAR technologies through Business/ Industry Meets, Exhibitions, Industry Interface Programs, etc. This has helped in strengthening the public private partnerships and in bringing together innovators involved in research and development and entrepreneurs from the field of fisheries. Technology exhibitions are regularly organized and entrepreneur-ready innovations and technologies developed by the ICAR Institutes specialized in fisheries and aquaculture are exhibited to the Industry. The areas addressed are seed

production technologies of fish and shrimp, cost-effective and nutritious fish feed formulations, diagnostic and test kits, new and improved aquaculture methods, harvest and post harvest technologies, ready-to-cook or ready-to-serve products from fish, pharmaceutical and biotechnological products, and techniques for fisheries waste management.

Human resource development

Human resource development for the fisheries industry has been in the mandate of CIFT since its inception. The fish processing industry is a fast growing industry in India and other countries, where there are immense opportunities for trained professionals. CIFT has the expertise and facilities to provide hands-on, application-based training courses such as Hazard Analysis and Critical Control Points (HACCP) concepts and audit, seafood quality assurance, basic food hygiene, food processing and preservation, energy efficient harvesting techniques, boat construction, etc. Successful trainees have high potential for employment in India and various foreign countries including those of the Middle East and South Africa. The ZTM-BPD Unit organizes several awareness workshops, seminars, training programs, etc. for human resource development in the fisheries sector. The Unit also conducts capacity building programs to help the incubatees build their competence in the areas of business practices, scaling up technologies, networking and financing strategies.

Case studies of Business Incubation Centre in technology development and commercialization

Integrated zero waste inland fish agribusiness at Karnal

CIFT has set up a model for the public-private partnership through the establishment of India's first inland fish processing facility at Karnal, Haryana. Mr. Sultan Singh, a registered incubatee under the BIC has set up a fish processing unit at Karnal, in technical collaboration with the Fish Processing and Quality Assurance and Management division at CIFT, Cochin. He is the first incubatee from CIFT to establish a successful business venture in the field of inland fisheries in India. Scientists from CIFT provided technical guidance in setting up the zero waste fish processing unit and have imparted training in the production of fish-based value added products. The certified farm and processing unit are spread over sprawling 27 acres of land and has the capacity to process one metric ton of fish per day. The plant is expected to improve the economic status of hundreds of the families engaged in fish farming in the village ponds and other entrepreneurs. The products, such as fish nuggets, burgers, fingers, balls etc., are prepared and marketed under the brand name "Fish Bite." The Unit is designed in such a way that even the waste from fish processing is converted into fish feed, thereby setting a fine example of zero waste agriculture. The fish and fish products from the farm are of superior quality. The ZTM-BPD unit is providing further assistance to the incubatee in strengthening their marketing channel by establishing retail kiosks in Delhi, Punjab, Haryana and Maharashtra. It is envisaged that in the near future, this initiative will reach new heights through setting up food chains, with a large variety of fish and fish products all over India and abroad.

Product brand 'Fish Bite' developed by CIFT Incubatee

Commercialization of Chitin and Chitosan

CIFT has developed a technology for the extraction of Chitin and Chitosan from crustacean wastes, which has various industrial applications in biotechnology, food processing, pharmacology, cosmetics and medicine. The technology was commercialized by Uniloids Biosciences Pvt. Ltd. Hyderabad, which is specialized in the domain of bio-fertilizers and respective chemicals. Uniloids Biosciences is a registered incubatee under the ZTM-BPD Unit. The company was given the technology know-how and training to convert the seafood process waste to Chitin and Chitosan using the scientific methods developed at CIFT. The ZTM-BPD Unit provided all necessary business support services and the Fish Processing and Quality Assurance and Management Divisions at CIFT provided the technical support and training. Uniloids is now successfully manufacturing, supplying and exporting Chitin and Chitosan to major market players in this field.

Thermal validation studies

M/s Horizon Fisheries Pvt. Ltd., Mandhoo, Maldives, one of the leading fish processing and marketing companies in Maldives, is an incubatee under BIC. Their activities include the collection, storage, processing and marketing of tuna and tuna-related products. The Tuna Processing Plant produces products like canned tuna, cooked loins, tuna in retort pouch and a number of by-products that can be found in major international markets like Thailand, China, Japan, Iran, Oman and New Zealand. As part of its virtual incubation, the CIFT has conducted an on-site thermal validation studies and training program in Maldives. The management and technical staff of the company were trained in various aspects of thermal process validation, retort operation and optimization of the process for thermal processing of products from tuna in retort pouches and rigid cans.

International Consultancy undertaken by BIC at Horizon Fisheries, Maldives

Development of organic liquid fertilizer for ZTM-BPD incubatee

Green Allies Organics Pvt. Ltd., is a registered incubatee at Business Incubation Centre (BIC) at Central Institute of Fisheries Technology (CIFT), Cochin. The company joined hands with CIFT, the objective of developing effective and reliable nature/farmer friendly agricultural technologies for the benefit of the society. A range of organic fertiliser products are being developed under the trade mark of VITAGREEN.

The first product under this brand is released under the name Vitagreen Plant Health Booster, which is a liquid fertilizer containing Poly-(D) glucosamine, renowned for its beneficial effects on growth, yield and resistance enhancement in flowers, vegetables and a number of cash crops. The product is derived from de-proteinised, de-mineralised and de-acetylated Poly-(D) glucosamine prepared from natural shrimp shells from Indian waters. Poly-(D) glucosamine increases photosynthesis, promotes and enhances plant growth, stimulates nutrient uptake, increases germination and sprouting, and boosts plant vigour. Agricultural applications of Poly-(D) glucosamine can reduce environmental stress due to drought and soil deficiencies, strengthen seed vitality, improve stand quality, increase yields and reduce fruit decay.

BIC provided technical guidance and assistance to Green Allies Organics Pvt. Ltd. for standardising the process for the production of Poly-(D) glucosamine by retaining the organic nature of the product for ensuring maximized plant protection. VitagreenTM Plant Health Booster was introduced into the market during January 2013. The product is now the only organic liquid fertilizer currently in the market, containing pure Poly-(D) glucosamine. The organic certification of the product is in process with INDOCERT, which would qualify VITAGREENTM as the only organic certified liquid fertilizer containing Poly-(D) glucosamine.

Lessons learned in business incubation and way forward

From the experience gained from interacting with budding entrepreneurs, three primary causes of difficulty to the small and medium start-up businesses in remaining competent have been identified. They are: 1) lack of access to capital; 2) lack of managerial skills; and 3) the lack of knowledge about how to estimate their markets, gauge growth and potential business basics (*Peter C. Van der Sijde (2002)*). Incubators are proven tools that can specifically address these three issues. High-risk start-ups are instrumental in creating jobs, and business incubators play a role in making and leveraging the investments these entrepreneurs make. In a country like India, entrepreneurship is ubiquitous and is reflected in all the major dimensions of civilization *viz*. social, political and economic. With the initiation of economic reforms in early 1990s, India's business environment has witnessed considerable improvement. Domestic and foreign investors are finding it easier to do business after the reforms, which are aimed at reorientation of the centrally controlled economy to a market-oriented one in order to foster greater efficiency and growth. In spite of the global financial meltdown, the Indian economy offers ample opportunities for business, for both domestic and foreign entrepreneurs.

Way forward

Amidst the changing paradigms and demanding global structure, India, in order to remain a frontrunner among developing nations, has primarily focused on the agriculture sector. The scope and level of protection of intellectual property rights (IPRs) has been increasing in the past few decades. The three-tier IP management system introduced in ICAR is an incentive for investing in research and development, creative activities, and for extending markets for technology and products. Among the various strategies to promote planned growth in this sector, focus was also given to promoting viable small and medium scale enterprises. However, the Indian agricultural sector, despite its importance in the industrialization strategy and immense potential for employment generation, is confronted with several problems in business development and management. In this context, business incubators can help entrepreneurs turn their ideas into viable businesses and promote innovation by providing business support services and resources, and have great scope and significance.

References

Edwin Leela, Razia Mohamed A., Nitin Singh, Vineeth Kumar P. and C.N.Ravishankar (2011), *Intellectual Property and Technology Management of Agricultural Research Institutes under National Agricultural Research System (NARS), India: Initiatives of a Zonal Institute*

ICAR (2006), *ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization:* Indian Council of Agricultural Research, New Delhi

NAAS (2003), *Intellectual Property Rights in Agriculture*: National Academy of Agricultural Sciences, New Delhi

Peter C. Van der Sijde (2002), Developing strategies for Effective Entrepreneurial Incubation. *International Journal of Entrepreneurship and Innovation*. November, 2002, 233-236

Ravishankar C.N., Nitin Singh, Razia Mohamed A., Rakesh Thomas Kurian, Elizabeth Carolin, and Leela Edwin (2011), *Business Incubation – Prospects in Indian Fisheries*

Razia Mohamed A., Vineeth Kumar P., Abhilash S., Ravishankar C. N. and Leela Edwin (2012), *Design and Development of an Online Database Management System (AGRI-TECHBASE): For Agricultural Technologies of ICAR*

Web Link

www.agriincubator.com

Chapter 9. Institutionalization of Technology Commercialization Process: Experience of Indian Agricultural Research Institute

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Technology has been a major driver both for increasing agricultural productivity and to ensure financial success of many farms and agribusiness firms (Boehlje 2004). World over, invention and adoption of innovative technologies is imperative for resolution of food security problems. “A seed saved 100 million people,” a famous saying associated with India’s Green revolution, truly reflects the importance of technology towards accentuating the agricultural production. Indian policy-planners have pinned high hopes from National Agricultural Research System (NARS) for facilitating innovations and new technologies in the agriculture and allied sectors. In partnership with the industry, research organizations are focusing on research, development, and most importantly on transfer of safe, productive, and sustainable agricultural technologies. Technology transfer is a process through which technical information and products developed by research organizations are provided to potential users in a manner that encourages and accelerates their evaluation and utilization. Rather than merely disseminating information, technology transfer techniques involve other important components as well, important ones being marketing of developed technologies and products as well as demonstrating the proper method for use of these new technologies. The process also includes the identification of such research developments or technologies, which possess high potential for commercialization and picking out the target market segments and user groups. Publication of advertisements, highlighting these products to the public at large and assistance in commercialization of technology are equally important.

From an Indian perspective, the main purpose of technology transfer is to bolster the Indian economy by making Indian products more attractive and qualitatively competitive in world markets. From the view of public-funded research institutions, it will include getting ideas, making inventions, and developing new technologies and products in a form that is useful to the community. Coupled with development of knowledge economy and new intellectual property rights (IPR) regime, it was important to develop an efficient organizational structure within the research institutes to manage the issues related with Intellectual Property (IP) and technology transfer process. The Indian Council of Agricultural Research (ICAR) has taken various positive steps in this direction by setting up of five Zonal Technology Management and Business Planning and Development (ZTM and BPD) Units to serve as specialized entities for facilitating IP management and technology transfer.

Evolution of ZTM and BPD Unit

ICAR is the apex body for coordinating, guiding, and managing research and education in agriculture, which encompasses horticulture, fisheries, and animal sciences in India. With 99 ICAR institutes and 53 agricultural universities spread across the country, it is one of the largest national agricultural systems in the world. Keeping in view the immense importance of IP management and technology transfer, ICAR has created a specialized 3-tier institutional framework for IP management and technology transfer in the form of Apex Technology Management Committee (ATMC) at ICAR headquarters level, five ZTM and BPD units at Zonal level, and Institute Technology Management Unit (ITMU) at each institute level. Moreover, India has been divided into five zones, with ZTM and BPD units playing the most important role. These units have been delegated with functional autonomy and are responsible for ensuring different aspects of IP management including protection, valuation, commercialization, etc.

The North Zone unit is located at Indian Agricultural Research Institute (IARI), a premier institute of ICAR, hailed as the seat of Green revolution in India. The institute is now focusing on creating an ever-green revolution through new developments and inventions in technologies aimed at crop improvement, crop protection, natural resource conservation along with machinery-based technologies, post-harvest technologies, biotechnologies or other related technologies. "Zonal Technology Management and Business Planning and Development (ZTM and BPD) Unit at IARI" was established in 2009 under the National Agriculture Innovation Project (NAIP) funded by the World Bank. It is a unique business model devised to utilize the strength and innovative potential of IARI and 20 other associated ICAR institutions located in Indo-Gangetic region (the Indian Grain basket), for the benefit of society through commercialization of agricultural technologies. This centre has developed a robust network with four similar other ZTM and BPD units of NARS, BPDs of State Agriculture Universities (SAU), other R&D institutes such as CSIR, Indian Institutes of Technologies(IITs), International institutes such as ICRISAT etc. The unit facilitates Public Private Partnership (PPP) and extends support to industries and entrepreneurs with transfer of technologies, consultancies, project planning, and business development.

Mandate of ZTM and BPD Units

ZTM and BPD unit, IARI has mandated to:

- Disseminate agricultural technologies developed at research institutes to private and public companies so that innovations and research can reach farmers and the society as a whole.
- Develop cutting-edge yet simple and low-cost technologies to improve existing agricultural practices and improve productivity. This is achieved by promoting research through contract and consultancy mode with public and private organizations.
- Promote entrepreneurship and reduce dependency on the government system. This is being achieved by organizing training programs, Entrepreneurship Development Programs (EDP) and workshops.
- Nurture young talents by providing technical support and business hand holding and helping them start their own ventures and create employment within the society. This is achieved by setting up of a functional business incubator.

The organizational structure of ZTM and BPD Unit

The Unit is managed by a multidisciplinary team of eight members. Keeping in view the nature and activities to be undertaken by this unit, the roles and responsibilities of the staff were established. People with specific skill sets were recruited to efficiently accomplish these roles and responsibilities. The organizational framework was developed by defining clear line of authority and responsibilities (Figure 1, next page).

IP management

The IP management to the organized R&D departments, such as ICAR, CSIR, IARI etc, may mean the entire process of research from original conception to obtaining of patents and licensing of technology. In broad sense, the concept of the management of IPRs covers the administration of all phases of management from the original concept of the invention to the final commercialization of the invention.

In keeping with innovative developments and evolving national and international policies that further emphasize the need to create awareness and develop skills for IP management, Indian agricultural research system is gradually shifting towards more aggressive IP management strategy. IP management includes protection, management, and commercialization of various types of IP such as patents, trademarks, copyrights, designs, plant variety protection rights, geographical indication, etc.

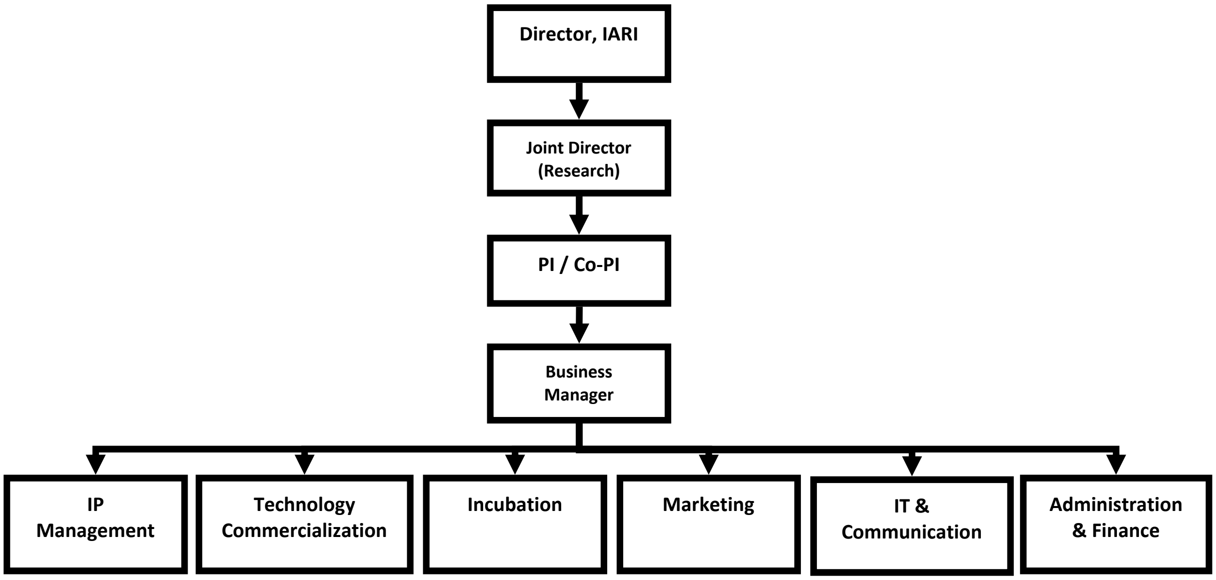

Figure 1: The Organization Structure

Patent protection

The ZTM-BPD unit evaluates the newly developed technologies using patentability criteria. This involves conducting and facilitating a prior art search, and drafting and filing the patent application of technologies developed by scientists of IARI. Till date, 82 patent applications have been filed in different sectors including agro-chemicals, pesticides, bio-fertilizers, bio-control agents, and agricultural machineries (Figure 2), 16 of these patents have been granted to IARI.

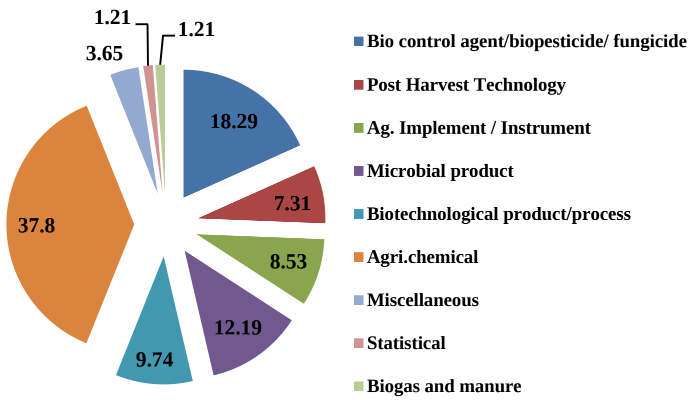

Figure 2: Sectoral composition of Patent filed by IARI (%)

The five ZTM-BPD units service the various ICAR institutes in the respective zone. For instance, the ZTM-BPD unit in North Zone-1 is in-charge of hand holding 20 ICAR Institutes of North Zone-1 on matters relating to evaluation and prioritization of technologies; drafting and filing of patent applications. The unit is also filing patent application for technologies of non-ICAR research Institutes, in which case ICAR holds IP rights.

Trademark protection

The outlook of a product and an indication identifying the producer or supplier of the product and services used in trade often influence consumers' decision to buy or not to buy them. Visible elements of products and services could be protected from acts of unfair competition by intellectual property rights such as trademarks and service marks. These types of intellectual property are expected to make a contribution towards brand equity value of private companies. They also make such companies more competitive enabling them to realize higher market share and profit.

Figure 3: Trademark for PUSA as label

A trademark is a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise. Trademarks may be one or a combination of words, letters, and numerals. They may also consist of drawings, symbols, three dimensional signs such as shape and packaging of goods, or colors used as distinguishing feature.

IARI is selling its seeds and other technological products under the brand name "PUSA" and the institute received the "PUSA" trademark registration in 2005 (Figure 3). It was later realized that the word "PUSA" was being used more frequently as a trademark, so it was felt to register the word "PUSA" as a word mark. Therefore, ZTM and BPD unit has filed the trademark application for the protection of "PUSA" as word mark in eight different classes.

Plant variety protection

With the enactment of Protection of Plant Varieties and Farmers' Rights Act (PPV and FRA), a unique system was established in 2001 by expanding plant variety protection (PVP) to varieties registered by farmers, NGOs, and public sectors institutions while also protecting the rights of plant breeders. The new plant varieties cannot be protected through Indian patent system.

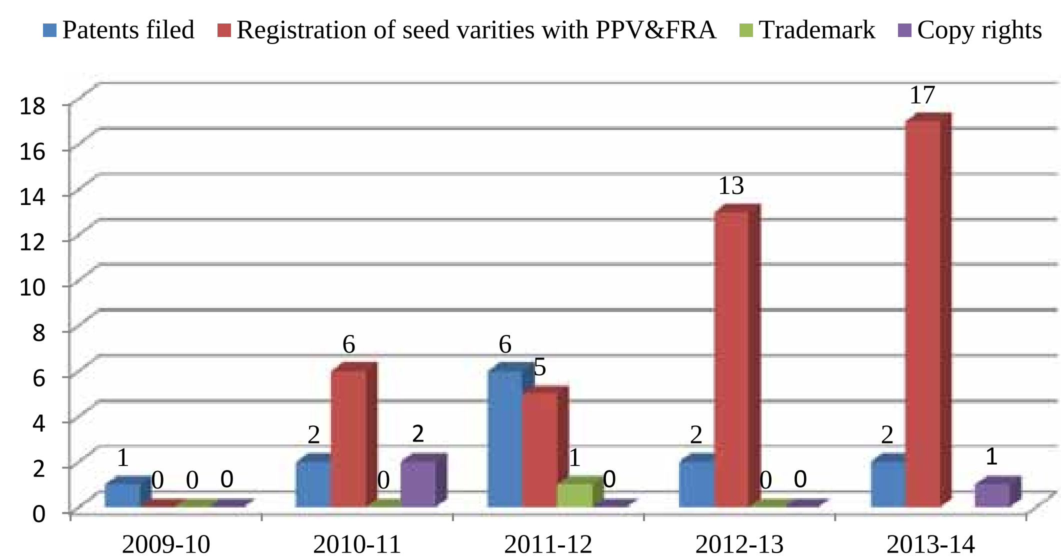

Figure 4: The Unit's endeavor in protecting IP assets of IARI

The important feature of Indian enactment is that in addition to incorporating all the required technical features of International Union for the Protection of New Varieties of Plants (UPOV), it provides rights to farmers to use the seeds from their own crops for planting the next crop. It also has provisions for benefit

sharing with farmers, penalty for marketing spurious propagation material, protecting extant varieties, and farmers' varieties. The total period for protection is ten years from the date of registration.
This act allows for the protection of seeds and plant varieties based on several criteria including novelty, distinctiveness, uniformity, and stability. ZTM and BPD unit at IARI has filed 41 applications with PPV and FRA in last three years for different crop varieties like rice, wheat, mustard, cabbage, cauliflower, brinjal, tomato and chrysanthemum (Figure 4, previous page).

Transfer of agricultural technologies

The transfer or licensing of technology entails the licensing of a patent or technology. In other words, the owner of a patented invention or technology grants permission to the licensee to use the patented invention. The licensee gets the right to manufacture and sell products, and in return the licensor receives revenues. The licensor does not own the risk of manufacturing, promoting, and selling those products. The licensee on the other hand receives the rights to use the IP without investing in research and development as well as meeting the costs of developing the product. Through this process, the licensee will be able to sell products or services more quickly by acquiring a license to use existing IP, instead of re-inventing the wheel. The licensee may also obtain necessary expertise from the licensor. The transfer of technology may also involve licensing of other forms of IP, for example: design, trademark, copyrighted material, trade secret, or know-how.

ZTM-BPD unit of the North Zone-I has started to play a major role in commercializing agricultural technologies developed at IARI and the zonal-institutes. The unit has more than 250 technologies which are ready for commercialization. These technologies encompass various agricultural innovations including cereal, pulses, legumes, and commercial crop varieties (87), vegetable crop varieties (75), fruits seeds and plant materials (5), flower seeds and plant material developed (11), crop production and agricultural chemical technologies (28), microbial-based products (19), disease resistance, detection kits, and biotechnology based technologies(30), post-harvest technologies (11), machineries and farm Implements (22) and computer and bioinformatics based technology (10).

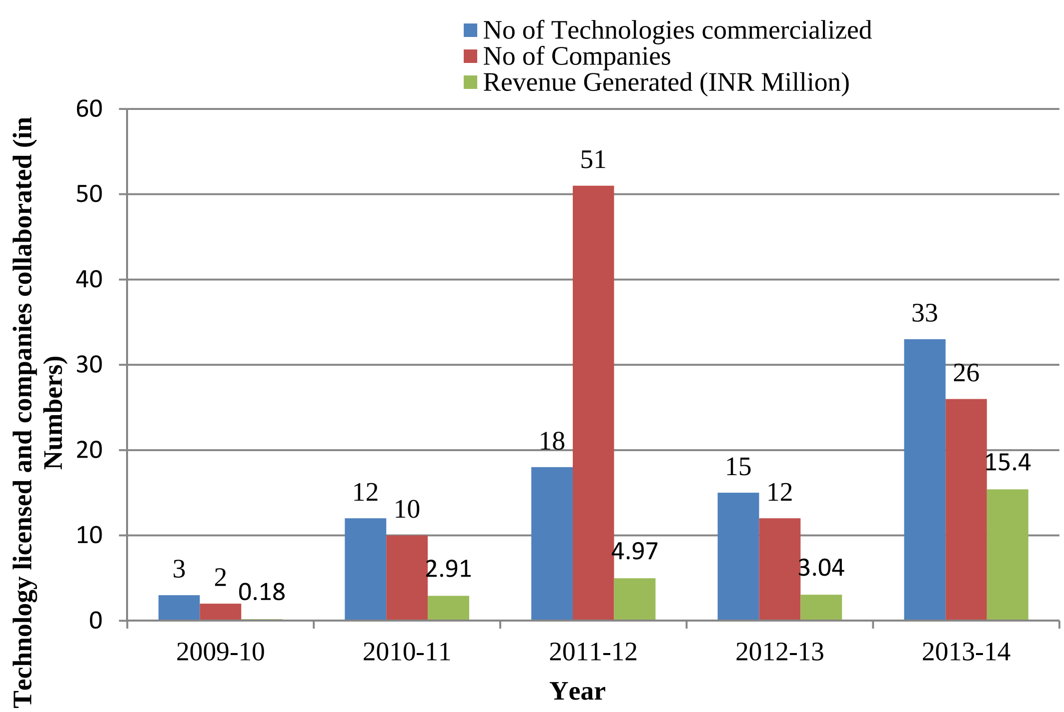

Figure 5: Trends in commercialization of technologies

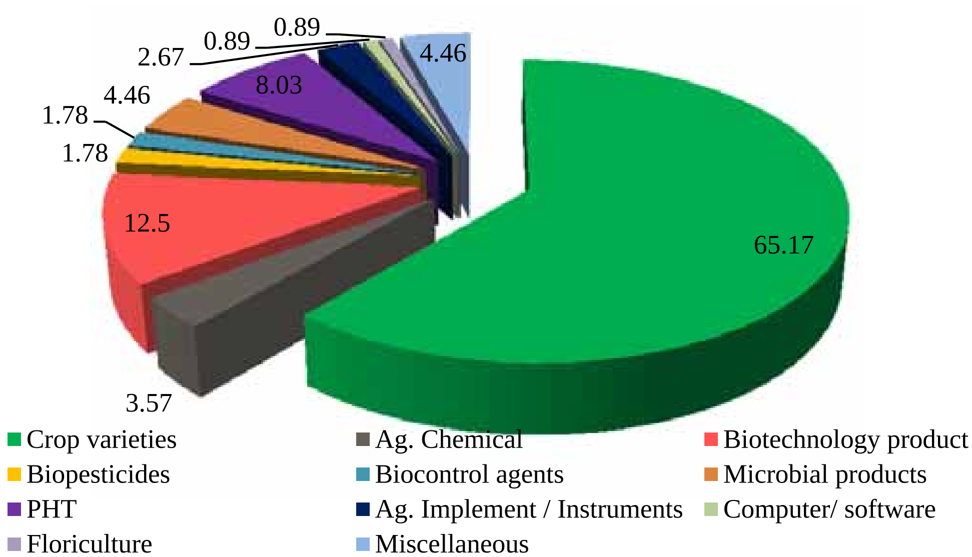

Figure 6: Technology commercialization in different sectors (%) by ZTM and BPD Unit, IARI

A paradigm shift can be easily observed in type of product or technology being commercialized due to the efforts of ZTM and BPD unit. There is a noticeable increase in the proportion of revenues generated from technologies from sectors other than varieties or hybrids of crops.

The unit has commercialized more than 60 technologies of different disciplines with reputed companies. The commercialization process has generated Indian Rupees (INR) 26.5 million in revenues (Figure 5, previous page). Among the technologies commercialized, rice variety Pusa Basmati 1509 (PB 1509) generated the highest revenue followed by wheat variety HD2967, Pusa rice hybrid (PRH10), maize hybrid (PEHM-5), nano-formulations, soil testing and fertilizer recommendation (STFR) meter, and animal feed block making machine (AFBMM). In addition, Pusa soya nuts, Pusa drinks and Pusa pearl puff also witnessed high demand in the market. Among the various technologies commercialized, the crop varieties recorded very high proportion (65.17 %) followed by biotechnologies (12.5%) and post-harvest technologies (8.03%) (Figure 6). ZTM and BPD Unit is also involved in consultancy projects, contract research, and collaborative research services which have yielded revenue generations of INR 3.3 million.

Commercialization approaches

The first step in the commercialization process is to understand the invention. The inventor presents the invention to the Institute Technology Management Committee comprising of Director, Joint-Director (Research), In-charge of ZTM and BPD Unit, concerned Head of the Division, and Director of neighboring ICAR Institute. The committee evaluates the technology based on its stage of development and market potential and fixes upfront licensing fee, milestone payments as well the royalty rates. If the technology is ready for commercialization, it is licensed to companies for undertaking commercial production, product promotion, and marketing. The technologies which need further development are offered to start-ups, faculty and students develop, refine, and nurture new ventures through the incubation facilities of ZTM and BPD Unit. If the technology is in the proof of concept stage, then industry partners who could scale-up the innovation are identified. For such technologies, organizations who would like to undertake collaborative reasearch are also encouraged. The systematic catagorization of technologies and identificartion of appropriate collaborative partners ensures proper growth and exploitation of promising inventions with commercial potential.

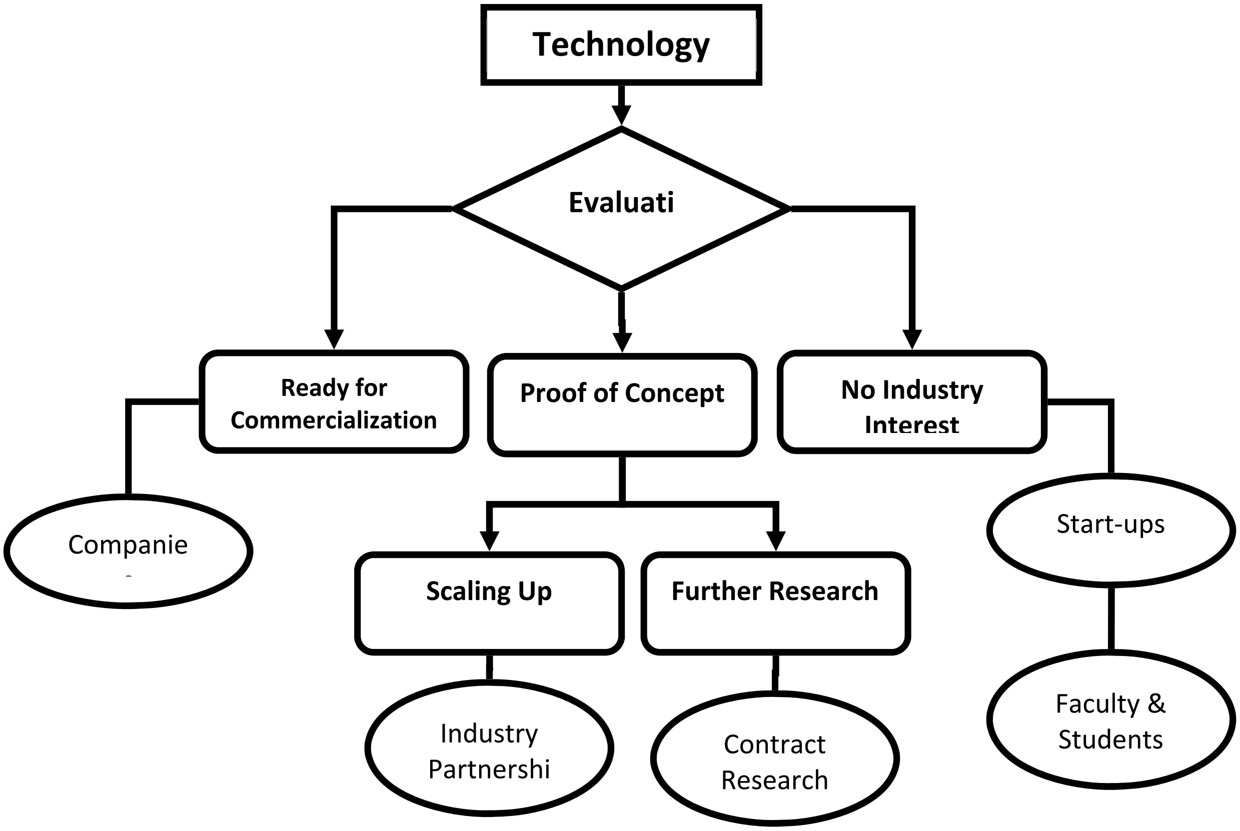

Figure 7: Evaluation of Technology

Pricing and marketing approach

The technology is classified into three types, based on commercial variability and market potential. The high-end technologies needing large investments are offered to corporate sector. The technological products developed using nano-technology are being commercialized to companies with large capital base and well developed marketing network. The low cost technologies are suitable for small and medium scale industries. The efforts to commercialize such technologies are intended to identify, appraise, and attract such industries; example of a successful technology transfer is the commercialization of extraction technologies for anthocyanin, lycopene, stevia and carotenoid extraction to Vaishnavi Biotech Ltd, Secunderabad. The low cost technologies for fruit drinks, nutri-cookies, and soya nuts are offered to start-ups, entrepreneurs, NGOs, and self-help groups (SHG). Some of these technologies have been licensed to companies such as Messers (M/s) KAD Biotech and Shri Krishna Pickles Pvt. Ltd. M/s KAD Biotech is a start-up company launched by a fresh graduate and the technology is able to help the firm generate revenue of over INR 40,000 per month.

Figure 8: Pricing approaches for commercialization of technologies

Innovative marketing practices

The technology is promoted by adopting multidimensional marketing strategies including using social media like Facebook, LinkedIn, etc. and the industry partners are also corresponded through e-mail. An industry specific database is being updated regularly, which is used as a ready reckoner for promoting technologies and for organizing business/industry meetings. The interested industries are also invited for a Business to

Business (B2B) meeting and queries are redressed through proper follow-up procedures. The industry or firm is also requested to provide input using feedback forms. Investor networks like Mumbai Angels, Indian Angel Network, etc. are utilized to source capital for the budding entrepreneurs. The BPD also participates in business/industry meets to show case technologies.

Web portal

The ZTM and BPD of IARI has created and launched a new dynamic web portal (http://ztmbpd.iari.res.in) that provides information on services and products for technology commercialization, agri-business incubation etc. The site gives clear view of technology bank and business handholding provided by the unit. It also serves as an interface for promotional and marketing media platform. The portal presents a data repository, news, events, publications, and brochures in both video and graphic form. It has introduced features like query forms, feedback forms, mobile compatibility mode, email and social media integration for better communication and knowledge sharing.

Future interventions

The unit endeavors to reduce the process of technology transfer starting from receipt of letter of interest for technology to licensing of technology. Also the unit is working on a strategy to take some of the innovations not only to all parts of India but also to other parts of the world. The unit is also working towards understanding the needs of consumers and clients leading to demand-driven collaborative research.

Business incubation

With the mission of *"Utpadak se Udhyami" (transforming producers into entrepreneurs)*, ZTM and BPD unit has begun entrepreneur development and business incubation activities. The unit has organized 12 Entrepreneurship Development Programs (EDP) during the period of 2009-2012 in the area of production of fruit based beverages, quality seed production in vegetable crops, production of bio-fertilizer and bio-pesticides, plant tissue culture (micro-propagation), vermin and microbial composting, hydroponics, protected cultivation for vegetable crops, embedded dried flower production and post-harvest technologies (Figure 9).

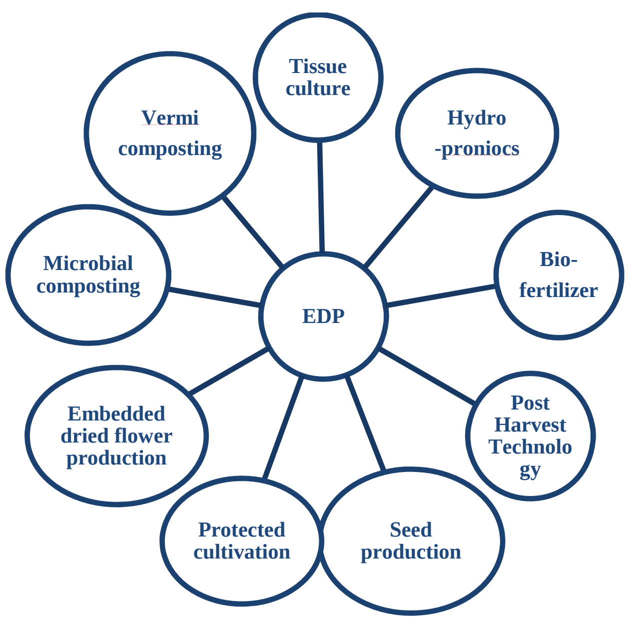

Figure 9: Diverse areas in which EDP is organized by ZTM and BPD Unit, IARI

The unit provides a platform to perspective entrepreneurs with the assistance of eminent scientists of the institute in the field of agriculture and allied sectors.

The Unit has developed and offers the following facilities and services to incubatees:

- Infrastructure facility: office space, phone, internet, fax etc.
- Business Planning and feasibility analysis of business concept
- Contract, consultancy and collaborative research services
- Laboratory facility for microbial, molecular, biotechnology, and plant tissue culture research
- Greenhouse or polyhouse facilities
- Conference facilities
- Entrepreneurship Development Program (EDP) for skill building
- Accounting and legal guidance and other related services
- Market research, sales, and marketing services
- Development of new products and services
- Opportunities for networking with other entrepreneurs, customers and other support agencies

beejIndia Producer Company Limited

A farmer producer company "beejIndia Producer Company Limited" has been formed and nurtured by the ZTM and BPD unit. Identified by a unique logo (Figure 10), the company was established with farmer groups based at Hapur and Bulandshahar districts of Uttar Pradesh and Jhunjhunu district of Rajasthan. It has been formed with the objective of enhancing income of the farmers by meeting their ever-growing demand of quality seed and other agricultural produce through an ideal model of demand and supply. The impetus behind the formation of a seed producers' company is to empower farmers with power of aggregation and build capacity by training them in quality seed production, processing, storing, and marketing so that they can meet their own seed demand and that of their fellow farmers. The benefits attached to members of the producer company are: entrepreneurial development of farmers; maintenance of quality seed of major crops; linkages to market to professionally market the produce; cooperative benefits such as revolving funds and shared maintenance costs; development of community based public infrastructure for storage and processing; and the establishment of a data bank and information system for facilitating faster flow of information on the availability of seeds. Through participation in trade fairs, industry meets, B2B meets, etc., efforts are being made to promote the logo and build the brand of beejIndia so as to create demand for the products of farmer members.

Figure 10: Logo of beejIndia Producer Company Ltd

Corporate membership

The PPP, which in broader sense means the use of limited resources possessed by both government and private sector jointly, begins with the formation of a system of corporate membership of public sector R&D institutions. Accordingly, private and non-government organizations are invited to become corporate members of ZTM and BPD unit. Many multinational companies, as well Indian companies such as MAHYCO, Bejo Sheetal Seeds Pvt. Ltd., Bhartiya Beej Nigam Ltd., Syngenta India Ltd., Advanta India Ltd., Indo-American Hybrid Seeds (India) Pvt. Ltd., Rasi Seeds Pvt. Ltd., Standard Hydraulics, Ozone Biotech Pvt. Ltd., and Multiplex Bio-tech Pvt. Ltd., etc. have become corporate members of ZTM and BPD unit of IARI. Such partner organizations require the assistance of agricultural technologies of IARI and expert consultations for accomplishing their development goals. Research organizations also need the cooperation of private partners to achieve a comprehensive product development approach.

With this motto, the ZTM and BPD unit has started corporate membership facilities. At present the unit networks with 350 corporate members, including individuals, farmers, NGOs, private seed companies, private companies, KVKs, *samiti*, farmer groups, and clubs etc. (Figure 11, next page). The corporate membership also serves as a source of revenue generation for the ZTM and BPD leading to realization of INR.1.5million.

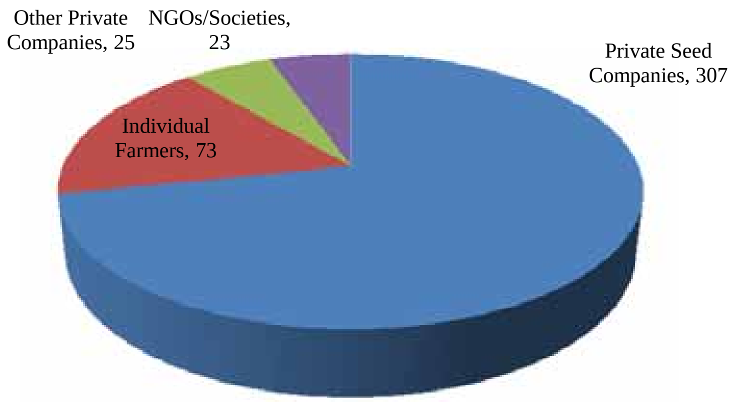

Figure 11: Nature of Corporate membership at ZTM and BPD Unit, IARI.

Success stories

The ZTM and BPD has commercialized a number of technologies, a few of them have been described here.

Nanotechnology basket –the future technology

Nano sulphur

The invention entails the development of surface modified monoclinic sulfur nano-particles of average size 20-100. Their liquid synthesis using polyethylene glycol-400 acts as a surfactant and can be used as fungicide. Nano-particles thus synthesized provide excellent fungi-toxic efficacy against the fungal pathogens and have excellent bactericidal properties. Thus the invention is a combo product for farmers. The positive aspects of the technology are: lower price alternative for the existing fungicides and bactericides, eco-friendliness, high efficacy, safe to handle, and very slow development of resistance. The technology has been licensed to which is one of India's biggest phosphatic fertilizer company.

Nano fertilizer

Nano Fertilizer technology is related to rapid synthesis of agriculturally important mono-disperse nanonutrients, more particularly nanoparticles of P, Fe, Zn and Mg using microbes. The technology enables production of nanofertilizers to get cheaper, organic, and efficient nutrient sources for plants. The beneficial aspects of technology are: threefold increase in nutrient use efficiency; 80-100 times less requirement than chemical fertilizer; highly environment friendly being a complete bio-source; 10 times more stress tolerance by the crops; 30% more nutrient mobilization in the rhizosphere; and 20-48% improvement in crop yield. The companies are showing good interest in nano fertilizers and this technology is being welcomed by the market.

Animal Feed Block Making Machine (AFBMM)

This technology was developed to serve the purpose of animal feed management and useful for making animal feed blocks (20 cm X 20 cm) by mixing crop residues with essential nutrients, powered by 25 HP electric motor. The positive aspects of the feed block machine are: feed blocks can be formed in customized shapes and sizes; feed materials can be handled easily; labor cost is reduced; large quantities can be stored in less space (volume reduction: up to 42 times); transportation is economical and efficient; and shelf life is extended; formulations can be adjusted for different animals; and feed is softened on compaction and animals prefer eating these blocks. The machine has been licensed to M/s Perfect Hydro Machines, Haryana and M/s Standard Hydraulics, Manesar, Haryana. These licensee companies are reaping good returns and more companies are showing interest in this technology.

Pusa Basmati 1509 (PB 1509)

PB 1509 is first early maturing Basmati rice variety with seed to seed maturity of only 110-123 days with an average yield of 3.94 t/ha. It has moderate resistance to leaf blast and brown spot diseases. It possesses extra long slender grains (8.19 mm) with very occasional grain chalkiness, very good kernel length after cooking (18.2 mm), desirable ASV (7.0), intermediate amylose content (21.24%) and strong aroma. The advantages of PB 1509 over other rice varieties are its semi-dwarf stature, non-lodging and non-shattering habit, reduced duration. With this variety in 2013-14 kharif season, farmers earn around .1 million INR per acre. This variety has been commercialized to 14 companies namely, M/s Metahelix Life Sciences Limited, Bangalore, M/s VNR Seeds Pvt. Ltd, Raipur, M/s KRBL Ltd, New Delhi.

Pusa Early Hybrid Maize – 5 (PEHM- 5)

Pusa Early Hybrid Maize -5 (PEHM-5) is suitable for normal sowing and water logged conditions and gives higher yield of 5-6 t/ha. It is an early (78-82) maturing single cross hybrid and gives good response to high nitrogen levels. The PEHM-5 has been commercialized to three companies namely, M/s Sampoorna Seeds, M/s Sri Laxmi Venkateshwara Seeds, Kulnoor (AP), M/s Victory Seeds Pvt. Ltd, Kurnool, AP. The variety has shown good results in Haryana and Andhra Pradesh and is in high demand by many other companies.

Wheat variety- HD 2967

The HD 2967 is a high yielding wheat variety yielding 5.0 t/ha in North West Plain Zones (NWPZ) and 4.4 t/ha in North East Plain Zones (NEPZ) and also has potential for wide scale adoption. It is suitable for timely sown irrigated conditions and possesses adult plant resistance against most prevalent leaf rust disease as well as of 78S84 and 46S119 two most virulent races of yellow rust disease. This variety of wheat also has better degree of resistance against leaf blight and matures in about 143 days in NWPZ and 129 days in NEPZ. The technology has been commercialized to 36 companies and important among these are: M/s Kurukshetra Seeds Pvt Ltd, Haryana, M/s Parbhat seed Traders, M/s Kamboj Export, M/s Model Agritech India Ltd., Karnal, M/s Bhawani Seeds and Biotech and M/s Haryana Seeds Co. The farmers and the companies who have adopted or licensed this variety have reaped good returns and are very much satisfied with the performance of the variety.

Conclusion

Under the new framework of globalization and liberalization, Indian agriculture sector needs to focus on science-based growth rather than resource or input-based growth. In this paradigm shift, the flow of knowledge and innovations plays a critical role. R&D activities, new inventions, and their protection through patents and IP tools of plant variety protection are going to assume more importance in the future as it is a cost-effective method for promoting growth with sustainability while attaining competitiveness. The innovative 3-tier structure framed by ICAR in the form of ATMC, ZTM and BPD unit, and ITMU is playing a major role in the protection of IP assets of the ICAR institutes in the interest of scientific community, institute, and society. This mechanism is actively involved in transfer of agricultural based innovative technologies to responsible companies, thereby benefitting the society at large. The BPD unit established with the World Bank funding under the NAIP project has been able to achieve the following in a short span of time:

- The BPDs have evolved into niche entities within the ICAR institutes and has acquired the expertise in IP management.
- The efficient management of technology transfer has led to better identification of technical needs of end-users and development and delivery of relevant technical solutions.

- Frequent contact with end-users through industry meets, field days, etc., have facilitated information sharing on needs and opportunities and have elevated mutual understanding and established trust.
- The evolution of full proof system of distribution of license fee and royalty has developed an incentive system for giving impetus to knowledge creation.
- The scientific personnel have been trained to educate them of the merits and techniques of commercialization.
- The exercise of economic reasoning and justification of proposed research projects has been found to increase the effectiveness of R&D in terms of research output and posterior commercial success.
- The research priorities have now become more sensitive to demand pull rather than science push forces.
- BPDs have inculcated the entrepreneurship culture among the scientists.

However, the real challenge lies ahead as the World Bank-funded NAIP project support is coming to an end by March 2014. It is likely to be continued with the fund support by Government of India under its 12th five-year plan. Presently these units are not being run on self-sustainable basis as these are not permitted to retain the revenue earned by them. The BPD units need to be further empowered and supported for them to be able to continue to support the ICAR institutes and the vast agrarian economy of India.

References

1. ICAR (2006), ICAR Guidelines for Intellectual Property Management and Technology transfer/ Commercialization, 2006, Indian Council of Agricultural Research, New Delhi.
2. Bhooshan, Neeru. (2010), Fundamental of Intellectual Property Rights, published by UPCAR, Lucknow, Uttar Pradesh, India.
3. Boehlje, M. (2004), Business Challenges in Commercialization of Agricultural Technology, International Food and Agribusiness Management Review, Vol. 7(1): 91-104.
4. http://www.copyright.gov.in/, accessed on 1st Oct, 2013
5. http://www.ipindia.nic.in/ipr/patent/patents.htm, accessed on 1st Oct, 2013
6. http://www.plantauthority.gov.in/, accessed on 1st Oct 2013

Chapter 10: Institutional Mechanisms for Technology Commercialization to Promote Entrepreneurship among Women

Sudha Nair, Golden Jubilee Biotech Park for Women Society, Chennai, India
With inputs from Ms. Anandhi, General Manager of the Park; Dr. K. Rajeshwari; Dr. R. M. Anjana and Ms. Anitha

Background

Golden Jubilee Biotech Park for Women Society was established with a mission of providing opportunities for professionally qualified women to make a remunerative self-employment career through the organization of environmentally-friendly biotechnological enterprises.

"The experience gained at the Womens' Biotechnology Park established in Chennai nearly 15 years ago has underlined the need for translational research designed to convert scientific discoveries into commercial products and processes. The various steps involved in the process of commercialisation include capacity building, market intelligence and quality assurance. Cost, quality and reliability of supply will determine the viability of a technological enterprise. Modern information and communication technology helps to provide timely information on market conditions. It also helps in e-marketing. Women scientists and technologists are in the forefront of this knowledge and science-based revolution in the manufacturing sector. To be sustainable in the long term, such enterprises should be rooted in the principles of ecology, economics, energy conservation and employment generation."

- Dr. M S Swaminathan, Chaiman, M.S. Swaminathan, Research Foundation, India.

Genesis

In late 1996, UNDP-UNIFEM and M S Swaminathan Research Foundation organized a meeting of women scientists and technologists at Chennai. The members and experts realized the inherent capabilities of women in management, and the need for women entrepreneurship development became a prime concern. It was recognized that the resources and strengths of women need to be channeled to develop their full potential so as to take their rightful place as equal partners in all spheres. In order to give shape to these ideas, the concept for setting up of Women's Biotechnology Park, a novel approach, came up. This was recognized as one of the priority areas identified by the Department of Biotechnology (DBT), Government of India, and the report of the working group for the formulation of the ninth Five Year Plan (1997-2002). On the recommendation of the task force on Biotechnology-Based Programs for Women and Rural Development constituted by DBT during 1997-98, the park was included among the approved programs for commemorating the 50^{th} anniversary of India's independence.

The first phase of the park became operational in May 2001 with generous financial support (Indian Rupees (INR) 40 million (US $735,768) from the Department of Biotechnology on 20 acres of land allotted by the state government; it was implemented by the Tamil Nadu Industrial Development Corporation (TIDCO) with the concept and technical inputs from the M S Swaminathan Research Foundation. The Park was fully occupied in the year 2006-07. It was also featured as one of the programs being implemented as part of plans laid out by the State of Tamil Nadu in its policy document to promote the Biotechnology Sector in the State (TN Policy Doc 2000) along with the Ticel Bio Park – a commercial venture of the State of Tamil Nadu to support biotech-based industries.

Organizational structure and services

The Golden Jubilee Biotech Park for Women Society is registered as a society under the Tamil Nadu Societies Registration Act. The Governing Body of the Park has members from promoter organizations, research and industry, central and state governments, financial institutions and women entrepreneurs. It is chaired by Prof. M. S. Swaminathan.

The **main objectives** as stated in the bylaws of the Park are:

- To provide opportunities for remunerative self-employment for women entrepreneurs based on biotechnological enterprises.
- To foster and promote a close and productive linkage between industry, associations, trusts, societies and Rand D institutions, including universities engaged in research and development in the field of biotechnology or/and other relevant technologies.
- To catalyze the interaction between industry and research and development (R&D) institutions (including universities) engaged R&D activities comprising: quality control, testing, technology incubation, market research, and research into engineering design with a view to convert the concepts and ideas in the field of biotechnology and other relevant technologies into processes and products to enable them to reach the market. Also, to organize training, capacity building and information and skill empowerment programs for women entrepreneurs in the field of biotechnology and related technologies.
- To assist, financially and otherwise, innovation and development, including application and commercialization of biotechnology and other relevant technologies, or any other technology in general in India and abroad, and to encourage industries of sole proprietorship, partnership or registered as company that are or will be engaged in innovation and development, including application and commercialization of biotechnology or other relevant technologies.
- To provide counsel or advice or assistance in obtaining counsel or advice related to biotechnology or other relevant technologies to the government, individuals, firms or companies or any association of persons.
- To assist, financially or otherwise, preparation of all types of prefeasibility reports or detailed project reports on concepts and ideas in the field of biotechnology and other relevant technologies, establish a mechanism of screening these, and facilitate the setting up of commercially viable projects in the area of biotechnology and other relevant technologies and to provide marketing support.
- To take steps and secure the filing, registration and issue of patents, licenses, and consent forms in respect of any know-how and technical knowledge developed; and transfer, sell or dispose of such patents on terms and conditions, as may be deemed fit.
- To promote, coordinate, assist and undertake the acceptance and certification of products and processes in biotechnology and any other technology.
- To arrange for a single window concept on data dissemination schemes and subsidies, etc., available to women.
- To promote market linkages, helping in promoting their products, for example, through web pages and other forms of electronic commerce.

While the first phase of the Park was setup amongst challenges like hesitant support from the banking sector and also a long gestation phase due to its unique concept (being pro-women when the industry was of the opinion that entrepreneurship is gender neutral), the Park with its full occupancy proved to be a successful model thanks to the extensive support systems that were put in place right from its conceptualization.

These included various support services for the entrepreneurs, a scientific advisory committee that helped in the selecting and addressing the technical viability of the enterprise, a financial advisory committee that helped in the financial aspects in the management of the Park, and facilitation in all other matters needed to set up an enterprise.

Some of the best bio-clusters are in the south, especially in Bangalore and Hyderabad. To name a few: 1) the 14-acre Bangalore Helix; 2) the Shapoorji Pallonji Biotech Park (300 acres), specializing in life sciences, health care and pharmaceuticals; 3) the 200-acre ICICI Knowledge Park has R&D companies involved in the life sciences; and 4) the 25-acre Agri-Science Park, with 3,000 square feet of laboratory space, which has already incubated more than 100 ventures in the agribusiness sector. Tamil Nadu also has the Ticel Bio Park Ltd, which has completed its first phase, with 87 modules of labs and is fully occupied. They are now promoting the second phase, coming up in 5-acres of land, with more than 0.4 million sq. ft. lab space and 0.2 million sq. ft. space for commercial and other purposes. The state also has 12 incubator Parks as clusters associated with universities.

The Golden Jubilee Biotech Park for Women Society is recognized as a good model of such an initiative at the national and international levels. It was also recognized as one of the successful clusters that has nurtured entrepreneurship in the Biotech Sector in Nature Biotechnology, issue Nov 2010, in its special feature on India's emerging biotech industry.

Occupants and activities at the park

The Park currently has 11 entrepreneurs of which 50 percent are first generation entrepreneurs. Seven have moved out of the park. The current total turnover of the Park is INR. 50 million ($919,710 USD), with a little more than 150 employees consisting of both skilled and unskilled workers, of which 50 to 60 percent are women. The Park is also recognized by many banks today that have supported the individual entrepreneurs. The profile of current entrepreneurs is:

- **Dream Finders** - Production of herbal cosmetics, health and home care products
- **Elbitec Innovations Ltd** - Manufacture of agricultural bioinputs
- **Farm Suzzane Pvt Ltd** -Sea food processing unit
- **NGR Foods –** Ready-mix products and ready-to-eat products
- **Bioklone –** Custom antibody services, diagnostics
- **Hirise Food Tech Lab -** Quality testing for food products
- **Radianz Biotechnologies –** Antibiotic discs
- **Madras Diabetic Research Centre - Research Centre and Training Institute** – diagnostics, specialty food and footwear for diabetic people
- **Nouveau Dietitque Pvt Ltd -** Production of biotech-based medical/functional food products
- **Thiruvensun Bio botanica Pvt Ltd -** Herbal cosmetics and home care
- **Asean Aromatics -** Natural extracts, essential oils and aromatics
- **Yaathum Biotechnology -** Diagnostics

Technology development and commercialization

One of the objectives of the Park is to help with commercialization. Most of the entrepreneurs at the Park have their own technologies being adopted for their entrepreneurial activity. The Park normally plays the role of a facilitator to help in accessing a technology from other agencies. Some of the biotech enterprises have a major research component in their work, and most of them have memorandums of understanding

(MoUs) and confidential disclosure agreements (CDAs) when they have collaborators. Patenting is a very expensive proposition for SMEs, and especially for first generation entrepreneurs, and the Park tries to help them. A few case studies are presented here that reflect the profile and the options they have chosen. The Park has a very active IPR person on its Board and is in the process of helping individual units case by case.

Case studies

Case study 1: Madras Diabetes Research Foundation

The Madras Diabetes Research Foundation (MDRF) was established in 1996 as a 100 percent non-profit Research Foundation under Societies Act by Dr. V. Mohan and his wife late Dr. M. Rema in Chennai. Its objective is to carry out research of world standards on diabetes and its complications and to establish an environment for developing innovative technologies and products, which can be translated to be used in therapy of the disease. MDRF took possession of the land module within the Park in 2003 and initiated their operations in 2007 after putting a state-of-the- art facility within the park. Among their main areas of focus, collaborative research is one main activity which helps in developing innovative technology in the area of diagnostics. Some of the ongoing collaborations are described here.

Noninvasive type 2 diabetes screening: Clinical evaluation of 'SCOUT DS®' and 'DiagnOptics AGE Reader™' in an Asian Indian cohort

Several novel methods [non-invasive point-of-care (POC) screening technology] for screening for diabetes and pre-diabetes with potential application in low resource settings are currently in late stage R&D. So far, all technologies that have been reviewed are targeted towards high resource settings and have been evaluated primarily in the USA and Europe. While many features of the proposed products appear to be a good fit for developing country healthcare, there is a dire need to evaluate these POC technologies in Indian settings and compare their performance with the existing technologies. Recently, noninvasive diabetes screening based on skin fluorescence has been proposed as an alternative to blood-based screening.

MDRF is currently testing and validating non-invasive, point-of-care (POC) devices with prognostic/diagnostic value for general public patients with type 2 diabetes and associated complications, which will have immediate translational applications. The two devices being evaluated are the Scout DS® (VeraLigth, Albuquerque, NM, USA) and DiagnOptics AGE Reader™ (DiagnOptics BV, Groningen, Netherlands). This ongoing study is supported by the U.S. National Institute of Biomedical Imaging and Bioengineering and the Indian Government's Department of Biotechnology (DBT) and is being done in collaboration with PATH, Seattle, WA, USA.

Both the SCOUT DS and DiagnOptics devices are small hand held electrically line-powered devices that measures skin fluorescence using proprietary technology to detect abnormal concentrations of advanced glycation end products (AGEs) which are diabetes-related biological markers found in skin. If found feasible to use in the Indian population, this will be a groundbreaking non-invasive technology, which is easy to operate, needs no blood draw and does not require fasting. The patients simply have to place their forearm onto the portable table-top unit and a quantitative result is reported in about three minutes. Once proven, the same can be marketed as the equipment has good commercial potential.

A pilot intervention study on “Substituting brown rice for white rice- effect on diabetes risk factors in India”

Polished white rice has been found to be the major contributor to the dietary glycemic load and is associated with type 2 diabetes risk in the Indian population. Meta-analyses from observational trials and randomized controlled trials have found that a low-GI diet and increased intake of whole grains were associated with a reduced incidence of diabetes and a fall in HbA1c among persons with diabetes. With this in view, MDRF, in collaboration with Harvard School of Public Health (HSPH) has initiated a pilot randomized feeding trial (cross-over design) to evaluate the effect of substituting brown rice for white rice in two meals daily for a four-month period, on several biomarkers for diabetes risk among overweight participants in Chennai. The project is sponsored by NIH-Fogarty R03, USA. Given the predicted marked rise in diabetes incidence in India, and the high consumption of fully-polished white rice, this study has important implications for public health and food policy. This is the first such Indian study to conduct a feeding trial with brown rice and evaluate the same among overweight Indian adults.

Established Glycemic Index Testing Centre for evaluation of the glycemic index of various foods

Glycemic Index (GI) measures the rate at which the food gets digested and converted to blood glucose. This is the property of the food and ranked on a scale of 100 being the GI of glucose. In collaboration with Oxford Brookes University, UK, MDRF has set up the Glycemic Index Testing Centre for evaluation of the glycemic index of various foods at the Siruseri campus. GI testing of around 100 foods (both International and national foods samples provided by various clients) has been completed from 2007 to 2011. This department of MDRF is first in the country to use validated methodology to test the glycemic index of foods in the country.

To develop gene chip for diagnosis/prognosis of diabetes and its related disorder

The Department of Molecular Genetics, which was designated as an “ICMR Advanced Centre for Genomics of Type 2 Diabetes” by Indian Council of Medical Research (ICMR), New Delhi, collaborates with many national and international institutes and companies such as the University of Minnesota (USA), Genentech (USA), Imperial College, London (UK), London School of Hygiene and Tropical Medicine (UK), Xcelris Genomics (Ahmedabad), Scigenom (Kochi) and others. The ultimate goal is to develop a gene chip for diagnosis/prognosis of diabetes and related disorders.

For all the above individual worked out MoU’s and CDA have been put in place apart from MTA’s which have been followed by them. As the work has not reached a level of commercialization as yet, the other aspects have not been spelt out. While, by and large the organization has a policy that the “Society should be benefitted,” the Park is helping the unit in putting their IPR Policy in place (Source: Dr. R. M. Anjana, Vice President, MDRF; email: dranjana@drmohans.com).

Case study 2: Bioklone

Bioklone was set up with the primary aim of providing an indigenous supply of high quality custom antibodies for research, diagnostic and pharmaceutical applications in India. Antibodies to well known proteins are already available from many foreign and also a few Indian companies. These are called commercial antibodies. Many researchers import commercial antibodies from foreign companies. These antibodies are expensive. Moreover there may be delays in procuring them, due to shipping problems or non-availability of stocks. Hence many scientists have been constantly looking out for Indian firms that would develop high quality antibodies at a competitive price. Other than commercial antibody requirement, scientists are also in need of custom antibodies for the new proteins and bio-molecules identified by them frequently. Unlike commercial antibodies, these custom antibodies are not available in the market. Although many foreign and a few Indian firms have stocks of commercial antibodies, very few firms in India undertake development of customized antibodies based on the client’s needs.

In the last six years, Bioklone has developed several antibodies to various peptides and proteins in mice (monoclonal and polyclonal) and rabbits (polyclonal). For generation of mouse monoclonal antibodies, somatic cell fusion between splenocytes from immunized mice and mouse myeloma cell-line is carried out using a fusogen. The firm has been able to procure the mouse myeloma cell line from indigenous sources and has been successfully involved in raising mouse monoclonals to several custom antigens. The other main focus of Bioklone is to successfully generate rabbit monoclonal antibodies. Ever since the advent of hybridoma technology in 1975, mouse monoclonal antibodies have been extensively generated and used in research and diagnostics. In the recent years, rabbit monoclonal antibodies are being raised for commercial and custom antigens, because of the following advantages that they offer over their mouse counterparts: rabbit monoclonals display higher specificity and binding affinity to the antigens; they exhibit better immune response to small antigenic epitopes which might have failed to induce response in mice and they are very useful in immunohistochemistry of formalin fixed, paraffin embedded sections.

Very few companies abroad have been successful in generating rabbit monoclonal antibodies. Considering the advantages of rabbit monoclonals, a rabbit antibody service platform in India would be useful to Indian researchers. Bioklone has received several requests from scientists in premier research organisations in India and also a company in the USA for developing rabbit monoclonal antibodies to custom and commercial antigens. The most important requirement for generation of stable rabbit hybridoma is rabbit myeloma cell-line which is currently available with only one company in the USA. Efforts by Bioklone in procuring the cell-line were not successful since license for rabbit myeloma cell lines was prohibitively high for a company of our size. They are in the process of developing alternatives and seem to be making a good progress.

As in the case of the other company, since this unit is more CRO category, citation is recognition for their work. Once the technology is developed by them, the Park will help them in the appropriate protections they would need (Source: Dr. K. Rajeshwari, Proprietrix, bioklone; email: vrajie@yahoo.com).

Case study 3: Yaathum Biotech

One of the new entrants at the Park is a very young entrepreneur – Ms. Anitha Rajagopal who is basically interested in developing kits for fast diagnosis of diseases in India. After her post graduation in Bio-Medicine in the UK, she had an opportunity to work in a company which was involved in producing and marketing of qPCR kits in developing countries including India. She felt that it would be good to develop a technology based on this for diagnosis. She along with a few friends, who were fellow students, moved into the Park and are in the process of setting up their lab and required infrastructure for developing a rapid and sensitive multiplex real time assay for the simultaneous diagnosis of a few prevalent diseases. Having done their preliminary work, they are confident that they will be able to make a major breakthrough and commercialise it, too. The Park is helping them in many ways (Source: Ms. Anitha Rajagopal, MD Yaathum Biotech , email: anithavahini@gmail.com)

Key constraints and lessons learnt

The objectives spelt in the MoA have been met at various degree of success. Providing a platform to encourage women, especially first generation entrepreneurs to take to self-employment based on biotechnological enterprises is the best met of these.

Fostering a close productive linkage between industry, associations, trusts, societies and R&D institutions including universities engaged in field of biotechnology or relevant field has been met through the individual entrepreneurs to a large extent. To a very small extent interaction with universities through the summer/winter training sessions offered by the TRC and a couple of individual entrepreneurs like MDRF, Bioklone, Hi Rise Food Tech Lab has been met. This is one area which can be expanded vastly and could be done through formal MoU with universities and colleges which offer biotechnology as a course. Bioklone has shown the way by initiating such options and MDRF is considering setting up a school of nursing and diabetes technologies to train nurses and technicians in specialized diabetes nursing. Thus, these activities will not only help in enhancing the training capacity of the Park, but also help in inculcating the entrepreneurial instincts in the young students.

The Park will focus more on recognising the innovations happening in the Park and commercialization of the technologies being developed. The capacity of the entrepreneurs to protect their innovations is an area which the Board will be actively working in the months ahead and also developing the capacity of the individual units. The Golden Jubilee Biotech Park for Women Society is considering an expansion to make it more vibrant and to meet the demand emerging from women entrepreneurs.

With an increased thrust in concept of promoting incubators to strengthen the concept of innovation and scale up by DBT and other agencies, the Park is considering establishing an incubator in the second phase and successful incubatees could then move on to establish their enterprises within the Park so as to get an effective hand holding until they prosper.

The scope for introducing an incubator as part of the expansion plans will help in strengthening the motto of nurturing entrepreneurship in the biotech sector. Today the atmosphere is more enabling in terms of policy support and various departments who can partner the park in doing so. Also, with the uptake of students in the Bitoechnology Course being offered, going down, it is important to create career options for those who take BT as an option.

There is also a huge potential in the area of facilitating NRI Science stream members who want to come back to India and set up their units. The Park can be one of the identified bodies to facilitate such members to come back and set up their units. One such applicant is already a new entrant in the Park as covered in case study 3. One of the main indentified focuses in the second phase is positioning the Park as a mentoring centre for first generation entrepreneurs and IPR will be one of the themes.

Web link

www.biotechpark.co.in

Chapter 11. Private Seed Sector Perspective on Technology Transfer and commercialization in India

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Indian society is an agrarian society where 60% of the population is directly engaged in agriculture. This huge population is contributing only 14 to 15% to the GDP. Average annual growth of the agriculture and allied sector during the Eleventh Five year Plan at 3.6% fell short of the 4% growth target. The Gross Capital Formation (GCF) almost doubled in the last 10 years. The average land holdings are continuously decreasing and presently stood at 0.6 ha which will decrease to 0.3 ha by 2030. In the last two decades, the cultivable land decreased by more than 3 million ha by urbanisation and degradation. According to the National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), most of the cultivated lands in India are fertility degraded. Indian agriculture is mainly monsoon rains dependent because 60% of the area is under rainfed agriculture. The post rainy season is also affected by rain patterns due to availability of residual moisture. The food production growth in the 11th five year plan was around 3.6% from 4% planned and again planned 4% in 12th five year plan. All these factors will shape the future of research in agriculture and technology infusion to develop a sustainable system of food production for the growing population. India is producing at present more than 250 million tons food.

Development of agriculture sector in India

India has mega public sector in agricultural research. There are 47 agriculture universities, 4 deemed universities and 4 central universities with agricultural faculty. There are 45 central institutions,17 national research centres, 25 project directorates, 6 bureaux and 630 Krishi Vikas Kendra (KVK) for extension activities. More than 35,000 agricultural scientists are working in the public sector and developing regional and national solutions to the various agriculture-related issues of the farmers. India is growing a large number of crops including cereals, oilseed, fibre, pulses, vegetables, fruits, industrial crops like sugarcane, rubber etc., ornamentals, medicinal plants, spices, dry fruits like cashew, etc. All these crops are taken care by small regional institutes which are specialized to cater to one or more than one crop. For seed production and distribution, National Seed Corporation (NSC) was created as early as in 1963 and subsequently 15 State Seed Corporations (SSC) and one State Farms Corporation (SFC) was created. The basic mandate of these corporations was to multiply and distribute the seed developed by universities and institutions.

Private sector entered in the agri-business sector to improve the inefficiencies of public sector in agri-marketing and supply chain system. Initially in the seed sector in the sixties and seventies, many of the public bred varieties are restricted to very small areas of production and distribution. Private sector took those varieties and produces the quality seed and distributed those seed across country. With this activity, a new era of private sector entry into not only in seed production and distribution started but also in R&D to develop new cultivars. In the eighties, with the introduction of New Seed Policy (1988) many MNC's started their operations in India and delivering hybrid technology in key crops to the Indian farmers. The decade of the nineties was the era of expansion of seed sector and introduction of upstream technologies both in Indian companies and MNC's.

From a university or institute-based agriculture system, now it was moving towards a management-based corporate system of agriculture. The investments by private sector in breeding and upstream research started in a big way. The introduction of hybrids in corn, sunflower, millets and sorghum in the eighties set the strong base for privatisation of breeding and seed supply chain system in India.

The demand for food is increasing due to increasing population and rising per capita income. Currently India is producing food grains in the range of 240-250 million tons and by 2030 India needs around 350 million tons (Figure 1). So almost 6 million tons more food is to be produced every year to reach to that target. The demand for high value commodities such as vegetables, fruits, milk, fish, meat and eggs is increasing faster than food grains. These commodities demand will increase more than 100% by 2030 (Figure 2). These commodities are all perishable ones and require different infrastructure for handling, value addition, processing and marketing.

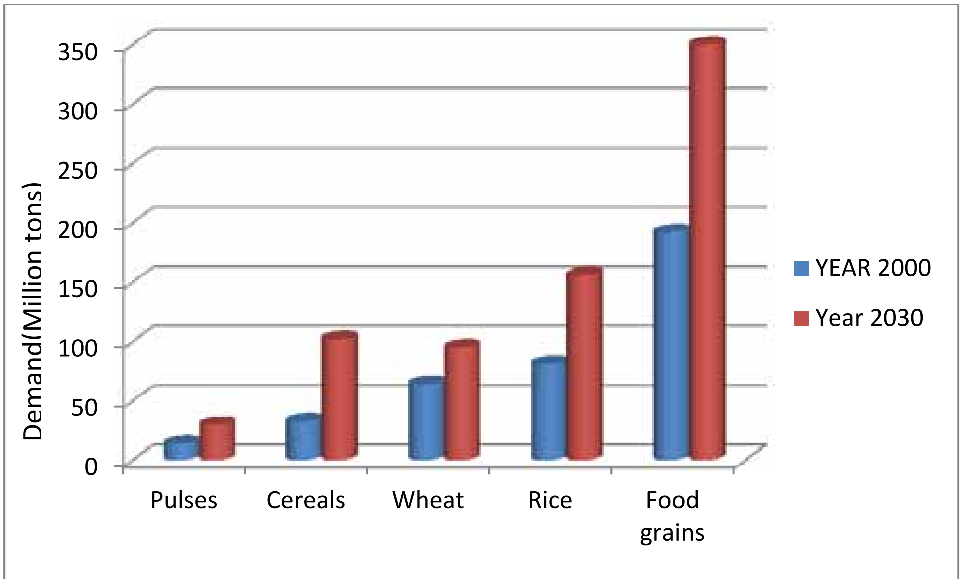

Figure 1. Demand of food grains in 2030

Source ICAR Vision document 2030

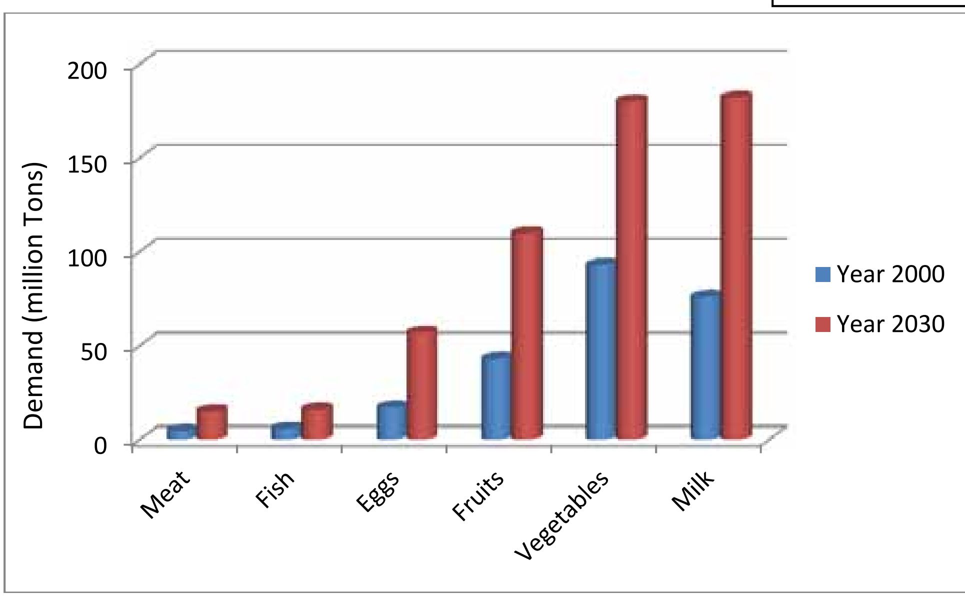

Figure 2. Demand of perishable commodities in 2030

All these challenges also create lot of opportunities for all stakeholders involved in research and value chain. For private sector, there is huge opportunity to develop promising technologies and management to raise the productivity in deteriorating production environment. There is also opportunity in research to develop products with better post- harvest shelf life in perishable commodities like vegetable and fruits and have increased value addition in these crops.

Current role of private sector in technology commercialization in agriculture sector in India

Top multinational and indigenous seed companies are presently operating in India. There are about 500 seed companies operating in India and only 20% have their own R&D while others are either producing and selling public or licensed hybrids and varieties, or only trading licensed hybrids. Total traded seed market in India is worth 2.6 billion $.The Open Pollinated Varieties (OPV'S) which are grown in large acreage of many field crops have a value of US $550 million (Figure 3), while hybrids in key crops have a value of US$ 1.20 billion. Cotton seed alone is contributing US $770 million (Figure 4). The hybrid cotton market is almost saturated and Bt. cotton is covering almost more than 90% area. Cotton is the first genetically modified crop released in India all by private sector. Today more than 10.5 million ha area is under private sector hybrids. Most of the Bt. technology is licensed by Monsanto. Small portion of the technology is provided by a public institutes from India and China. There are about six events of Bt. In cotton are approved.

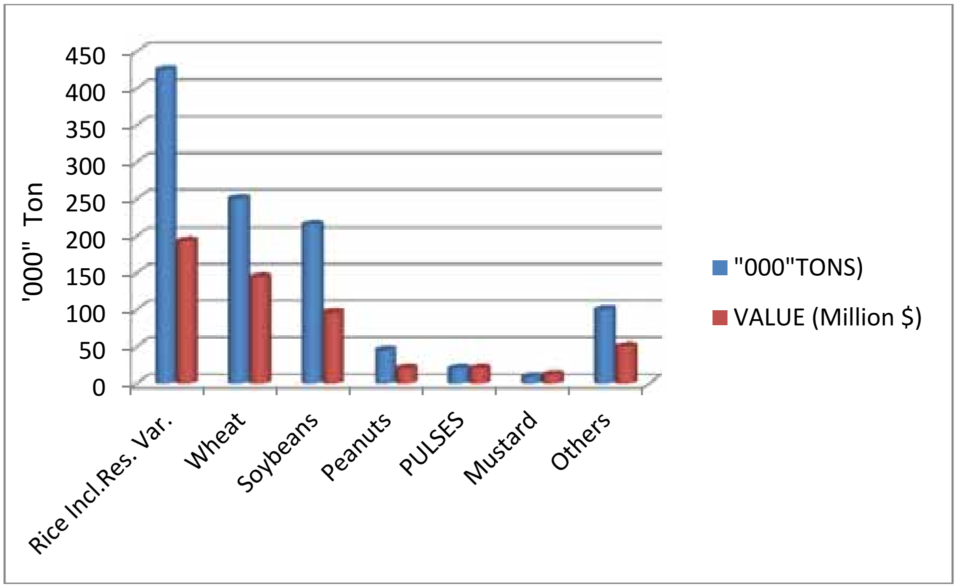

Figure 3. Volume and Value of OPV seed of Field crops

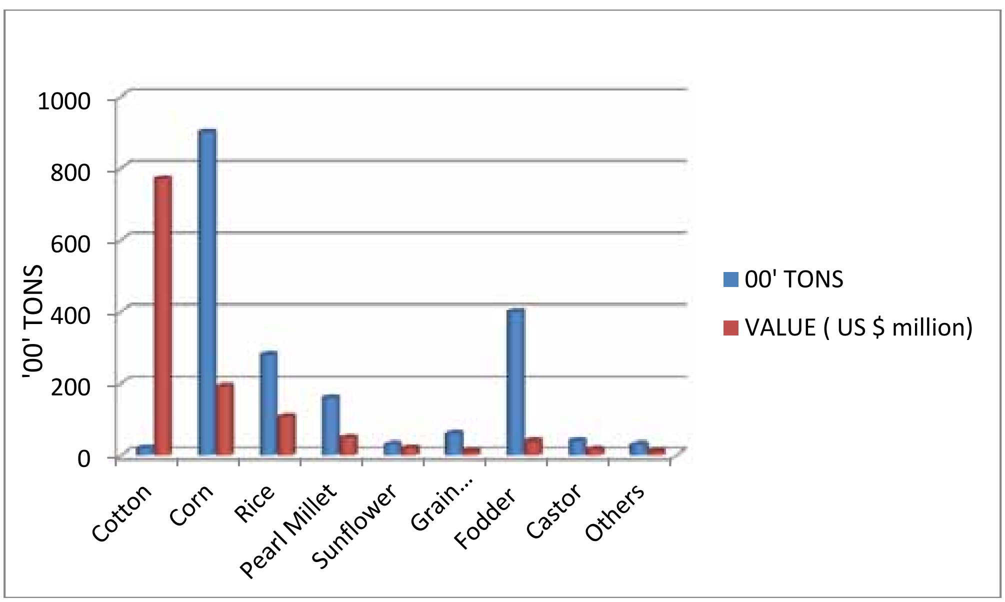

Figure 4. Volume and value of Hybrid seed of field crops

Corn hybrid seed market is increasing both in rainy and post-rainy seasons. Large area is coming under now single crosses and productivity per ha has increased from 1.8 tons to more than 2.5 tons on average. In winter corn areas, the productivity is more than 6.0 ton per ha. Rice hybrids are also expanding and now covering 2 million ha. The major adaptation of hybrids is happening in the northeast region of India. The reason for this is the productivity difference between local open pollinated varieties and hybrids.
The major rice producing areas are still not adapting the hybrid rice. The reasons for non- adaptation are that the open pollinated varieties are yielding equivalent to hybrids and quality of the grain of hybrids are not acceptable to millers and consumers.

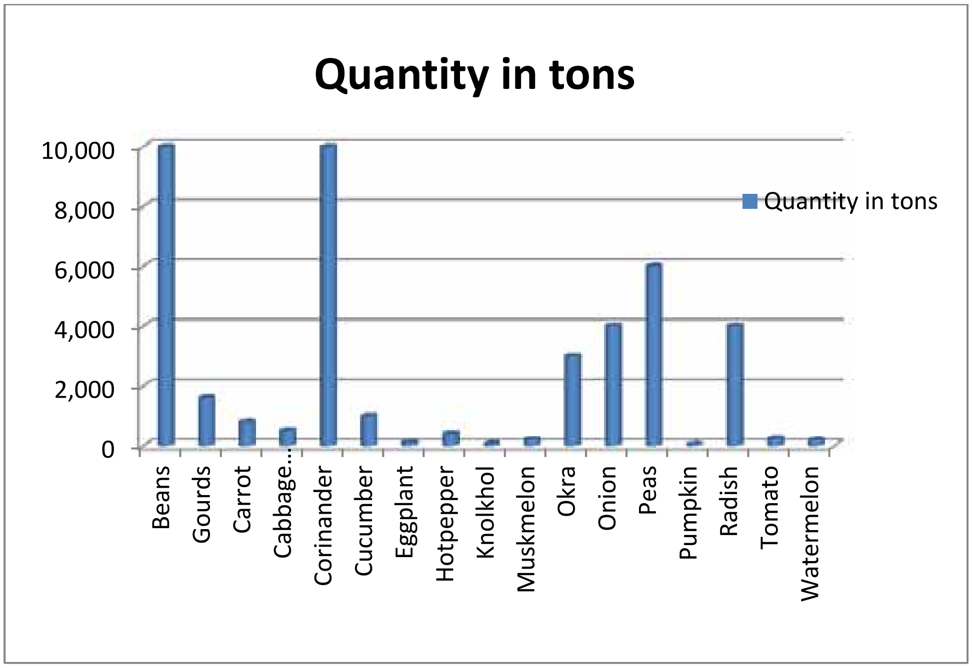

Figure 5. Open pollinated vegetable seed sale in India

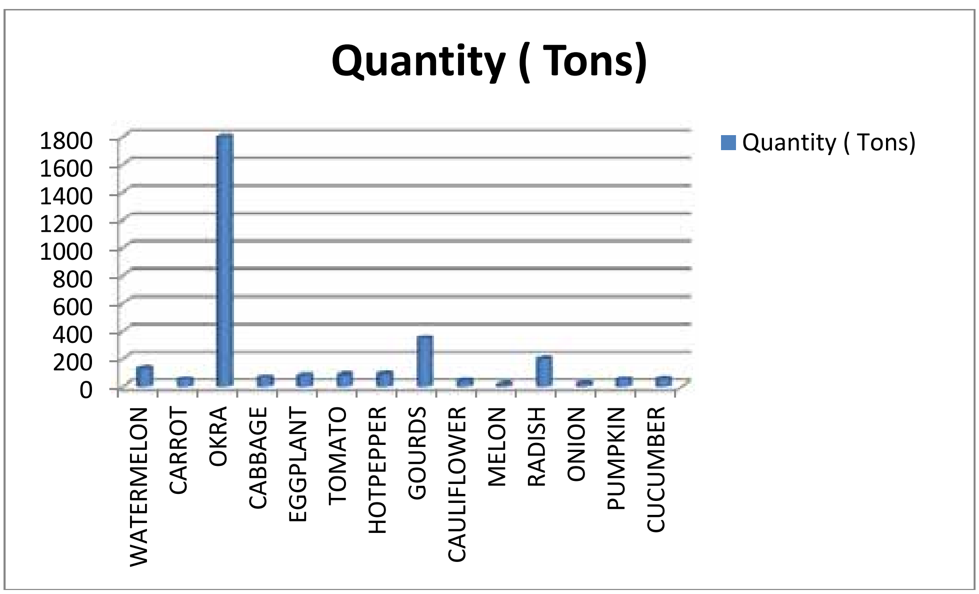

Figure 6. Vegetable hybrid seed sale in India

Vegetable seed market is expanding in India rapidly and all global players of vegetable seed research and sale are operating in India. The area under vegetables is more than 8 million ha and is growing due to increase demand of vegetables. Though India has still large market of open pollinated vegetable seeds of local and global crops by volume but by value it is around US$ 250 million (Figure 5). Major Open Pollinated (OP) crops are peas, beans, onion, okra, gourds, etc. The hybrid vegetable seed market is also expanding and is growing by volume and value. It is presently by value is worth US $300 million (Figure 6). The main hybrid crops are tomatoes, hot peppers, okra, watermelons and melons, cucumbers, etc. Major breeding in vegetables is through conventional methods and now many companies are using molecular markers for trait selection and introgression of novel traits in different background.

New developments in agri. industry in India

The private seed industry is playing a key role in improving crop productivities by providing high potential seeds to the Indian farmers. Mix of MNC's and Indian companies are able to improve both local and global crops. Today the private seed industry is contributing 50% by volume and 70% by value to the agriculture sector. With the collaborative research projects with technology companies and in source finished technologies, Indian companies are entering in new era of technology-driven companies. Many MNC's have established their big centres of upstream research. DuPont, Pioneer, Bayer, Dow, BASF and Monsanto are in the forefront in upstream research while Rasi, Vibha and Nuziveedu seeds have established state of the art biotech laboratories in India. Collaborations of Indian companies with global biotech companies like Keygene, Evogene and many others is bringing trait specific technologies to India. All these efforts are improving the skills of Indian companies.

Growers have seen innovations in developing high performing seed and in the next decade they will see innovative products designed to increase efficiency and yield. Marker assisted breeding have significantly shrunken the time line for commercial introduction

Partnerships in agricultural research

Private to private partnerships are increasing for technology sharing and upstream research while public private partnerships are slow and only in few areas. There are many issues of policies and clarity in IP which are responsible for this slowness. Technology transfer to end user is only successful if it is packed in the elite background and gives complete solution to the farmers. So there are private sectors that are rich in germplasm and conventional breeding and there are companies who have developed upstream technologies to be introduced to make products sustainable for the farmers. Public sector in India is also engaged in developing new technologies and now opens to share with private sector. The technologies developed in public sector are not deliverable as such and need further research and improvement while many technology companies are providing finished technologies so the risk factors are minimum. The other issue is of non-exclusivity. Public sector is providing all technologies on non- exclusive basis and companies are apprehending risk of capital investment and realization. For smaller companies, who can't invest in upstream technologies, the non-exclusive model can work well.

The other challenges in the development of technologies are the issues of patents. Most of the new technologies and processes to develop these technologies are patented and are in the hands of very few in private sectors. Most of the public sector research is in the domain of improving the processes or in the area of software for interpretation of technologies. With the fast development of new biotech research machines, the time and cost is reducing and the data value is increasing. Now for 50,000 data point for 384 individuals will cost few cents. The issue is in the interpretation of data. We need better bioinformatics tools and trained people to interpret the huge data. The public and private collaboration in this area is very important.

GM crops and their future

After the success of Bt. cotton in India, a hope was generated that now the new technology will bring revolution in other crops also. But opposite to this, the Bt. Brinjal release was almost stopped and deferred indefinitely by the Ministry of Environment and Forest, Government of India. This led to a new debate whether India will approve any food crop in near future. Now the case is with the Supreme Court of India between Green Peace and the Govt. of India to decide the future course of introduction of these crops in India. Globally the GM crops are expanding and except Europe, the China, Latin American countries are accepting this technology rapidly and many GM crops are being released.

Present status of GM crops in India

Today, 51 universities are engaged in GMO's research in India both in plants and animals with the help of grants from DBT and other local grants. Total 118 institutions of national level are engaged both in agricultural crops and animals.

In the private sector, more than 47 companies are engaged in developing GMO's in various agricultural crops. Most of the companies are engaged in Bt. cotton research, but MNC's and local companies are developing new traits in many commercial crops. In cotton, Mahyco is developing RRF cotton with *cp4epsps* gene while Bayer Crop Science is developing Twinlink cotton for insect resistance with stacked event of cry 1Ab, cry 2Ac and bar. Bayer is also developing Glytol cotton with *2mepsps*. In corn, Syngenta is developing insect resistance and herbicide tolerance with *Bt11* and *GA21* stacked event while Pioneer is developing insect resistant and herbicide tolerant corn with *cry 1F* and *cp4epsps* stacked event and also with another stacked event *cry1F, cry 1Ab* and *cp4epsps* genes. Monsanto is also developing herbicide tolerant corn with *cp4epsps*. Beside that E.I. DuPont is developing transgenic rice with SPT1 and SPT6 maintainer event to maintain male sterile line along with Bt. genes against yellow stem borer in rice. Bayer is also developing Bt. Rice with *cry1Ab, cry1Ca* and *bar* stacked genes. A Metahelix Life science is also developing Bt. Cotton with their own gene *cry1C* event or *GFM cry1A* event. Beside that in public sector institutes, development of Mustard male sterile system with *barnase, barstar* and *bar* is being developed by Delhi University. In vegetables also many companies are engaged in development of GMO's. Mahyco is developing Bt. Brinjal. Bt. cabbage and cauliflower and okra with *cry1Ac*. Rasi Seed is developing virus resistant okra with *RNAi* technology and Bt. Brinjal with *cry1F*. Indian Agricultural Research Institute (IARI) is developing tomato resistant to TYLCV using Antisense replicase gene technology. With all these projects going on in both public and private sector, Indian agriculture will benefit from these in near future

Emerging issues related to public-private sector partnership for technology transfer and commercialization

The public private partnership had been in discussion for a long time in agricultural research and some success had been achieved but lot has to be done to achieve the desired results. Very few technologies which are developed in public sector are directly applicable for commercial releases. The technologies which are purchased or licensed from public sector have to be researched or developed further to develop commercial viable product. The emerging issues of public and private partnerships are:

1. **Policies.** In partnerships the policies, whether administrative or regulatory play an important role. The hierarchical policies exist in public sector where decision making and functional accountabilities are distant apart. The delegation of decision-making and implementation is very important for successful partnership. The regulatory policies governing financial, functional and administrative are important and need transparency and clarity with public sector.
2. **Controlling interests**. In partnerships, it is important to establish the fact that based on the financial and functional contribution, the controlling rights are assigned but these are again, not well defined in public sector.

3. **Protection rights.** In partnerships it is important to define the protection rights of each partner. The joint ownership or majority ownership has to be decided based on certain parameters.
4. **Exclusive rights.** Because of public good criteria, the public sector always work on non-exclusive rights of their developed technologies while private sector always look for exclusive rights.
5. **Partnership management.** It is always important to have a joint management board which will govern all financial, functional and administrative duties of the partnership. In most of the public private partnerships these instruments are lacking thus causing lot of issues.
6. **Profit/loss in partnerships.** Public sector always looking for sharing the profit but not taking responsibility of losses. It is always an inbuilt phenomenon in partnership to take onus of these things.

Conclusion

Our food systems can be understood as bringing together all the links of the food chain from input producers and research and development, to farmers, agro-industries, supermarkets -- all the way down to the consumers themselves. Yet, even though food systems as a whole fail to deliver global sustainable food security, analysts tend to pay more attention to one of its component- farming systems. “Business as usual” is not a solution and we have to make fundamental changes in the way we practice agriculture and manage our natural resources ensuring sustainability of food for all. From traditional agriculture which ensured “Green Revolution,” we now move to “Gene Revolution” where we are doing precision-breeding using modern tools of biotechnologies. The major drivers for innovative breeding are climate change or shifts and time lines to introduce adaptable crops. We are now moving from EVOLUTION type of breeding to REVOLUTION type of breeding using upstream research tools.

The resource intensive agriculture needs participation of public and private research. We should not move together like railway lines where we remain side by side but never meet. The ultimate goal is deliver the performing varieties to farmers for higher productivity and production and should be sustainable under all adverse conditions.

References

1. Indian Council of Agricultural Research 2011-Vision 2030.www.icar.org.in
2. Agriculture and Food Management –Economic Survey 2012-13,http://indiabudget.nic.in
3. http://igmoris.nic.in- Information on biotech activity in India.

Chapter 12: Agribusiness and Innovation Platform at ICRISAT

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International Crops Research Institute for the Semi-Arid Tropics

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development (AR4D) in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid or dryland tropics has over 2 billion people, 644 million of whom are the poorest of the poor in the world. ICRISAT and its partners work towards empowering these poor people to overcome poverty, hunger and a degraded environment through better agriculture and envision a prosperous, food-secure and resilient dryland tropic. ICRISAT is headquartered in Hyderabad, Andhra Pradesh, India, with two regional hubs and four country offices in sub-Saharan Africa and is a member of the Consultative Group on International Agricultural Research (CGIAR).

ICRISAT conducts research on five highly nutritious, drought-tolerant crops: chickpea, pigeon-pea, pearl millet, sorghum and groundnut. It also develops sustainable management of semi-arid tropic (SAT) systems through efficient and sustainable management of natural resources, and enables policies and institutions for improving livelihoods and achieving food, nutrition and health security while protecting the environment.

ICRISAT implements its research programs in ways that benefit smallholder farmers by enabling them and their families to go beyond subsistence farming to produce surpluses that can be stored and sold to markets, paving the way for prosperity in the drylands. Surplus produce, which is stored as food, serves as a buffer in times of hunger. Income from marketed produce enables farm families to purchase more food when needed, including inputs such as seeds, fertilizer, labor, tools, livestock, insurance and education. As this further raises farm productivity, it kicks off a series of investments that bring about economic growth. As this is sustained, it creates a self-reinforcing pathway to prosperity.

The foregoing describes a socio-economic process called inclusive market-oriented development (IMOD) on which ICRISAT's Strategic Plan to 2020 is anchored. This inclusive (broad-based) strategy focuses on bringing the small-holder farmers, particularly women and youth, into the mainstream to participate and reap the benefits of development. IMOD will enable the poor, particularly women and the children, to participate, rather than be sidelined, in the development process.

There are two major dimensions of IMOD (Figure 1). As farming moves away from subsistence to market-oriented (higher value agriculture) mode, it allows the smallholder farmer to access inputs and market opportunities, bringing in resilience and prosperity to the farmer and rural economy in general. Entrepreneurship in the sector will also act as the catalyst for developing an innovative ecosystem.

Figure 1. ICRISAT's IMOD strategy

Source: ICRISAT

The research programs of ICRISAT have been designed to align with the IMOD strategy:

- **Resilient Dryland Systems.** Reducing vulnerability to drought and climate change while increasing crop diversity and value.
- **Markets, Institutions and Policies.** Harnessing development pathways for inclusive prosperity.
- **Grain Legumes**. Raising and securing legume productivity for health, income and sustainability.
- **Dryland Cereals.** Increasing dryland cereal crop productivity to help end hunger.

Under the above research programs, ICRISAT has set four bold targets to be achieved in the next ten years:

- Help halve rural poverty by increasing farm incomes through more productive, stable, diverse and profitable crops and crop products,
- Help halve hunger by contributing innovations that increase yields by 30% on a wide scale and through policy advice that stabilizes food prices and availability,
- Help halve childhood malnutrition by enhancing the nutrient content of staple food crops and helping the poor diversify their crops, delivering more nutritious and safer food, and
- Increase resilience of dryland farming through innovations that stabilize, safeguard and enhance natural resource capital, biological and systems diversity, and land health.

Through the above targets, ICRISAT's programs aim to achieve six development outcomes namely: development food sufficiency, intensification, diversification, resilience, health and nutrition and women empowerment.

Intellectual property management and technology commercialization

ICRISAT strives to create a fruitful climate to encourage innovation and knowledge generation in support of its mission. However, ICRISAT must take steps to help the products of its work reach the greatest number and range of beneficiaries. Considering the emerging challenges and issues in the SAT, and the changing agricultural research environment globally, ICRISAT setup the Intellectual Property (IP) Management Office in 2002, to strengthen the Institute's position in the area of IP management in line with its vision and strategy.

The IP office provides essential vision, training, scientific backstopping and information flow for ICRISAT scientists in intellectual property management. As part of on-going dissemination, this page provides basic information on intellectual property, ICRISAT's IPR policy, access to various material transfer agreements and links to IP-related websites.

The IP Office, which reports to the Deputy Director General (Research), executes a program of work for implementing the Institute's policy on IP under DDG-R direction. The IP office also provides a forum for information dissemination and discussion for the wider community of ICRISAT's beneficiaries.

Policy on protecting IPRs of research products developed at ICRISAT

Considering that many countries have enacted or are in the process of enacting Intellectual Property Right (IPR) laws, ICRISAT has ensured that others [private sector (PS) company, public sector institution or individuals] do not take IPR on ICRISAT's research products (breeding lines, techniques, technologies, etc.) that would preclude others from using that product, and also prohibit ICRISAT from distributing the product to others. This could amount to infringing the international public goods (IPG) nature of ICRISAT's research products, resulting in ICRISAT not being able to deliver on its mandate. Therefore ICRISAT developed a workable strategy/ policy on protecting the IPRs on its developed research products.
The following strategy/policy on protecting ICRISAT IPRs was endorsed by the Governing Board of ICRISAT during September 2004. These procedures are meant to reinforce the Material Transfer Agreement (MTA) system and not replace it.

Documentation of research products in public domain

ICRISAT effectively manages its IPR on research products (breeding lines, research methods, techniques, technologies, gene constructs, etc.) by placing them in the public domain and making them prior art and preventing others from infringing on its IPR. Four methods that ICRISAT follows to document the research products are given below.

1. **Documentation and library access.** The research methods, products or techniques are documented and made accessible to the public through public libraries with appropriate accession numbers. In case of breeding lines/parental lines, ICRISAT's Plant Materials Identification Committee is being strengthened for documentation (registration of lines), and the seeds of parental lines are being deposited in the ICRISAT gene bank.
2. **Formal publication of research results.** Results are published in globally recognized journals. In case of breeding material, lines and varieties are formally registered in journals such as *Crop Science*. At ICRISAT, scientists can register the parental lines (and genetic stocks) in the *International Sorghum and Millets Newsletter*, the *International Chickpea and Pigeon-pea Newsletter*, *International Arachis Newsletter*, etc., and deposit the seed of parental lines in the ICRISAT gene bank.
3. **Seed depositing.** Seed can also be deposited along with the characterization data (including the DNA finger printing) with the NBPGR, New Delhi, India for registration of lines and publication of documentation in the *Indian Journal of Plant Genetic Resources*.
4. **Website display.** ICRISAT also publishes the foregoing information on the institutional website.

With these measures, ICRISAT research products become prior art, preempting infringement by others and enabling ICRISAT to effectively challenge any infractions.

Opportunities in commercialization of technologies

In the past, non-proprietary conventional technologies from the public sector (like drawing genes for wheat and rice that led to the Green Revolution) were freely accessible. However, agri-biotechnologies have increasingly become proprietary and are owned mainly by the private sector. As public sector institutes in developed and developing countries are protecting biotechnology with patents, sharing IP from north to south becomes essential for helping the poor, smallholder farmers. Equally important is the need to promote public sector research through technology commercialization. Innovative linkages like private public partnership (PPP) has the potential to create synergies between public and private sector reduce the risk in commercialization of agri-technologies, while creating substantial capital inflow through technology commercialization and enhancing impact on the ground. The involvement of the private sector will also help in employment generation and wealth creation at the *bottom of the pyramid,* especially in the developing and under-developed countries.

Technology development and transfer at ICRISAT

ICRISAT is a non-profit and public sector institute with a main focus on developing IPGs in food crops through biotechnology and breeding for providing nutritious crops for the people in the SAT region of the world. In recent years with new framework, ICRISAT is initiating effective public, private, farmers and NGOs partnerships (PPP) to develop new technologies and also to transfer the technologies to grass-root level farmers through a non-profit approach. The transfer of technologies in ICRISAT is taken care of by the Agribusiness and Innovation Platform (AIP).

The Agribusiness and Innovation Platform at ICRISAT

The Agribusiness and Innovation Platform (AIP) was established as an initiative of ICRISAT to promote PPPs for furthering ICRISAT‘s mission of helping the poor farmers of SAT. The AIP envisions agricultural prosperity and strives to accelerate agricultural growth through innovation, entrepreneurship and value-adding partnership initiatives. The expected outcomes of the Platform are the development of farmer entrepreneurs through agribusiness incubation, growth of the farming community through value addition and prosperity of the agricultural sector through innovative partnerships. To achieve its mission, AIP operates the following three programs.

Agri-Business Incubation (ABI) program was started with support from the Department of Science and Technology, Government of India in 2003 to facilitate the creation of competitive agribusiness enterprises through technology development and commercialization. ABI promotes technologies that have been developed either exclusively by ICRISAT, or jointly developed with its NARS partners. ABI incubates entrepreneurs and start-up companies by providing technology and business consultancy, facilitating funding and providing business support services.

Innovation and Partnership (INP) program was established with support from the Government of Andhra Pradesh as a bigger platform for already established agri-companies to set up their own R&D facilities within ICRISAT. The INP program develops strong collaborative research and development partnerships with public, private and allied sectors to benefit the small-holding farmers of dry land tropics across the agricultural value chain.

NutriPlus Knowledge (NPK) program is a platform for R&D and innovations in food processing with focus on cereals, legumes, fruits and vegetables, medicinal and aromatic plants. The verticals for applied research are nutraceuticals, fortified foods, flavors and fragrances, phytoceuticals, functional foods, functional beverages, food additives and colour bio-actives and enzymes, post-harvest management and bio-products. The NPK program was setup with the assistance of the Government of Andhra Pradesh.

The AIP and its programs work towards furthering ICRISAT’s mission as follows:

- **ABI program** promotes agribusiness ventures through technology development and commercialization that benefit the SAT farmers directly or indirectly through incubation services in seed, biofuel, farms, agri-biotech or innovative ventures.

- **INP program** initiates PPP through collaborative research cum development agreements with ICRISAT scientists in the areas of plant breeding, agricultural biotechnology, natural resource management, knowledge sharing, training and value chain development that support the empowerment of the SAT farmers.
- **NPK program** supports value addition and post-harvest management in agri-food sector through innovative processing, product development and enhancing food safety.

Governance and management

AIP is linked to one of the Research Programs (RP) that of fostering agro-enterprise in the ICRISAT Strategic Plan to 2020.. The operation of AIP-ICRISAT is handled by the Chief Executive Officer (CEO), who is assisted by three Chief Operating Officers (COO's) of the respective programs. The CEO of AIP reports directly to the Director General for all administrative and operational aspects of AIP. The respective program managers oversee the day-to-day operations of individual programs under the program COOs. The organizational structure for AIP-ICRISAT is given below (Figure 2).

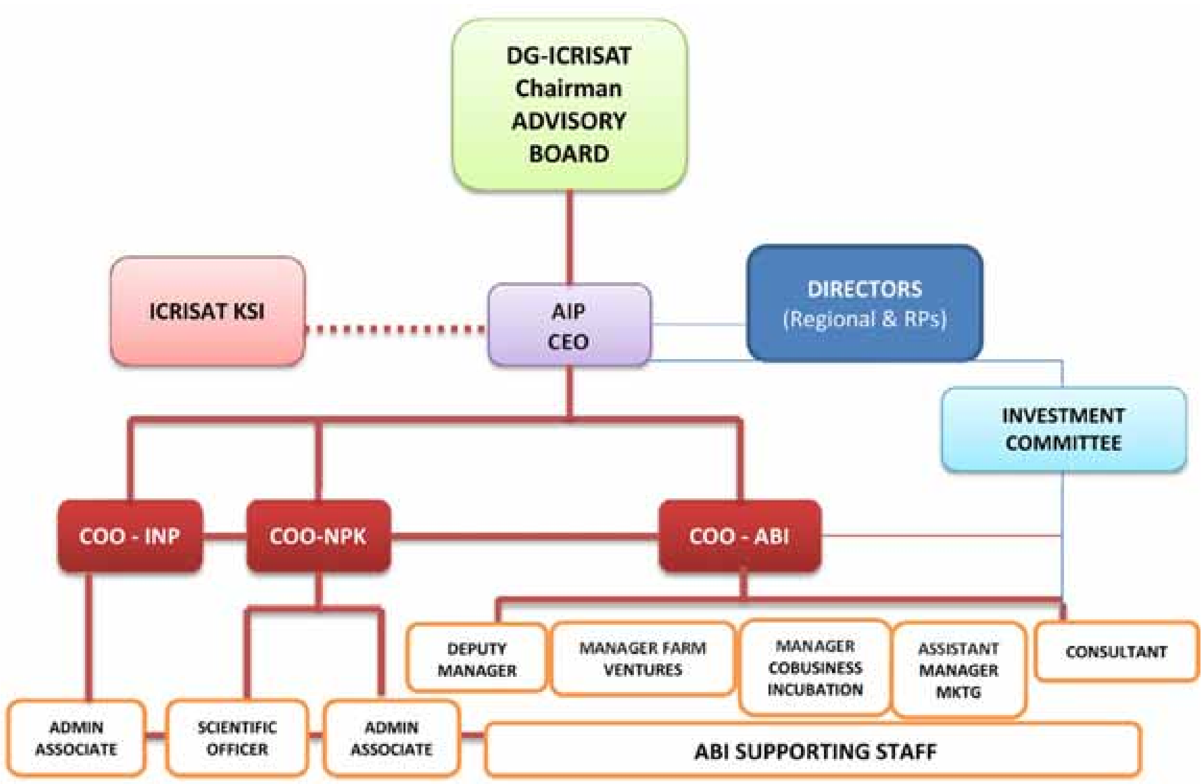

Figure 2. Organogram of AIP @ ICRISAT (*Source: AIP Strategic Plan)*

Operations of AIP

Clients of AIP are engaged through various instruments including Memorandum of Understanding, Agreements and Contract Research Agreements. AIP conducts due diligence for the identification and selection of clients and partners before their acceptance into AIP and its three Programs. This due diligence process evolved in line with the mission and goals of ICRISAT. Partnerships within AIP place no additional cost of its operation on ICRISAT and ensure long-term financial sustainability of AIP and its constituent Programs. AIP and its programs use different approaches for engaging with public and private sector for commercializing its technologies (Figure 3, next page).

Innovation and Partnership (INP) program
Established in 2007, the INP program is a platform for already established agri-companies and institutions to collaborate with ICRISAT through partnership research. INP focuses on market research and opportunity mapping, strategic marketing and partner specific value proposition and Collaborative Research Agreement (CRA) development through:

- Strategic partnerships for enhancing IMOD
- Co-creation of institutional innovation models
- Value chain innovations
- Collaborative research and PPP projects
- Common infrastructure and facilities creation

Figure 3. Components and activities of AIP (Source: AIP Strategic Plan)

Agri-Business Incubation (ABI) program
The ABI program is a pioneering concept to incubate agri-ventures and facilitates business for entrepreneurs and technology developers. ABI supports business initiatives with a host of services and facilities in the areas of technology commercialization and new venture creation. ABI offers technology consultancy, business facilitation, training, office space, agricultural land, computers and IT enabled aids, etc., that are required for entrepreneurs. The key focus areas of ABI are:

- To accelerate agricultural-based technology transfer and commercialization.
- To foster creation, development and innovation of agribusiness to farming communities to maintain competitive edge.
- To provide services to start-up agri-business on technology, business consultancy, business development, funding assistance, infrastructure facilities and escort services.
- To promote agri-technologies developed by ICRISAT or developed by other R&D centers of excellence, universities, ICAR, CSIR and other institutions.
- To be a champion for creating entrepreneurs by helping agribusinesses sustain and succeed.

Nutriplus Knowledge (NPK) program
The NPK program, setup in 2008, aims to work towards value-added new product development, technology commercialization, training, food safety, capacity building, technical consultancy, quality control services and R&D for value addition.

Technologies commercialized

Sweet sorghum for bio-ethanol production

Sorghum is one of ICRISAT's five mandate crops, and the Institute is carrying out research for alternative applications of this crop. It was found that the stems of sweet sorghum that are rich in sugar content, can be used for production of ethanol which in turn, can be used for petrol blending (Gasohol). This would be a significant step in the search for alternative sources of fuels when crude prices are steadily increasing.

Thus, the huge demand for ethanol has created new commercial opportunities for sweet sorghum farmers. Further, compared to others like sugar cane, sweet sorghum needs less water, is of less duration, and requires less investment per acre while ensuring higher return on investment per acre is high apart from the advantage of this being a low duration crop.

ABI-ICRISAT has commercialized sweet sorghum through its incubatee M/s. Rusni Distilleries Pvt. Limited. ABI supported the company in commercializing ethanol production from sweet sorghum by providing agro-technology and business facilitation support.

ABI provided consultations to the company on the command area development by providing practice packages of sweet sorghum for cultivation, facilitated recruitment of field workers and promoted sweet sorghum cultivation to farmers through organizing *melas* and farmers' days.

The company was a start-up concern and the concept for the business was new, and so it was difficult for them to commercialize this idea. ABI stepped in by conducting a proof-of-concept study and ensuring prototype success. The prototype study carried out by ICRISAT has instilled confidence in the minds of investors and bureaucrats ensuring anchoring of this project. This project is first of its kind in the country since ethanol is produced here through the non-molasses route and would be done with feedstock of sweet sorghum. This technology directly benefits 4,000 farmers and cover 10,000 acres of sweet sorghum annually. Farmers enjoy additional returns of Rs 4,000/acre/crop.

BTA Fermentor

ICRISAT created a revolutionary new idea of using small fermentors to produce high volumes of microbial bio-fertilizers and bio-pesticides. The fermentor can be used for multiplication of aerobic and micro-aerophilic bacteria, and strains of actinomycetes and fungi. Its major application will be in the biopesticides and biofertilizers industry. In addition, companies with pharmaceuticals R&D and pilot scale antibiotic production will find it highly useful and attractive due to its low cost. Ultimately, this technology makes bio-pesticides and bio-fertilizers affordable to farmers.

Commercialization of the fermentor was not easy; the challenges were basically poor market potential and low returns on investment for the entrepreneur. To circumvent this problem, ABI scouted for entrepreneurs who were already in a related line of business, for whom this product would fetch additional revenues. ABI identified two entrepreneurs, Slesser Tom Electronics Pvt. Limited and High Glass and Chemicals, both with experience in marketing high-end equipment. ABI forged a partnership between the two companies on mutually agreeable terms, and to initiate and strengthen the relationship, provided them with an initial business order of ten units besides providing them the fermentor technology.

The commercialization of the fermentor technology has benefited the two entrepreneurs with additional product and revenue, and since they have sold these fermentors to 20 companies, the technology helps produce high-quality, low-cost bio-pesticides and bio-fertilizers. In turn, the farming community benefits by having access to quality bio-fertilizer at affordable costs.

Groundnut variety ICGV 91114

Groundnut an oilseed crop, is one of ICRISAT's five mandate crops wherein it has done significant research for over 30 years and has released over 34 improved cultivars in India in partnership with National Agriculture Research System (NARS). One such variety, ICGV 91114, is the latest developed by ICRISAT. Commercializing ICGV 91114 was challenging because the groundnut seed business is not as profitable as other commercial crop seeds. Besides, the process has bottlenecks such as registration and certification before the seed can reach the farmers.

ABI identified a public sector partner, Andhra Pradesh State Seed Development Corporation (APSSDC), to commercialize this product since it was mandatory for them to provide quality seeds of groundnut. However, APSSDC was not convinced about the market for the new variety. Therefore, ABI took on an assignment from APSSDC for product promotion and commercialization support assistance to help APSSDC market ICGV 91114. ABI further sub-contracted this assignment to its clients Aakruti Agricultural Associates of India (AAI) to conduct field demonstrations for farmers in Anantapur district during *rabi* 2005. The promotion and fieldwork carried out by AAI made ICGV 91114 a very popular variety among the farmers of Anantapur. A demand for about 10,000 quintals of seeds, and business worth Rs. 2.5 crore was generated.

Bt cotton

Bt cotton is a transgenic cotton, which has resistance against cotton bollworm, a major pest of cotton. Bt cotton has been developed through the transformation of an alien gene from a soil bacterium, *Bacillus thuringiensis* into elite germplasm of cotton. By undergoing this transformation, the crop has inherent resistance against pests. Farmers cultivating Bt cotton need not use extensive pesticide to control this pest and the quality of the cotton is also good. Monsanto Company patents this Bt cotton technology and they are licensing it to Indian seed companies selling hybrid cotton varieties. Bt cotton reduces the high amount of pesticide applied by farmers, reducing ill-effects on their health and the environment in general. It also benefits farmers economically with a high return of investment of Rs 4,000 per acre.

ABI ICRISAT is helping two clients – M/s SriRam Bioseed Genetics Pvt. Limited and Seed Works India Pvt. Limited – both of whom have licensed this technology from Monsanto-Mahyco Company. ABI is providing them with infrastructure support and expertise in molecular biology for the introgression of Bt genes from Monsanto Company's seed material into their own hybrids. ABI has facilitated the companies on technology licensing from Monsanto, advice on bio-safety aspects, consultancy on introgression process and accesses to infrastructure like biotechnology lab and greenhouses.

Bio-pesticides

The use of synthetic pesticides is widespread in the management of crop pests. However, the problems associated with their inappropriate use are surfacing. Insect pests have become tolerant to several chemical molecules. Alternative solutions, i.e., bio-pesticides, have been mooted to address this issue. Bio-pesticides are extracts from natural products, and sometimes they are derived from microbial organisms like bacteria, fungi and virus. These extracts or microorganisms act on the pests and pathogens of the crop and control them. Some bio-pesticides are HNPV, SNPV, *Bacillus subtilis, Tricoderma viridae, Metarhizum thurinje* and so on.

Mekins Biotech Limited came to ABI for incubation in the area of bio-pesticides. Further they sought to do this for a new formulation and products. ABI provided the entrepreneur with the business plan, technology support, bio-pesticide lab, NPV Lab and agricultural land. ABI has also facilitated the registration, tie-ups with two leading service providers and also tried to contract bulk business.

ABI assisted ICRISAT scientists in commercializing the bio-pesticide technology through an innovative model on public and private partnership called the Bio-pesticide Research Consortium (BRC). Nine companies – AG Biotech Research, Ecosense, Biotech Internationals, Indore Biotech, Multiplex Bio-tech, Navayuga , Romvijay, Nirmal Seeds and Mekins Biotech Limited – joined this consortium and have benefited from the research and consequent commercialization.

Chickpea varieties KAK 2 and JG 11

Chickpea, a pulse crop, is another one of ICRISAT's five mandate crops wherein it has been involved in chickpea research for more than three decades. The Institute has released more than 100 varieties in 27 countries with its NARS partners. The latest in this line, chickpea varieties KAK 2 and JG 11 are particularly suited for confectionary and table consumption. The challenge faced in commercializing the varieties was related, however, to economics of the entrepreneur. Here as with ICGV 91114, ICRISAT sought the help of APSSDC, the public sector seed company to commercialize it. Since APSSDC was not confident of market penetration, it assigned ABI to promote the product in Anantapur and Ongole. ABI further sub-contracted this job to its client AAI. In the *kharif* season of 2006, AAI promoted the varieties by field demonstrations and farmers meetings, which created a good demand for the varieties.

With this, ABI was able to benefit three agri-entrepreneurs in Anantapur, Uruvukonda and Ongole. Farmers using these varieties are able to get additional returns of Rs 2000 per acre since KAK 2 fetches higher market realization when compared to conventional varieties.

Key constraints area and capacity building required

Lessons learnt in India

Segments	Challenges	The way out
Goal and objectives	Balancing technology commercialization and agriculture development	Focus on agriculture development oriented enterprise which will result in technology commercialization.
Target segments	Innovators identification and retention is difficult.	Target on niche areas of innovative venture to retain the clients and provide express platform for mutual benefit.
Innovations	Limitations to innovations in R&D institute due to lack of right commercial ecosystem Individual innovators in employed environment handicapped due to IP clause.	Organizing regular innovation camps and motivational programs in the institute would serve the purpose. Individual innovators need to be encouraged through official innovation camps with the employers and duly recognizing them both in a public forum.
Markets	Low pricing of end products deters the market opportunity for envisaged programs. Ag-biotech market segment is not buoyant and is deterred due to IP clause.	Work for alternative end products in the envisaged programs to increase the market opportunity.
Enterprise initiatives	Technopreneurs are risk averse and it deters incubation. Rural enterprise has less enterprise and risk taking ability needs high amount of management support.	Technopreneurs must be given internship on innovation and incubation with part time options. Rural enterprise needs high amount of management support and package of service inclusive of risk coverage.

Issues or bottlenecks in Agri-Technology Transfer

The main bottlenecks in technology transfer in developing countries where there is lack of institutional support (like extension institutions, credit facilities and market integration) are described here.

- They have tended not to interface with private enterprise. The public sector research is disconnected from broader market development and demands for new products.
- The transfer of technology and commercialization is not a part of the public sector. There is lack of emergence of more iterative relationships between research technology development, technology transfer and technology use.
- Environmental degradation and loss of biodiversity are emerging as major threats to the sustainability of current agricultural development strategies.

- Rural poverty is also a major challenge (>450 m people survive on less than 1 $ per day). This is due to lack of institutional support for the poor farmers to adoption new technologies.

Agricultural development must address these problems through technological and institutional changes that draw on the creativity of science and the public/private sectors to genuinely enfranchise the poor.

Solutions for agri-technology transfer

The problems in the technology transfer in the developing countries may be solved by:

- Developing strong relationship between research, technology development, technology transfer and technology use.
- Focusing on human resource development in modern technologies.
- Creating a congenial environment for encouraging research and development in biotechnology and agricultural fields through the development of infrastructure and incentives (like subsides, credit, etc.).
- Promoting conservation of bio-diversity and sustainable exploitation of bio-resources by adopting the new sustainable NRM technologies.
- Interface public and private sectors for enhanced synergies in technology development and transfer of the technologies to the poor farmers through good market mechanisms.

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Chapter 13. Technology Transfer and Commercialization Policies and Practices at Michigan State University

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Background on Michigan State University

Founded in 1855, Michigan State University (MSU) is a premier land grant university in the United States of America (US). In the US, each state has at least one land grant university. The land grant universities were established under the Morrill Act through granting of free land by the federal government to establish a college of agriculture to serve the citizens of the state to improve their farming practices and livelihoods (http://en.wikipedia.org/wiki/Land-grant_university). The year 2012 marked 150 years of the establishment of land grant universities.

Over the years, MSU has evolved from a single college of agriculture to a comprehensive public university with more than 15 colleges and units (http://www.msu.edu). As a land grant university, MSU has a three-fold mission – research, education and outreach/extension. The outreach mission of MSU goes beyond the boundary of Michigan to all over the world. MSU has become a global university and the College of Agriculture and Natural Resources at MSU is now recognized as a center of excellence in international agricultural research and development.

MSU has an annual enrollment of more than 48,000 students from all over the US and more than 130 countries. MSU has over 5,000 faculty members and academic staff. As a public university, MSU receives funding from diverse sources including state government, federal government, private foundations, private companies, commodity groups, international agencies, tuition fees, gifts and donations, endowment income, royalty income from licensing and other sources. The external funding for research programs at MSU totaled $502 million in the year 2011-12.

Technology transfer at Michigan State University

As a public land grant university, MSU is dedicated to technology transfer so that farming communities and society can benefit from the research results and innovations resulting from MSU. MSU transfers technology in two ways: One is through the extension service and second is Intellectual Property Rights-led technology transfer through licensing and agreements.

The traditional way of technology transfer at MSU and other land grant universities has been through the well-established Extension Service. The MSU Extension Office is located on the campus of MSU with field offices in various counties of the state of Michigan where extension specialists are housed and serve as conduits for technology transfer process to local farmers and rural communities in Michigan.

Enabling environment for IP management, technology transfer and commercialization at MSU: The more recent approach to technology transfer is intellectual property rights-led technology transfer through protection, licensing and agreements facilitated through MSU Technologies, a special office serving the entire MSU community.

The passage of the Bayh-Dole Act in 1980 and the Supreme Court decision of Diamond vs. Chakrabarty case on biotechnology products in 1980 created an enabling environment for public institutions to establish intellectual property management and technology transfer offices/programs. With this enabling environment for technology transfer, MSU created an office of intellectual property in 1991, which has now evolved into MSU

Technologies (MSU-T), with more than 15 full-time technology managers. In addition, during the last three years, MSU has established two new offices: MSU Business-CONNECT and Spartan Innovations.

Technology transfer and commercialization service units at Michigan State University

MSU Innovation Center consists of the following three units: (http://spartaninnovations.msu.edu/msu-innovation-center)

- ***MSU Technologies*** (IPR/Technology Licensing Office of the university) was established in 1992 and re-organized in 2007. MSU manages its IP and technology transfer through MSU Technologies (MSU-T). MSU-T is staffed with more than 15 technology management professionals. MSU Technologies provides many services to the university, including acquiring, protecting and licensing of IP. (http://technologies.msu.edu/)
- ***MSU Business-CONNECT*** was created in 2009 as MSU's portal for engagement with the business community and industry. It establishes research partnerships between MSU faculty and industry, provides entrepreneurship support and promotes businesses that stimulate regional development. (http://businessconnect.msu.edu/)
- ***Spartan Innovations*** was established in 2012 to convert MSU innovations into successful Michigan businesses. It is an incubator and provides business development services, university-wide entrepreneurship education, internships for student entrepreneurs, mentoring to help manage new business startup projects, access to venture capital support, and funding for scale-up of early stage technologies. (http://spartaninnovations.msu.edu/)

To further strengthen technology transfer and commercialization activities, MSU researchers have access to **Michigan Biotechnology Institute (MBI),** a non-profit wholly owned subsidiary of Michigan State University Foundation. MBI is involved in developing and commercializing bio-based technologies. MBI's mission focuses on de-risking and scale-up of bio-based technologies. http://www.mbi.org/

MSU has an IP policy (http://www.msu.edu/unit/provost/patentpolicy.html). According to the MSU IP Policy, any new inventions developed using MSU funds and facilities are the property of Michigan State University. Also according to the MSU IP policy, royalties generated through licensing of technologies are shared with the inventors(s).

Table 1. Royalty Distribution Rates at Michigan State University

Net Licensing Proceeds on a Particular University Invention	Inventor(s)	Major Administrative Unit	University
First $5000	100%	0	0
Next $100,000	33 1/3 %	33 1/3 %	33 1/3 %
Next $400,000	30%	30%	40%
Next $500,000	20%	20%	60%
All Additional net licensing proceeds over $1,005,000	15%	15%	70%

MSU currently holds more than 1835 US patents. About 125 new inventions are disclosed per year, and about 50% of new inventions are patented based on the assessment of their market potential. Patent costs of the university are about $1 million per year. Of the inventions patented, 15-20% are licensed. MSU has earned approximately $3-5 million per year in the last few years in royalty income from licensing of technologies. MSU policy allows MSU inventors to form companies based on technologies developed at MSU. Many new startup companies have been launched based on MSU inventions. To further expand technology transfer and commercialization activities, MSU has set up a new platform, the MSU Innovation Center (See Box 1).

Table 2. Metrics of MSU Technologies

Fiscal Year (July 1 – June 30)	Total Research Expenditures	No. of IDs	No. of Start-Ups	Licenses Executed	Revenues
2007	$360,852,000	161	5	28	TOTAL: $6,280,787 COPYRIGHT: $3,368,659 PATENT: $2,912,128
2008	$356,767,000	91	3	25	TOTAL: $6,777,131 COPYRIGHT: $4,185,938 PATENT $2,591,193
2009	$373,184,000	140	0	44	TOTAL: $5,574.287 COPYRIGHT: $1,984,828 PATENT: $3,589,458
2010	$495,474,789	109	9	28	TOTAL: $5,280,946 COPYRIGHT: $1,586,747 PATENT: $3,694,199
2011	$438,994,610	112	TBD	16	$3,078,867
2012	$502,000,000	126	TBD	TBD	TBD

Intellectual property and plant breeding at MSU

MSU is a leading institution in the field of IP rights (IPR) and management in agriculture. As such, it can serve as an example for other public research institutions and universities trying to establish their own IP management and technology transfer policies, especially in the fields of agriculture and agricultural biotechnology. MSU's IP policy covers most of the major forms of intellectual property rights (IPR) related to agriculture and/or biotechnology, including patents (plant, utility and design), plant variety protection (PVP), trademarks, copyrights and trade secrets.

Plant breeding programs at MSU

Agriculture is a vibrant sector in the Michigan economy. Michigan has the second most diverse agriculture in the United States. Michigan farmers grow a variety of crops, vegetables, fruits and ornamentals. The diversity of crops includes maize, wheat, dry beans, soybeans, alfalfa, sugar beets, oats and potatoes. The vegetable crops include tomatoes, asparagus, melons, peppers, etc. The fruit crops grown in Michigan include peaches, apples, cherries, grapes, blueberries, strawberries, blackberries and others.

Michigan State University's College of Agriculture and Natural Resources has active plant breeding programs for a number of crops. MSU breeders are engaged in research focusing on both development of improved germplasm and, in some cases, improved varieties of minor and specialty crops. The general trend in plant breeding and biotechnology at MSU is to move away from developing finished varieties to identification of novel traits and development of elite germplasm that can be licensed to private sector for developing finished varieties or hybrids.

The improved germplasm and/or varieties are transferred through both public and private releases. Public releases are done through the Michigan Crop Improvement Association (MCIA), a membership based non-profit organization. Private releases are done through licensing and agreements with private seed companies on a competitive basis. The terms of the license, including royalty rates, are negotiated on a case-by-case basis, depending on the crop and the traits licensed.

The Variety Release Process at MSU. The College of Agriculture and Natural Resources at MSU has established a formal process for the release of varieties. MSU follows a multi-step process that ensures that the key stakeholders are consulted and their approval granted before a variety is released. This multi-step process includes the following steps:

1. Commodity Committee at department level – breeder presents data on variety for release

2. Commodity, Policy and Review Committee (CPRC) at department level for all commodities
3. Plant Material Evaluation and Release Committee (PMERC) at the AgBioResearch (Agriculture Experiment Station) level
4. Commercialization Advisory Committee (CAC) at University level involving MSU Technologies (Office of Intellectual Property), establish licensing agreements, royalties
5. Signature by Vice-President for Research and Graduate Studies (VPRGS).

This process normally takes 3-4 months and has worked very well for the past many years. Several varieties have been released successfully using this multi-step process.

Names of selected companies that have licensed MSU varieties

Varieties released by MSU have been licensed to various companies. Below is a list of some crops and examples of companies that have licensed MSU varieties.

- Wheat: Michigan Crop Improvement Association; Genesis Brand Seeds
- Peach: International Plant Management
- Beans: Michigan Crop Improvement Association; Treasure Valley (Idaho); ADM Company
- Potato: Iott Company
- Cherry: Starks Brothers
- Blueberry: Fall Creek; HortiFruit (South America)

Categories of IP protection used by MSU in plant sciences

MSU protects improved germplasm and varieties through plant variety protection (PVP), patents, and trademarks.

Plant patents

Examples of plant patents include MSU blueberry varieties Draper, Liberty and Aurora. They are protected under patents instead of PVP because they are asexually propagated via stem cuttings and tissue culture micropropagation.

Utility patents

MSU also holds several utility patents. These include CBF cold/drought tolerant genes, licensed to Mendel Biotechnology Company in California. MSU researchers have also invented a process for isolating anthocyanins in tart cherries, which have anti-inflammatory properties and other health benefits; this has been licensed to the Leland Cherry Company in Michigan, which uses the technology to make Hip Bones, a dog treat.

Plant variety protection (PVP)

MSU breeders develop improved varieties of a number of crops, including dry beans, wheat, potatoes, oats, etc. These varieties are protected through the Plant Variety Protection Office at the US Department of Agriculture. PVP is regularly used for minor and specialty crops that are released through public releases. In 2012, MSU released 6 varieties: 2 potato, 3 soybean, 1 bean. In 2011, MSU released 5 varieties: 3 beans, 2 soybeans.

Trademarks

An example of trademark protection is the Balaton® Tart Cherry, which was evaluated and released by MSU in partnership with researchers from its native Hungary, where it is a local variety. It could not be patented as it was publically available. It has been licensed to a private nursery, and royalties are shared between MSU and the Hungarian Institute.

Royalties received from licensing of plant-based technologies

Depending on the crop and the traits licensed, MSU receives royalty income in a number of different forms.

Crop	Amount	Per	Notes
Cherry	$0.50	Plant	
Blueberry	$0.30	Plant	
Blueberry	$0.15	Plant	Plus additional amount based on plants per acre
Wheat	0.01/# $0.55	 Bushel	Royalty is on Certified class of seed.
Potato	$0.25	100 pounds	Royalty for seed potatoes
Beans	$3.00-$4.00	100 pounds	For Certified class seed

In addition to developing plant varieties and improved germplasm, MSU plant scientists are engaged in basic and applied research. New inventions are protected and licensed to private companies. Often these inventions are commercialized in partnerships with the private sector.

MSU IP policy allows faculty to start new companies based on their technologies. One such example is VAMTech Inc., which specialized in the synthesis of formononetin, a compound that stimulates the growth of mycorrhizal fungi already existing in the soil, and which was acquired by the company Plant Health Care in 2004. To help start-up biotechnology firms, the Bio-Business Incubator of Michigan (BBIM) was created as an independent subsidiary of Michigan Biotechnology Institute (MBI) International. Spartan Innovations was established in 2012 to convert MSU innovations into successful Michigan businesses (See Box 1; http://www.spartaninnovations.org/).

Case Studies of Successful Transfer of Agriculture Related Technologies

MSU has successfully licensed plant-based technologies to private companies and nurseries. The following four examples provide a short summary of successful transfer of agriculture-related technologies representing a broad range of IP protection methods.

1. Balaton® Cherry

In 1983, the tart cherry breeder of Michigan State University, Dr. Amy Iezzoni, visited Yugoslavia, Bulgaria, Romania, Hungary and Poland, the ancestral home of tart cherries. She met with other tart cherry breeders and explored the natural variation in the germplasm. She was impressed by the genetic resources and advanced breeding in Hungary. In 1984, she brought germplasm from Hungary to the US under a material transfer agreement (MTA) for testing. Out of many varieties she tested, the first one chosen for release was a common variety grown for years in the towns and villages in Hungary, selected near the Soviet border.

The variety was evaluated extensively with commercial growers and fruit processors in Michigan, Utah and Wisconsin. Dr. Iezzoni made selections for improved fruit quality and disease resistance. The resulting improved variety is disease-free. MSU protected the variety using the trademark "Balaton®," named after a lake in Hungary to celebrate its heritage. Because the variety is an established variety in Hungary, it could not be protected with a plant patent or plant variety protection. However, the trademark indicates that the foundation materials are disease-free.

In 1995, after twelve years of testing, MSU and the Hungarian institution that provided starting material jointly began licensing the variety to private nurseries. Per the agreement, half (50%) of the royalty ($0.25) for every Balaton® tree sold in the United States is shared between the Enterprise for Fruit Growing at Érd and the Fruit Station at Újfehértó in Hungary to support continuing efforts in tart cherry breeding. The amount returned to Hungary has been in excess of $30,000. This experience has provided a good blueprint for collaboration on university introduction of materials from foreign provider. MSU is also following this model with two new cherry varieties.


2. Blueberries

Michigan is a world leader in blueberry production and is the top blueberry-producing region in the US, harvesting 109 million pounds in 2010. Michigan State University has an active blueberry-breeding program headed by Dr. James Hancock, a small plant breeder specializing in blueberries and strawberries. After two decades of breeding, MSU released three varieties of northern highbush blueberry in 2005 (Draper, Aurora and Liberty). Prior to their release, no new varieties had been released in decades.

Dr. Hancock focuses on developing mid- to late-season varieties with extremely high fruit quality. These varieties were developed for relatively warm climates. Draper is a midseason variety with high-quality, machine-harvestable fruit and a long storage life. Liberty is an unusually flavorful late-season variety. Aurora is a late-season variety with the latest fruit production and also has good post-harvest storage. A newer variety, Huron, an early-season variety developed for colder climates, blooms late to avoid early frost damage and has a complex flavor.

These four varieties are protected by plant patent in the US and by Plant Breeders' Rights abroad. Blueberries are asexually propagated, and tissue culture microshoots were provided for foreign nurseries, which are easier to get through customs than whole plants. Bare rooted plants were sent to Canada and Europe for DUS testing. Because the plants have to be dormant, there have been issues with the phytosanitary process, and in one case the test plants died in the field and needed to be re-supplied.

The varieties have been licensed widely around the world - 19 licenses and sublicenses in the US, Australia, South America, Europe and Canada. Goodman Partners, LLC, a South Korean company, has sublicensed the varieties through Hortifrut, the company that holds the exclusive license from MSU on the varieties released in Asia. Breeding rights have been licensed in New Zealand in exchange for breeding rights to New Zealand varieties and royalty on progeny sales. The release of the New Zealand licensee's varieties under the breeding agreement is expected in 2014. Part of the New Zealand contract was assigned to a US licensee, and this licensee released the first variety bred using "Draper" as a parent in 2013. In the US, breeding rights have been licensed to two companies.

Blueberry material in development is optioned for licensing to nine companies around the world. These optionees act as testing partners, who then have options on new releases coming out of the testing program. This program allows for field testing under a wide variety of growing conditions by commercial entities. This additional data and feedback speeds the selection and release process, shortening the time from initial crossing to variety release by two to three years. The testing network has led to the release of three varieties.

MSU's blueberry varieties have been very successful. They are planted on several thousand acres in blueberry growing areas around the world, making them among the most widely planted varieties in the world. Royalties from plant sales bring in about $1 million each year for the university, inventors and Foundation, making them one of the top royalty earners. In fact, the royalties saved MSU's breeding program; the local blueberry industry did not support breeding and selection work and university resources had nearly run out at about the time the varieties were released.

3. "Sparta – the Soybean Aphid Shield"

The soybean aphid, native to Asia, first appeared in Michigan in 2003. The soybean breeding program at Michigan State University, led by Dr. Dechun Wang, screened over 2,000 strains of ancestral and semi-wild soybeans, from which several genes that confer a high level of resistance to the soybean aphid were isolated, including the rag3, Rag3, rag4, and rag6 genes. From this starting material, Prof. Wang developed breeding lines with more acceptable agronomic traits that contain the resistance genes. These genes and the lines containing the trait genes, and the method of using the source lines to make aphid resistance are protected by pending and issued patents in the US and Canada.

The Michigan Soybean Promotion Committee (MSPC), a commodity group created by statute that is governed by a board of soybean growers and that is funded by a self-imposed fee of $0.01/bushel of soybean produced in Michigan collected from grower sales, has invested about $250,000 since 2002 to fund Wang's research and has first licensing rights to MSU's soybean aphid resistance patents and germplasm. The MSPC sublicensed the germplasm to a soybean trait genetics provider; this sublicensee is in turn working with most of the major soybean genetics companies to cross these traits into the major genetics companies' varieties. The grower board will earn royalties from sale of seed company varieties containing the trait. A portion of the royalties will come back to MSU.

The name 'Sparta' is also trademarked. MSU has licensed the aphid resistant soybean germplasm under the Trademark 'Sparta;' (U.S. serial number 77650367). When used in variety release by private companies, the seed tag/bag must state: "'Sparta' Aphid Resistance." The hope is to differentiate MSU's aphid resistance from other competing products in the market. If MSU's technology performs well in the field, then growers may seek out "Sparta" branded material, thereby increasing market penetration of this technology and revenues for MSPC and MSU.

Currently, varieties containing the genes are being developed, field tested and increased. Some varieties will contain stacked aphid resistance genes, both stacks of MSU's genes and stacks of MSU's genes together with other non-MSU aphid resistance genes, to enhance durability. Stacking may require royalty adjustments. Varieties are expected to enter the market in 2014-2015. Dr. Wang is in the process of developing precise molecular markers for enforcement, quality control, and speeding the breeding process. DNA markers may be particularly useful in advancing breeding, as several of MSU's aphid resistance traits require presence of two recessive loci for expression of aphid resistance. Additionally, the presence of one resistance trait makes it very difficult or impossible to detect presence of additional trait loci. Currently, there are not aphid populations that have differential responses to different aphid resistance trait loci. For example, there are not aphids susceptible to *rag3* but resistant to *rag4*, rather, all known populations of aphids are controlled by both *rag3* and *rag4*. Without aphid differentials, the phenotype of the first resistance locus would hide the presence of additional loci. Furthermore, phenotyping is difficult and expensive compared to DNA geneotyping. Therefore, DNA-based testing of the germplasm is the preferred means to identify trait stacks. Field testing is also underway to ensure durability of the trait.

4. MSU-Bejo-Sheetal Seed Co. (India) Co-Development Project

MSU signed a co-development agreement with Bejo-Sheetal Seeds Pvt. Ltd. Jalna, India. In this agreement, Bejo-Sheetal will advance the three technologies below and has exclusive rights to sell the resulting varieties in the South Asian Association for Regional Cooperation (SAARC; Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) market. MSU has right to license the advanced technology developed by Bejo-Sheetal outside of SAARC territory. Each party pays royalty to the other for use of the other party's technology.

Genetic and biological materials developed at MSU were transferred to Bejo-Sheetal Seeds for further development. Bejo-Sheetal intends to use the genes in their own varieties. MSU holds patents in the US and other countries excluding India. The materials transferred included 1) glyphosate-resistant turfgrass (ryegrass) seeds; 2) tomato seeds containing LEARG2 gene and plant transformation constructs containing the ARG and thiamine deaminase (TD) genes and 3) a plant transformation construct and a plasmid, each containing the Xerico gene. The transformation construct allows the licensee to easily replicate MSU's results in creating transgenic plants while the plasmid simplifies creation of more advanced or alternative plant transformation constructs by the licensee.

Glyphosate-resistant turfgrass (ryegrass)

Ryegrass with resistance to glyphosate was developed at MSU (Dr. Don Penner) and patented (both the gene and the biological material). It is licensed for non-GM uses in turfgrass to Scotts Co., who may have glyphosate resistant ryegrass on the market by 2015. The same technology is licensed to Bejo Sheetal for various crop plants in the SAARC region as described above. So far, Bejo-Sheetal has completed development of 5-enolpyruvyl-shikimate synthase-based (EPSPS) glyphosate resistance gene and is in the process of transforming crops with it for the Indian market now.

Tomato with non-Bt insect resistance

Tomato with non-Bt insect resistance (ARG and thiamine deaminase (TD) genes) was developed at MSU by Dr. Gregg Howe. Resistance is primarily targeted to chewing insects (such as moth and beetle larvae). It may also be effective against sucking pests (thrips) but this has not been tested yet. Resistance is based on over-expression of amino acid degrading enzymes, which cause essential amino acid nutrient deficiency in the insects. It is protected by patents in the US and has been licensed to Bejo-Sheetal for use in specified crops, and is currently under development.

Xerico

The gene *XERICO*, which confers drought tolerance through increased ABA biosynthesis, was developed in Dr. Kyung-Hwan Han's lab at MSU and is protected by US and foreign patents. It has been optioned to Bayer in non-SAARC territory for specified crops. Bayer funded additional development in Han's lab. The gene has been licensed to Bejo Sheetal in SAARC territory for specified crops.

Other programs in IP and tech transfer in Michigan

In addition to the technology transfer and commercialization programs at Michigan State University, a number of other universities in Michigan have active programs. As an example, Wayne State University has established a technology transfer office as well as "TechTown," a nonprofit business incubator and accelerator in Detroit, Michigan. TechTown supports industry startups that address the city's identified needs and harness the region's inherent assets.

In 1999, the president of one of America's premier urban research institutions, Wayne State University, had an idea to establish an incubator for the city that would serve technology-based businesses, including university spin-offs. The incubator would help stimulate and diversify the local economy. Agreements were negotiated with General Motors and Henry Ford Health System and the incubator was established with start-up funding from a public-private partnership of local and national sources. GM donated a facility (a 140,000-square-foot historic building) to house the incubator, which was renovated before opening as TechTown in 2004. Today, TechTown supports tech-based businesses and retail enterprises and encourages a holistic approach to economic development. Since 2007, it has assisted 647 companies that have created more than 1,000 jobs. These companies generated $52 million in revenue in 2011 alone.

International educational training and capacity building programs in IP management and tech transfer

MSU is known for being a global university and for its success in collaborative research, training and education of researchers, scientists, policymakers and others worldwide, especially in international agricultural development. MSU has 1,400 faculty and staff members engaged in international research and teaching. The university has 25 internationally focused centers, institutes, and offices and 280 partnerships with international institutions. It is also one of only four universities in the nation that rank in the top 10 for both study abroad participation and international student enrollment.

Its role in educating and enabling others in the area of IP and technology transfer is no different. In addition to the many research linkages between scientists worldwide, MSU's World Technology Access Program (WorldTAP) is actively engaged in building IP management and technology transfer capacity in developing countries. In order to build IP management capacity, MSU has been offering training programs and technical/legal assistance to developing countries, specifically in the areas of agriculture and agricultural biotechnology. WorldTAP works in close collaboration with MSU Technologies and the MSU College of Law in offering international training courses, internships, and workshops.

The capacity building trainings aim to help participants to develop and implement institutional IP policies, laws, and management infrastructure; establish Intellectual Property Offices and Technology Transfer Offices; develop the human resources needed to staff offices, manage programs, develop educational programs and generate researcher awareness; and create the institutional support and commitment needed for proper IP management. The goal of any technology transfer program should be to preserve free sharing of knowledge, but to also ensure adequate compensation and create win-win situations for the mutual benefits of all parties involved. In the changing landscape of technology transfer, having an appropriate intellectual property (IP) management policy in place is therefore necessary to both promote research and protect the interests of all parties.

MSU's training and capacity building programs in IP management and technology transfer in agriculture were launched in 1994 under the USAID-funded Agriculture Biotechnology Support Program (ABSP-I). Under this project, MSU collaborated with seven developing countries. MSU implemented collaborative research and technology development programs with Costa Rica, Egypt, Indonesia, India, Kenya, Morocco and South Africa to develop biotechnology products for resource-poor farmers. However, due to the lack of national and institutional IP laws and management policies/programs, the project faced legal hurdles while attempting to access and transfer proprietary research tools and technologies to the collaborating countries. The researchers from the collaborating countries had no experience or institutional policies and support in place for handling and management of IP. Therefore, the ABSP-I project put concerted efforts in building intellectual property management capacity related to agricultural biotechnology.

The project took an integrated approach to capacity building by sponsoring workshops, seminars, networking activities and internships to create general awareness, provide basic education in IP management and train public sector technology managers in developing countries. It also participated in obtaining freedom-to-operate (FTO) and licensing support to accompany technology development programs and also technical assistance for technology negotiations for accessing public-private partnerships (PPPs) in agriculture.

To build the IP management capacity in collaborating countries, a number of programs were initiated by MSU to raise awareness on the importance of IP and IP management, and to provide education to researchers, scientists, and administrators on various aspects of IP management and technology transfer. In order to build IP management capacity, MSU started offering training programs and technical/legal assistance to developing countries, specifically in the areas of agriculture and agricultural biotechnology (Maredia and Erbisch, 2004). As part of the international training and educational programs, a new short course on IP management and technology transfer was designed and launched in 1995 and since then has been offered annually. Over time, the course has evolved to meet the needs of the changing IP landscape. It has gone from focusing on institutional IP policy development, establishing IP offices, and issues related to IP for agricultural biotechnology to its current focus on protection, licensing and commercialization of inventions made by public sector institutions.

Impacts of MSU's IP management and technology transfer capacity building programs

The impact of MSU's international IP management and technology transfer programs has been tremendous in terms of raising awareness and building human resources as well as institutional capacity in IP management and technology transfer at public institutions. During the past 18 years through various programs, MSU has trained more than 500 policymakers, administrators, researchers, lawyers, private sector personnel, students in various aspects of IP management and technology transfer, and other areas related to technology commercialization.

MSU has offered these programs both on campus and internationally (Egypt, Morocco, India, etc.). These programs have led to establishment of new institutional and national policies on IP management and the formation of new technology transfer offices at public research institutions. For example, through funding from USAID, the collaborations MSU has had with India for building IP management capacity at public universities (state agricultural universities) have led to the establishment of IPR cells at Haryana Agriculture University (HAU) and Kerala Agricultural University (KAU). HAU's IP management policy (http://hau.ernet.in/iprpolicy.pdf) has been approved by the state government.

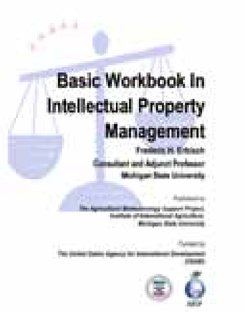
A number of resources and educational and training materials have been developed through international training and capacity building programs offered by MSU. These include:

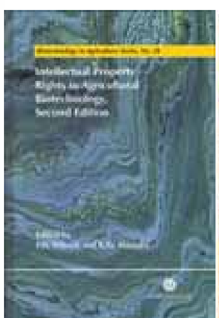
(i) The *Basic Workbook in Intellectual Property Management* (Erbisch, 2003), which is freely available on the website as a global public good (http://worldtap.msu.edu).

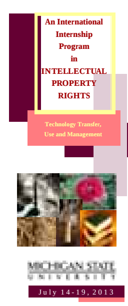
(ii) *Intellectual Property Rights in Agricultural Biotechnology, 2nd Edition*, Biotechnology in Agriculture Series, No. 28. Edited by F H Erbisch, Michigan State University, East Lansing, USA; K M Maredia, Michigan State University, East Lansing, USA. CABI Publishing, 2004 (Erbisch and Maredia, 2004).

(iii) *Intellectual Property Policies and Technology Transfer Practices in the South Asia Region*. K. Maredia, C. Ransom and C. Weebadde (eds). 2009. Intellectual Property Policies and Technology Transfer Practices in the South Asia Region: Experiences of Public Universities and Agricultural Research Institutions, Proceedings of the Special Session Organized at the Association of University Technology Managers (AUTM), San Diego, CA, USA, February 29, 2008. (Maredia, 2008)

(iv) IPR Resource CD was compiled under the India IPR Project and contains various documents and information resources related to IP management and technology transfer.








In addition, the enabling environment created through capacity building programs is leading to licensing of MSU technologies to private companies in developing countries through public-private partnerships (Siripurapu, 2007).

Special Projects in IP Management and Technology Transfer Emerging from MSU Programs

The IPR short course has led to other projects in IP management and technology transfer capacity building.

India IPR Project. In 2005, after an assessment of institutional IP management capacity at five public institutions in India, a clear need for a more focused program to address and build IP management capacity at the institutional level was identified. The overall goal of the India IPR project was to move beyond generic IPR workshops and seminars to a more focused and bottom-up approach to institutional capacity building in IP management and technology transfer. Through mentorship programs, focused internships and workshops, institutional IP management policies and Intellectual Property Rights (IPR) Cells were developed and strengthened at two SAUs: CCS Haryana Agricultural University (HAU) and Kerala Agricultural University (KAU). (The institutions involved included USAID, USDA-ARS, CGIAR-CAS-IP, MSU, and US-JWG in Biotech.)

Intellectual Property and Global Food Security: IP Rights, Innovation, and the Needs of 7 Billion. In February 2012, a special session of the *Modern Global Revolution*, Michigan State University College of Law International Law Review's annual symposium was organized by the MSU Law College, "Intellectual Property and Global Food Security: IP Rights, Innovation, and the Needs of 7 Billion." More than 60 legal and agricultural specialists and law school students attended. This symposium was part of an annual workshop series organized by the MSU Law College under special themes.

Indo-U.S. Bi-lateral Workshop on Technology Commercialization. In July 2012, MSU hosted 12 technology managers from India mainly working with Indian Council of Agricultural Research's (ICAR's) business planning and development units (BPDs) for a joint Indo-US workshop on Technology Commercialization.

More than 20 participants from several institutions in India and USA attended this joint workshop and shared experiences with each other.

International IP management and technology transfer capacity building resources

In addition to MSU, many other international development organizations and programs provide technical assistance and support for IP management and technology transfer. A selected list of organizations is as follows:

- AATF: African Agricultural Technology Foundation (AATF, http://www.aatf-africa.org/) strives to assist in bringing agricultural technologies to developing countries of Africa. It facilitates partnerships between public and private institutions that provide access to and transfer of proprietary agricultural technologies, materials, and knowledge.
- AUTM: The Association of University Technology Managers (AUTM, http://www.autm.net/) has more information on IP policies of public institutions.
- Donald Danforth Plant Science Center (http://www.danforthcenter.org/) conducts basic and applied research in biotechnology and hosts the International Laboratory for Tropical Agricultural Biotechnology (ILTAB), which works to improve staple food crops of developing countries, such as cassava, sweet potato and rice, and transfer the new technologies and transformed plants to those developing countries through collaborative partnerships.
- International Service for the Acquisition of Agri-Biotech Applications (ISAAA, http://www.isaaa.org/) is an international network with centers in the Philippines, Kenya, and the US. Its goal is to assess the needs of developing countries and transfer and deliver needed biotechnology applications to them, thus building partnerships with the private sector in developed countries.
- LES: Information on the development, use, transfer, marketing and management of intellectual property can be found at the Licensing Executives Society (LES, http://www.usa-canada.les.org/).
- PIPRA: The Public Intellectual Property Resource for Agriculture (PIPRA, http://www.pipra.org/) is a non-profit initiative that endeavors to bring new agricultural technologies to developing countries by reducing IP barriers and increasing TT.
- TTOs: Technology transfer offices (TTOs) have been established throughout the world and local ones can serve as a resource for policymakers and institutions endeavoring to develop their own IP policies.
- USAID Agricultural Biotechnology Support Program (ABSP II—Cornell University, http://www.absp2.cornell.edu/) is a USAID-funded project created to assist developing countries in the development and management of tools and products of agricultural biotechnology.
- WIPO: The World Intellectual Property Organization (WIPO, http://www.wipo.int/) is a specialized agency of the United Nations dedicated to establishing a balanced and accessible international IP system. It administers IP treaties and aids in setting up national laws on IPR.
- WorldTAP: MSU's World Technology Access Program (WorldTAP, http://worldtap.msu.edu/) offers many resources to make knowledge, information and technologies accessible to those who need it most through training, capacity building and networking. Several short courses are offered, as well as internship programs in IP management and technology transfer.

Way forward

The technology transfer programs at MSU continue to evolve. MSU has established an excellent system for IPR-led technology transfer and commercialization. With the high cost of patenting, a major shift in technology transfer practices has been to focus more on assessment of market potential of new inventions before decisions are made on patentability. With the exception of minor and specialty crops, the MSU plant breeding community is moving away from developing finished varieties to basic research focusing on development of elite germplasm with specific traits that can be licensed to private companies, leaving the responsibility of developing final products in the hand of the private sector.

With the globalization of the agricultural sector, the landscape of technology transfer is rapidly changing. With the role of private sector growing, the IPR-led technology transfer and commercialization is being institutionalized at many public research institutions and universities. Michigan State University continues to play a major role in raising awareness and strengthening institutional capacities of public organizations.

Many developing countries are taking positive steps in terms of adjusting policies and building their capacity to meet the global challenges of technology transfer. More efforts are needed to strengthen capacities in valuation of technologies for decisions related to patenting and marketing and negotiation. In addition, mentoring programs are needed for continued sharing of information, experiences, and best practices.

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References cited

Erbisch, F. H. 2003. *Basic Workbook in Intellectual Property Management.*

Erbisch, F. H., and K. M. Maredia. 2004. *Intellectual Property Rights in Agricultural Biotechnology*. Second Edition. Oxford University Press.

Maredia, K. M., Ransom, C. and C. Weebadde (eds). 2009. Intellectual Property Policies and Technology Transfer Practices in the South Asia Region: Experiences of Public Universities and Agricultural Research Institutions, *Proceedings of the Special Session Organized at the Association of University Technology Managers (AUTM)*, San Diego, CA, USA, February 29, 2008

Siripurapu, J. 2007. An Overview of Technology Transfer Practices in India, as of 2007. *les Nouvelles* XLII No. 4, Licensing Executives Society International.

Young, Terry. 2006a. Importance of Intellectual Property Management and Technology Transfer at Public Institutions Worldwide. *Intellectual Property Management and Technology Transfer: Experience of a Public University in the United States*. Michigan State University, July 11, 2006

Young, Terry. 2006b. Technology Transfer Overview. *Intellectual Property Rights (IPR) and Technology Transfer: An International Internship Program*. Michigan State University, July 9, 2006.

Chapter 14. Intellectual Property Based Technology Transfer at Cornell: An Agricultural Perspective

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An introduction to Cornell University

Cornell University was founded in 1864 by Ezra Cornell. At its founding, it was a most unique university. Cornell founded his university on some concepts that were, at the time, revolutionary: that students could study the classic disciplines of philosophy, mathematics, law, and natural sciences, etc. but also the applied arts of engineering, agronomy, horticulture, and animal husbandry. Also revolutionary at that time, Cornell was the first university to admit women. Although these concepts are now commonplace, Cornell was the first truly comprehensive university, where men and women could find study in both academic and applied subjects.

Another unique founding characteristic of Cornell – and one that continues today – is its duel public and private nature. Unlike other US universities that are either public or private, Cornell is the only one of its kind: privately owned and operated but also host to certain public colleges, including Agriculture.

Agriculture is a defining characteristic of Cornell. It was founded as an agricultural university and this tradition is as strong today as ever. Cornell was the second US University to become a "Land Grant" university (shortly after the first, Michigan State University). In 1862, the US Congress passed a law in which each state would establish a state agricultural university. The objectives of these so-called "Land Grant Universities" was the academic and practical study of agriculture, education of undergraduate and graduate agricultural students, development of new plant and animal varieties, design of new and useful agricultural methods and machinery, the general pursuit of solving farmer's problems and the delivery of knowledge and technology to agricultural practitioners

The Land Grant mission includes an emphasis on the creation of practically useful agricultural knowledge and its dissemination to farmers and others in the industry. From its founding, Cornell was established to transfer technology created by its researchers to its agricultural constituents. The tradition of technology transfer was embedded in Cornell's fabric – a tradition that continues to this day. However, in the nearly 150 years of its existence, Cornell's implementation of technology transfer has evolved.

In its early years, Cornell engaged in the traditional land grand form of technology transfer. This took the form of delivery of know-how and technology through the system of Cooperative Extension agents, as well as the transfer of new plant varieties through intermediaries, and farmers groups. A defining characteristic of this form of technology transfer is the lack of any proprietary (i.e., property right control) aspect to the information, new plants and animals, or machinery. In this model, all these benefits are to be delivered freely to the public and agricultural users, without any form of property control exerted their creator, the University. For many, this socialistic approach of using government funds to create information and technology which is given to all, without charge, is an enlightened and noble endeavor.

This original, land grant form of technology transfer through Cooperative Extension continues its tradition today at Cornell, and all other Land Grant Universities.

In addition to its deep roots in agriculture, Cornell has developed an international reputation in the basic and applied sciences such as physics, chemistry, material sciences, engineering, aeronautics, veterinary medicine, human medicine and architecture as well as the humanities. Given the range of its disciplines, Cornell remains one of the most comprehensive universities in the world. It consistently ranks in the top ten percent of all universities in terms of the size of its research budget and infrastructure. As of 2012, Cornell employs thousands of scientists and engineers in a very broad range of disciplines and maintains its long tradition of providing graduates, published knowledge, technology and public service.

Cornell's tradition of technology transfer

Technology transfer has been an integral part of Cornell since its founding. However, technology transfer at Cornell has expanded and evolved over the years into a dual model: the traditional Land Grant/Cooperative Extension model characterized by non-proprietary mechanisms; and the more recent property right approach such as those embodied in patent licensing. The evolution of Cornell's current dual technology transfer model can be broken into these three distinct phases:

The Non-Proprietary Period (1864-1932)
The Proprietary (pre-Bayh-Dole) Period (1932-1980)
The Proprietary (post Bayh-Dole) Period (1980-present)

The Non-Proprietary Period (1864-1932)

This period is characterized by the creation and delivery of information and technology without property right controls exerted by the University. A good example is the delivery of agricultural machinery designs to farmers by Cooperative Extension agents and new grain varieties disseminated through farmer-owned cooperatives. During this period, no thought was given to protecting information or plants with any form of property right. No patents of plant variety protection certificates were filed by Cornell. Furthermore, no fees were charged users by the University. While this model continues to this day, it became gradually apparent that a property-right approach had certain advantages over a no property right model.

In the early part of the 1900's it became clear that some technologies require a property right mechanism to be developed. Some technologies created by university researchers require significant further development to be made commercially useful. This typically requires financial investment. Without the market-place protection that a patent provides, there will be no incentive for investors to invest in the development of the technology. Why would an investor spend the money necessary to develop a technology if it can then be taken by others? The technology will therefore languish as a laboratory discovery, never realized as something of practical use to society. In addition, a patent can also be used to give the University the power to assure that the technology will be developed and brought to users. This feature of a property right approach to technology transfer has powerful implications that go to the heart of Cornell's mission: delivering its' technology to the public and its various constituencies

By the second decade of the 1900's it had became apparent that a property right model was needed by Cornell for certain technologies – and that this model would supplement, not replace the non-proprietary model of the first seven decades.

The Proprietary (pre-Bayh-Dole) Period (1932-1980)

In 1932, in response to the growing need for a property right technology transfer model, Cornell established the Cornell Research Foundation (CRF); a separate, not-for-profit corporation wholly-owned by the University for the sole purpose of owning and managing patents covering inventions made by Cornell researchers. CRF's sole goal: to facilitate and ensure the successful development and commercialization of Cornell inventions through patenting and licensing.

The first patent filed on behalf of Cornell and its inventors by CRF covered an animal vaccine. The patent was licensed to a company which successfully invested in the technology and brought it to the marketplace. This first patent license began the trend of the proprietary approach to technology transfer. Despite this first success, the intellectual property model of technology transfer was not well known across campus and in some cases, was opposed by some at Cornell who viewed this approach as a breach of the Land Grant mission. Despite this opposition, every year after it's founding in 1932, CRF received a handful of inventions of which a few it would patent and license. Many of these were veterinary vaccines.

The 50 years of low-profile and low-level activity of patent licensing by CRF would take a dramatic turn in 1980 with the passage of the federal Bayh-Dole Act. In the 50 years between the first patent license and Bayh-Dole, the proprietary technology transfer model was insignificant in comparison to the traditional non-proprietary model. The passage of Bayh-Dole would forever change this equation.

The Proprietary (post Bayh-Dole) Period (1980-present)

Passage of the national Bayh-Dole Act thrust Cornell (as well as all US universities receiving federal research money) into the modern era of property right (primarily intellectual property) based technology transfer. Bayh-Dole launched an endeavor that has evolved into the contemporary technology transfer function that exists today at Cornell and is now a fundamental part of the University's basic mission.

The Bayh-Dole Act gave Cornell and other US universities ownership of patentable inventions made with federal money. It also required the University take positive steps to patent and commercialize these inventions through licensing. This legal requirement was the catalyst to establish what would eventually become the modern university technology transfer office. Bayh-Dole also triggered events that would create a fundamental tension between the non-proprietary model (and its adherents) and the IP-based function. This tension ultimately played out in that bastion of the land grant ideal – in agriculture, specifically within the College of Agriculture and its plant breeding programs.

As the patent manager for Cornell, CRF became the focal point of the rise of the IP-based technology transfer model. Prior to Bayh-Dole, CRF received only a few invention disclosures each year. At the signing of Bayh-Dole in 1980, CRF received barely 20 disclosures per year. By the end of that decade, CRF was receiving well over 100 disclosures per year-without an increase in the number of researchers.

In addition to an increase in invention disclosures, patent applications, patents, and licenses, CRF was at the center of a growing, general appreciation across campus of the implications of IP-based technology transfer at the University.

In the 1980's decade, the IP-based technology transfer function went through a major evolution from a hardly-relevant, peripheral role to become a significant actor within the University with an important role to play across all technical disciplines and from the highest level of administration to the rank and file researcher.

In the Non-Proprietary Period, IP-based technology transfer was non-existent. Even after the first patent was licensed by CRF in the 1930's, awareness of the proprietary approach remained very low, and IP-based technology transfer, an inconsequential function of the University. This negligible role is reflected in the fact that CRF had neither office nor staff from 1932 until 1980. In fact, it wasn't until 1982 (two years after Bayh-Dole) that CRF was anything more than a part-time administrator's file on their desk. By 1982, CRF had two full-time staff persons: an attorney and secretary.

Several key events in the late 1980's further catalyzed the rapid growth of the IP-based technology transfer function: several, very financially successful veterinary vaccine licenses; several breakthrough technologies in agriculture; and CRF's first start-up venture based on Cornell technology and founded by Cornell faculty. These events triggered rapid growth in the 1990's at Cornell in awareness of IP and its potential value. Within 10 years, (1990-2000) the number of invention disclosures received annually by CRF had doubled to over 200. This increase was paralleled by similar increases in patents filed and issued, applications for plant variety protection, licenses, license revenue and even patent-related lawsuits. Patent license income also grew in this period, with many Cornell researchers receiving modest, but regular, royalty payments and a few made wealthy by very successful inventions.

The impressive growth of IP-based technology transfer was accompanied by an expanding understanding among faculty and administration of its potential power and growing importance. By the early 2000's, the president of the university had identified IP-based technology transfer as a critical element of the University's future, one that deserved prominence within and investments by the University.

One of the main factors of the president's belief was the realization that IP-based technology transfer can be a powerful tool for stimulating economic development through the creation of companies, new products and jobs – all based on Cornell's patented technology.

The power of IP-based technology transfer to create measurable economic development led to a campus-wide recognition that this provided a new and important resource for a modern university. This idea also captured the governing body of the university, its board of trustees. By the mid-2000's, Cornell's president, trustees and much of the faculty were in agreement that IP-based technology transfer is a fundamental and permanent function of the University – a function that deserves the commitment Cornell is capable of.

An outcome of this commitment was the creation of the Cornell Center for Technology, Enterprise, and Commercialization (CCTEC). CCTEC absorbed CRF and was designed to implement the modern, university model of technology transfer. CCTEC represents the culmination of decades of evolution of IP and IP-based technology transfer within the university. CCTEC also reflects the growth in the function's capability, staff and awareness across the university.

Development of Cornell's philosophy, policy, and practice of intellectual property based technology transfer

The years of evolution of IP-based technology transfer at Cornell have been accompanied by a progression and growth of the underlying philosophical basis, principles, and policy, and the development of the professional practice. Key issues have driven this progressive development of the underlying rationale for the contemporary University technology transfer model. Resolving the following issues has provided a crucible in which the University forged the character of its current IP-based technology transfer model:

- Ownership of University IP
- Exclusive vs. non-exclusive licenses
- Inventor's rights and obligations
- Financial vs. social goals of IP licenses
- University role in venture creation and economic development
- Relation with research sponsors and collaborators
- Technology Transfer Office position within the University
- Faculty entrepreneurs
- IP-related metrics in tenure decisions

Venture creation and technology transfer at Cornell

In 1989, Cornell made a fundamental policy shift: it agreed to take ownership in a start-up company based on Cornell technology, in lieu of a cash license fee. Those who were advocates of this change understood the reality of commercializing university inventions: some patentable technologies will only be developed by a start-up company. Existing companies simply will not take the risk to invest at such an early stage and most university inventions are at the earliest stage of development. Venture creation is often the only route to licensing and commercialization for these technologies. In addition, a few entrepreneurial faculty want the opportunity to create a company based on their inventions. As part of the general evolution of consciousness about IP-based technology transfer at the University, the University began to accept, and then later promote entrepreneurship among faculty.

The creation of Biolistics, Inc. was a watershed at Cornell, because it was the first Cornell-owned (a minority ownership share) startup, the first officially-sanctioned "intrepreneurship" by faculty, and was based on a dramatic agricultural biotechnology breakthrough referred to as the "gene gun."

Biolistics was eventually sold to Dupont. Cornell and the faculty that invented the technology and founded the company realized a significant financial gain. This money was used to further develop CRF's technology transfer capability through hiring of staff and creation of business infrastructure.

Biolistics opened a floodgate of entrepreneurial endeavors based on Cornell patents. It has been said that the fact that Biolistics faculty founders became wealthy through IP and entrepreneurship was a big motivator to others to participate in the process. By the 2000's, Cornell was launching approximately 10 start-ups per year. Some of these companies still exist and have become successful, some failed and some have been acquired by other companies.

Intellectual property-based technology transfer at Cornell: The agricultural experience

Given Cornell's long tradition of agricultural technology transfer, it's not surprising that agriculture was the leading force in the development of Cornell's IP-based technology transfer endeavor. For many years, starting in the 1980's, agricultural researchers at Cornell produced the greatest number of invention disclosures, patent applications filed, patents issued and licenses. For much of the three decades after the passage of Bayh-Dole in 1980, Cornell's College of Agriculture and Life Sciences led all other colleges (including the Colleges of Medicine, Engineering, and Veterinary Science) in all IP-related metrics. During this period, two areas dominated Cornell's IP-related technology transfer activities: licensing of new plant varieties protected by plant patents or Plant Variety Protection certificates, and genetically-modified crop technologies covered by utility patents.

The eventual convergence of land-grant traditions and modern IP-based technology transfer mechanisms led Cornell to initiate a program in the early 1980's, to patent and non-exclusively license (in the US) new varieties of tree fruits, berries, grapes and other crops patentable under US plant patent law. The policy of non-exclusive licensing reflected Cornell's land grant, public service mission and the desire to disseminate its technology as widely as possible.

This plant IP licensing program was driven, in part, by the arrival of a new generation of plant breeders who didn't see patents and licensing as a threat to Cornell's traditional mission, but as a tool for delivering the benefits of university plant breeding to farmers and the public. More traditional breeders at Cornell, responsible for apples and other tree fruits, were resistant to the notion of using intellectual property to control the dissemination of new varieties. They preferred the traditional route of placing new varieties in the public domain, involving no intellectual property, no controls over distribution and no direct financial return to Cornell or its breeding programs.

The traditional view of public domain releases of plant varieties began to change with the public release and eventual success of Cornell's "Jonagold" apple variety. Although this variety was only a modest success in the United States (often labeled as other, more commonly-known apples), Jonagold became hugely popular throughout Europe. For many years, it was the most popular apple there. But, because Cornell had not sought property right protection for the variety, there was no legal or contractual mechanism to convert this marketplace popularity into financial gain for Cornell or its breeding programs. It has been calculated that, had Cornell protected Jonagold and licensed it in Europe under typical terms, royalties on Jonagold sales in Europe would have generated hundreds of thousands of dollars to support Cornell plant breeding. Those inside and outside of the University began to question the logic of US and New York State taxpayers funding the breeding of crops that benefited those in other countries who contributed nothing to support those breeding efforts. This fact, coupled with a decline in state and federal support for university fruit breeding, changed the traditional "public domain" mind-set among Cornell researchers and administrators once and for all.

Since the mid-to-late 1980's, Cornell has had a comprehensive program of patenting and domestic licensing of apples, cherries, plums, grapes, apple rootstocks, raspberries and strawberries. These US licenses are nonexclusive, simple, two-page contracts that provide for a royalty to be paid to Cornell on sales of plants. These licenses have no up-front fees or minimum payments. While these licenses have often accomplished the goal of disseminating Cornell varieties, they have also been a disappointment because nonexclusive licenses provide little or no incentive to licensees to invest in developing the market for the licensed variety. So, sales volume per licensee generally stays small. It is tempting to wonder how successful some Cornell plant varieties might have been in the marketplace had exclusive licenses given licensees the incentive to invest significantly in their marketing and promotion.

In one rare instance, in the late 1980's, CRF decided to exclusively license the "Watson" raspberry variety in the US and other countries under terms that included significant license fees, minimum royalty payments, and higher royalty rates. The license proved to be a financial success for Cornell and its fruit-breeding program and one that catalyzed significant global market development for Watson. However, this exclusive license was a political failure. Various political constituencies both inside and outside of Cornell, including faculty, farmers, nursery owners, state legislators and others protested this license. This setback caused a *de facto* moratorium on exclusive plant variety licensing in the US that has largely lasted for years. Until recently, all domestic licenses for Cornell fruit varieties have been nonexclusive.

While licensing of varieties in the US has normally followed a non-exclusive model, licensing of plants outside of the US was a different matter entirely. From the beginning of Cornell's IP plant licensing efforts, non-US licenses were normally exclusive. These foreign exclusive licenses were not only politically feasible, they were of strategic importance to Cornell as they spawned the establishment of a global network of commercial partners for Cornell in the plant industries. These licenses created "master licensees" in various regions of the world who acted as Cornell's agents to develop and disseminate Cornell's plant varieties throughout the important crop regions of the world. These exclusive licenses also provided the basis for Cornell's implementation of innovative plant licensing approaches.

Examples of Cornell's creative plant licensing include the use of tangible property rights as the basis for licensing wine grape varieties, novel royalty structures based on sales of fruit, and unique trademark licensing approaches to licensing of crop traits rather than varieties *per se.*

In the 1980's, 1990's and into the 2000's, Cornell was a leader in the creation of new agricultural biotechnologies and these technologies were in demand by a nascent agbiotechnology industry. This placed Cornell at the forefront of licensing in this domain. For many years, CRF, Cornell's technology transfer office, was considered the leading university in the design and negotiation of licenses in this technology area.

In addition to licensing key agricultural biotechnologies such as the gene gun, viral resistance by coat protein gene insertion, and the rice actin promoter, CRF was a leader in innovative licensing approaches. For example, in order to transfer its virus-resistant papaya technology throughout the world, Cornell licensed-in enabling technology of third parties in order to deliver the IP "freedom to operate" to its licensees. This may be the only example of a US university licensing-in technology as part of the technology transfer process. CRF developed a variety of innovative approaches to licensing agricultural biotechnologies that included exclusive, group-exclusive (i.e., consortia), exclusive field-of-use (crop by crop), exclusive by country, and variants on non-exclusive.

A good example of Cornell's experience in IP-based technology transfer in agbiotechnology is the history of licensing of the rice actin promoter. This gene promoter, discovered in rice, has particular utility in transgenic corn and has been used in corn lines with stacked traits of herbicide and insect resistance. Use of the rice actin promoter in corn stimulated widespread interest by industry in its' licensing. Cornell's strategy of nonexclusive licensing of the rice actin promoter successfully disseminated the invention while providing reasonable compensation to Cornell. The licensing effort was complicated by the varied business models of the several nonexclusive licensees. Although Cornell attempted to maintain a standard set of license terms, each successive licensee asked for variations that were tailored to their particular business models. In order to maintain fairness to all licensees, this tailoring of license terms required Cornell to adjust the balance of rights and obligations.

A unique aspect of the non-exclusive rice actin licensing strategy has been the development of a hybrid of paid-up and royalty-bearing licenses. This development was based, in part, on the agbiotechnology industry demand for the accounting ease of paid-up licenses. While paid-up licenses alleviate much of the licensee's accounting burden, such terms make it difficult for the licensor to realize a fair and significant return, unless the paid-up amount is very large. So, CRF developed a hybrid in which the licensee would not pay an ongoing royalty on each sale; rather, lump-sum payments (of a predetermined amount) are owed upon reaching certain defined milestones. For example, payments are owed on signing, first successful field trial, first regulatory approval, first sale, third anniversary of first sale, and so on.

Agbiotech license agreements share many similarities with other types of intellectual property based technology licenses. Much of the standard, legal boilerplate is similar to that of any other license technology agreement. However, there are unique aspects of these licenses that set them apart, including:

- Multiple property types (intellectual and tangible) often covering a single technology and/or product
- Freedom-to-operate issues that drive anti-royalty stacking provisions
- Philanthropic and humanitatian use clauses
- Stewardship obligations

Despite Cornell's adherence to nonexclusive licensing in the domestic crop sector, Cornell continued to license veterinary technology on an exclusive basis. This was in consideration of the large investment necessary by the licensee to bring the product to market, but also the lack of political resistance to exclusive licenses in the animal health area. These conditions likewise existed in the food-process and agricultural-device fields. Throughout the 1970's, 1980's, 1990's and 2000's, Cornell patented and exclusively licensed several food-manufacturing processes including egg pasteurization and vegetable blanching, as well as the supercritical CO2 fluid extruder. The latter was unique in that the licensed device required a royalty payment on sales of food product made using the patented machine.

During these decades, a number of biological control technologies were patented and licensed, all exclusively. Two of these are notable because the technologies were commercialized through start-up companies. In both cases, CRF took an equity stake in the companies. One company, Bioworks is privately held, and Cornell retains ties to this New York company. A second company, Eden Bioscience originally traded on NASDAQ , was responsible for one of the largest equity-liquidation events realized by Cornell for its patented inventions.

The policy decision to allow CRF to take equity in Biolistics and its gene gun development was a watershed event. Although the Biolistics story was technology transfer success in many respects, the early participants were not fully aware of certain long term implications of some of the intellectual property aspects of the license arrangements. In particular, Cornell failed to retain the right to use the invention for research and technology transfer purposes and also failed to carve out certain philanthropic and humanitarian uses from the commercial license. This presented problems for some who wish to use the technology without constraints imposed by DuPont and its sub-licensees. Cornell has been criticized for this lack of foresight and, perhaps, rightly so. However, at the time, few people understood the full implications of licensing agbiotechnologies that were largely unproven.

There was one, very positive outcome of the gene-gun licensing experience. After the gene gun, agricultural biotechnology inventions licensed by CRF were also made available for philanthropic and humanitarian purposes. Furthermore, licenses by CRF contained explicit conditions that would ensure diligent use of Cornell technologies for all crops and in any geographical region.

In recent years, the Colleges of Engineering and Medicine at Cornell have overtaken the College of Agriculture and Life Sciences as leaders in IP-based technology transfer activity. This has been caused, in part, by the significant drop off of agbiotechnology inventions and licensing activity. However, Cornell remains a leader in the protection and licensing of its plant varieties.

Increasingly, agricultural universities around the world are looking to Cornell as a model for developing their own IP-based technology transfer programs. It will be interesting to see how Cornell and other agricultural universities inside and outside the US will use IP-based technology transfer models to disseminate their technology.

Chapter 15. The Unite States Department of Agriculture, Agricultural Research Service Technology Transfer Program

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Agricultural Research Service (ARS)

ARS is the US Department of Agriculture's principal intramural scientific research agency. The agency conducts research to find solutions to agricultural problems that affect Americans every day, from field to table. ARS research outcomes include protecting crops and livestock from pests and diseases, improving the quality and safety of agricultural products, determining the best nutrition for people from infancy to old age, sustaining soil and other natural resources, ensuring profitability for farmers and processors and keeping costs down for consumers. ARS technology transfer activities are designed to maximize the impact of ARS research programs and to ensure the availability of new technologies for broad public benefit.

ARS employs over 8,000 people. Approximately 1,950 permanent full-time scientists, and approximately 3,300 technical and support staffs, conduct research in projects funded by Congressional appropriations at more than 90 locations. Research projects are managed as 19 national research programs divided into four broad categories of research: (a) Animal Production and Protection, (b) Natural Resources and Sustainable Agricultural Systems, (c) Crop Production and Protection, and (d) Nutrition, Food Safety and Quality. The ARS Office of National Programs plans the scope and objectives of the agency's research projects, while eight area directors implement research projects at the locations in their geographic areas across the United States (US).

ARS conducts ongoing reviews of its research projects, which are designed both to ensure the relevance and quality of its research work and to maintain the highest possible standards for its scientists. Customers and stakeholders provide significant input into the project review process to insure that ARS research is focused on the needs of the American food and agricultural system. All ARS scientists and engineers have technology transfer as a performance element in their annual performance appraisals. Individual researchers and research projects are evaluated based on the impact of research outcomes for US agriculture and consumers.

The official mission of ARS is to conduct research to develop and transfer solutions to agricultural problems of high national priority and provides information access and dissemination to:

- Ensure high-quality, safe food, and other agricultural products;
- Assess the nutritional needs of Americans;
- Sustain a competitive agricultural economy;
- Enhance US natural resources and the environment; and
- Provide economic opportunities for rural citizens, communities and society as a whole.

This ARS mission statement makes it clear that technology transfer is fundamental to the ARS mission. ARS also has delegated authority from the Secretary of Agriculture to administer the patent and licensing program for all intramural research conducted by the US Department of Agriculture (USDA). The ARS Office of Technology Transfer has the responsibility for developing USDA technology transfer policies and for managing technology transfer activities.

Technology transfer from US federal laboratories

US Federal laboratories conduct research and development work for the purpose of finding technical solutions to problems of public interest. The transfer of technologies developed at federal laboratories to the private sector, and to state and local governments, is required by federal law. Technology transfer, consistent with each laboratory's mission, is a responsibility for all laboratory scientists and engineers. Broadly defined, technology transfer is the adoption of new technologies by end-users who benefit from their use. USDA defines technology transfer as the adoption of research outcomes for public benefit.

Science-based innovations from USDA intramural research create new or improved technologies, processes, products and services that benefit the nation by increasing productivity, increasing efficiency, and enhancing global competitiveness for the US agriculture sector. Thus, effective technology transfer is critical for accelerating the adoption of USDA innovations, stimulating economic activity, and creating jobs and sustainable economic development.

Sometimes, research results and innovations can be transferred directly from USDA to end-users or the general public. More often, the private sector serves as the essential delivery mechanism and intermediary between public research and the realization of public benefit. Private sector partners facilitate technology transfer by providing the complementary business assets needed for the commercialization of new products, processes, or services resulting from USDA research. Such assets may include manufacturing facilities, marketing and distribution capacity, product registration expertise and investment capital. By providing these assets, private sector partners make investments both in the development and marketing of new products and services and in making these products and services widely available to customers and consumers.

Companies who choose to make investments in USDA research results are taking some financial risk, because there is no guarantee of market success. Most businesses will not agree to take such risks without some protection for their investments. When private sector partners are needed to facilitate technology transfer, USDA has the authority to grant exclusive or partially exclusive invention licenses as an investment incentive (P.L. 96-517). Private sector partners may also choose to work together with USDA scientists to jointly create and develop new technologies. Such work can be conducted under a Cooperative Research and Development Agreement (CRADA). By Federal law, CRADA partners have the first right to negotiate an exclusive license for any invention made during the course of the CRADA research (P.L. 99-502).

USDA uses its CRADA and licensing authorities to manage its intellectual property for the purpose of attracting private sector partners when they are needed for effective technology transfer. Federal laboratories are required to design technology transfer programs that encourage maximum participation of small business firms in federally supported research and development efforts. Supporting small business development and entrepreneurial activity, and promoting technology-based economic development, are important goals for USDA's technology transfer program.

The ARS Office of Technology Transfer

The ARS Office of Technology Transfer (OTT) was created after Congress passed the Federal Technology Transfer Act (FTTA) in 1986 (P.L. 99-502). This Act requires each Federal laboratory to establish an Office of Research and Technology Applications (ORTA), and it also requires each Federal agency to make sufficient funds available to support the technology transfer function at its laboratories. OTT was created to perform the legally mandated ORTA functions for ARS, and was also delegated authority to administer the patent and licensing program for all intramural research conducted by USDA. These functions include, in part, assessing potential commercial applications for ARS research and development projects, providing information about

ARS research results and outcomes to private industry, and participating in regional, state and local programs designed to facilitate technology transfer.

The FTTA provides the authority for federal laboratories, including ARS, to enter into CRADAs with both private industry and public sector research partners. It also provides the authority for ARS to retain invention license revenues, to be used only for specific purposes. These include sharing license revenues with ARS inventors as incentive awards and using the remaining revenues to support ARS technology transfer activities. After the creation of OTT, ARS recruited qualified professionals with the technical, legal and business expertise needed for effective technology transfer.

The ARS technology transfer program has centralized policy and approval procedures that are managed by OTT. One-on-one customer service is provided to intramural researchers through Technology Transfer Coordinators (TTCs) stationed in the ARS area offices. The TTCs report directly to their regional area director. They serve as liaisons between ARS scientists and ARS line managers, OTT staff, and university and private sector research partners. TTCs assist scientists with both the confidential exchange of unpublished research data and the sharing of proprietary materials with public and private research collaborators. They work with scientists to develop statements of work for CRADAs and other cooperative research agreements.

OTT's activities are organized into four sections located at ARS headquarters in Beltsville, MD. The *Administrative Section* conducts day-to-day operations, coordinates technology transfer policy development, and executes Cooperative Research and Development Agreements (CRADAs), patents, and licenses. The *Partnership Section* coordinates the development of partnerships through formal agreements with the public and/or private sector. The *Patent Section* provides strategic guidance to scientists regarding patent protection for their research results. This section includes nine registered patent agents and attorneys, as well as paralegal support staff. The Patent Section is responsible for receiving invention reports, convening three National Patent Committees (Mechanical and Measurement, Life Sciences, and Chemistry), preparing and prosecuting patent applications, and reviewing patent legal work performed by cooperator and ARS contract law firms. The *Licensing Section* is responsible for negotiating license agreements for inventions made by intramural scientists in all USDA agencies. This section includes four invention licensing specialists, the ARS foreign patent specialist, and the license monitoring staff. The Licensing Section manages all aspects of USDA invention licensing, including the review of license applications, the negotiation of license agreements, and the monitoring of license agreements to assure compliance with agreement terms. Licensing Program staff collect and disburse license revenues, manage international patent filings and provide expert advice on all matters related to USDA invention licensing.

Effective technology transfer requires the full participation of scientists and research line managers. Both the initiative to enter into research collaborations with private sector partners and the creation of new inventions originate with individual ARS researchers. OTT's role is to provide expert advice and to guide researchers through the negotiation of research agreements, the reporting of new inventions, and communications with potential licensees. ARS scientists and line managers are provided incentives to participate in the technology transfer process. Both researchers and supervisors are evaluated and promoted based on the measurable practical impact of their research projects and programs. Individual inventors receive a share of invention license revenues as an incentive award.

Mechanisms for Technology Transfer

Technology transfer encompasses all means of transferring research outcomes to end-users and the public. A variety of technology transfer mechanisms and contract tools are available to ARS and OTT for accomplishing this goal. It is important to choose the right tool for the job. Decisions regarding the best technology transfer mechanism to use are made on a case-by-case basis, depending on the specific needs of the intended end users. Some examples include:

- Developing written information for customers and stakeholders, including scientific publications, publications in trade journals, and reports to stakeholders;
- Releasing plant germplasm to the public;
- Transferring research materials to scientists outside of ARS;
- Entering into formal partnership agreements, such as CRADAs, and other cooperative agreements;
- Delivering specific research results to regulatory agencies to support their actions;
- Licensing inventions (patents, Plant Variety Protections Certificates, and biological materials); and
- Participating in meetings with industry organizations and universities, workshops and field days; and distributing information to the public via the ARS Information Staff, the National Agricultural Library, and other sources.

Some technology transfer mechanisms are facilitated by various forms of contracts between ARS and research collaborators or commercialization partners. Unpublished ARS research results and company confidential information can be shared under Confidentiality Agreements (CAs). Proprietary materials are exchanged under Material Transfer Agreements (MTAs). The terms of these agreements can be modified to suit specific project needs. For example, new crop variety selections can be shared with collaborators for field testing using MTAs that include provisions designed specifically for testing plant materials.

There are several different types of cooperative research agreements available to ARS researchers when more extensive or in-depth research collaborations are required for technology transfer.

Non-Assistance Cooperative Agreement
This is an agreement between ARS and a research partner that describes in detail a jointly planned and executed research program or project of mutual interest to the parties, where both parties contribute in-house resources. There is no direct transfer of funding or in-kind resources between the parties, and no intellectual property rights are conveyed.

Reimbursable Cooperative Agreement (RCA)
This is an agreement between ARS and a sponsoring organization that involves cooperative research of mutual interest to the parties, where the sponsor pays ARS for costs incurred in performance of the research project when billed by ARS. RCAs do not convey rights to intellectual property.

Trust Fund Cooperative Agreement (TFCA)
This is a collaborative research agreement between ARS and a sponsoring organization that involves cooperative research of mutual interest to the parties, where the sponsor pays ARS in advance for costs to be incurred in performance of the research project. TFCAs do not convey rights to intellectual property.

Cooperative Research and Development Agreement (CRADA)
A CRADA is a contract between ARS (or any federal laboratory) and one or more non-federal research partners, such as companies or universities. A CRADA offers both parties the opportunity to leverage each other’s resources when conducting mutually beneficial research and development. ARS can provide personnel, facilities, equipment, or other resources to the non-Federal party, as needed for the specific research project, but ARS cannot provide funds to non-Federal parties. The non-Federal party can provide funds to ARS, as well as personnel, facilities, equipment or other resources needed to conduct the research and development work. CRADAs provide two benefits to non-Federal partners that are not available in other cooperative research agreements:

- CRADA partners have the first right to negotiate an exclusive license for any invention made during the course of the CRADA research, and

- CRADA research data may be treated as confidential business information for a period up to five years from the date that the data was generated.

Invention license agreements are the best available technology transfer tool when private sector research collaborators or commercialization partners require protection for their investments in the development and marketing of USDA developed technologies. USDA may grant exclusive, co-exclusive, exclusive territory, or exclusive field of use licenses for patents, pending patents, Plant Variety Protection Certificates, and corresponding intellectual property rights owned by USDA in other countries. Biological materials that are not protected by patent or plant variety rights can be licensed on a non-exclusive basis. Licensees must submit a commercialization plan before being granted a license to a USDA invention. USDA treats all commercialization plans submitted as confidential business information. License business terms are negotiable, and all USDA license agreements include due diligence milestones.

Because the ARS mission is to transfer technologies for broad public use by the most effective mechanism, ARS pursues patents and licensing only when needed to provide an incentive for private sector investments. Technologies that are most effectively transferred through publication, such as new research tools, or through public release, such as improved crop germplasm, are not usually protected by intellectual property rights. All exclusive invention licenses reserve the right for USDA to conduct research with third parties using the licensed invention. For exclusively licensed plant varieties, the reservation of rights also includes the right for USDA to make its varieties available to others for breeding purposes.

Examples of successful technology transfer

1) Technology transfer directly to end users: ARS Application Technology Research Unit, Wooster, Ohio

The Application Technology Research Unit (ATRU) uses a multi-disciplinary approach in developing methods to enhance crop protection while safeguarding environmental quality, food and worker safety. The unit conducts its research in partnership with agricultural extension agents, stakeholders and growers. Research results and new management tools are often communicated directly to end users. Published information is available through trade journals. The Virtual Grower and DRIFTSIM computer programs are available online and can be downloaded for free or at minimal cost. Virtual Grower is designed to help greenhouse growers to determine heating costs and to do simulations to show where heat savings could be achieved. Virtual Grower can not only help identify those savings through different greenhouse designs, but can also predict crop growth, assist in scheduling, make real-time predictions of energy use, and demonstrate the impact of supplemental lighting on plant growth and development. DRIFTSIM assists pesticide applicators to choose optimum spray conditions to minimize spray drift. It requires no special skills to operate, and computer requirements are minimal.

Figure 1. Spray nozzle design for greenhouse application

Pesticide applications are critical to ensure healthy, unblemished ornamental nursery plants. Conventional spray application practices recommend the modification of carrier volume for preparations of spray mixtures, but not the amount of active ingredients per unit area. ATRU researchers demonstrated that growers could use their existing spray equipment to reduce pesticide and water use by 50 percent by properly changing spray nozzles at no extra cost and still achieve effective pest and disease control. This equates to doubling the pesticide application efficiency while reducing pesticide costs, reducing health risk to applicators, and diminishing adverse impact to the environment. Other benefits accrued with this approach included increased operational efficiency (the area sprayed is doubled thus the frequency and travel time required for the tank refilling times are reduced) and reduced costs for energy consumption and new equipment, as well as reduced risk of pesticide exposure of workers. By using the half-rate practice, growers reported savings of over $200-$500 per acre.

2) Technology transfer through public-private partnerships that do not involve USDA intellectual property rights: ARS Small Grains and Potato Germplasm Unit, Hagerman, Idaho

ARS researchers, working with a commercial partner, demonstrated that rainbow trout can be grown successfully on a plant-based diet instead of a conventional fishmeal diet. This is significant because the current practice of feeding fishmeal to farm-grown fish is not sustainable. Supplies of the marine species used for fishmeal, such as anchovy, menhaden and herring, cannot keep pace with rapidly growing demand. The Small Grains and Potato Germplasm Research Unit not only developed a successful grain-based food formula, but they also cross-bred trout to produce fish that actually grow better with the plant-based formula.

These new strains of trout, grown by the commercial partner, Clear Springs Foods of Buhl, Idaho, are already reaching tables in American homes and restaurants. They account for 18 percent of all commercially grown rainbow trout in the US. More than half of the fish consumed in the US now comes from commercial aquaculture. In addition to trout, popular species include Atlantic salmon, sablefish, catfish, tuna and cobia. While the lab's research focused only on trout, their findings hold promise for commercial farmers of other species as well. Plant-based food, and new strains of fish that thrive on it, will help support the growth of commercial aquaculture in the US and keep fish a key component of the American diet.

These innovations will also benefit many developing countries, where farm-grown fish supply the only source of protein to much of the local population. Currently, most fish farmers in these countries use poor-quality feeds. But with better feeds and improved fish strains, production would increase dramatically.

Figure 2. New breeds of trout raised on plant-based feed

ARS scientists have been developing the plant-based fish feed and the new strains of rainbow trout in the Hagerman, ID lab for 11 years. In 2006, ARS entered into a CRADA with Clear Springs, the largest trout producer in the world, to test the plant-based feed and the new trout strains in a commercial environment. A second CRADA with Clear Springs was signed in 2011 to continue the research. In the early phases of this research, it was determined that some individual rainbow trout families were better able than others to process plant-based feed. By crossbreeding trout with those qualities for four generations over 10 years, fish were produced that gain weight quicker than standard commercial trout on fishmeal-based diets.

The new strains of fish also appear to have a firmer muscle texture. The lab has conducted a blind taste test for fish farmers, and found that they couldn't tell the difference between the plant-fed and fishmeal-fed trout. The lab's plant-based trout diet, in the form of pellets, is being produced commercially by several companies using their own proprietary formulations. Because the grains used in the feed do not contain Omega-3 fatty acids, which are a valuable dietary benefit of eating fish, current feed formulas include fish oil to make up for that deficiency. However, since the fish oil comes from the same marine species as the fishmeal, and those supplies are limited, the lab is now working to breed trout that can convert oil from algae and soy into Omega-3 fatty acids.

3) Technology transfer through intellectual property licenses: ARS Bio-Oils Research Unit, Peoria, Illinois

Organic chemists at the ARS Bio-Oils Research Unit in Peoria, IL developed a new kind of bio-based fluid, known as oleic estolides, that is already being used in race cars, and is expected to be commercialized for public use in the next few years. Although the idea of using plant-based motor lubricants is not a new one, previous efforts by scientists could not overcome several obstacles.

Figure 3. Vegetable oil-based industrial lubricants and motor oils

Prior biobased lubricants generally had poor cold temperature properties. For example, they froze or particulates formed, clogging up fuel filters. In addition, the earlier lubricants had low oxidative stability and therefore broke down more easily. The oleic estolide oils solve both of those problems. They have excellent cold-temperature properties, as well as outstanding oxidative stability properties. These breakthroughs pave the way for estolides to replace conventional motor lubricants, helping to reduce the nation's dependence on foreign oil. Estolide lubricants have important advantages over conventional petroleum-based and synthetic motor oils. Because oleic estolides permit the engine parts to move more freely, they don't impose as much wear on the engine, and provide a 10 to 15 percent increase in fuel economy.

Commercializing the estolides was not an easy task. ARS scientists spent endless hours preparing samples, trying to find a partner for a CRADA. They presented their data and findings at numerous meetings and in peer-reviewed scientific journals. An initial CRADA was signed in the mid-1990s, but the CRADA partner decided not to pursue the technology. After the partner agreed to assign its rights in the estolide technology back to ARS, another CRADA partner was sought. A new CRADA with Peaks and Prairies, a small start-up owned by farmers in Montana, was initiated in 2006. Subsequently, ARS granted the company, recently renamed Biosynthetic Technologies, an exclusive license to the oleic estolide patent rights. The company began commercializing the lubricant in 2011. It is currently being used in race cars, which is a common precursor use for motor oils before they are introduced to the broader market.

Biosynthetic Technologies has entered into agreements with two large oil companies to distribute the estolide lubricants. These companies will buy the base estolide oil from the ARS licensee, provide additives, and market their individual brands to consumers, likely sometime in the next few years. One of these companies has made a substantial investment in Biosynthetic Technologies to continue the research and development process. Recently, Monsanto and Biosynthetic Technologies announced a broad collaboration, involving license and supply agreements and an equity investment by Monsanto in the company. The purpose of this collaboration is to expand the market opportunity for soybean growers who plant Monsanto's new Vistive Gold high oleic soybeans.

In their search for CRADA partners, and in collaborations with them, the Peoria, IL lab provided technical assistance for the pilot production of selected products, provided equipment and data transfers, and conducted physical property testing and distillations of estolide materials. ARS scientists had the difficult task of demonstrating that estolides can not only equal the performance of petroleum-based materials, but they can exceed their performance.

Measuring successful technology transfer

In 2000, Congress passed the Technology Transfer Commercialization Act (P.L.106-404). Among it provisions, this law requires federal agencies to report annually to the Office of Management and Budget, as part of the agency's annual budget submission, on technology transfer activities performed by the agency and its laboratories. These reports must include an explanation of the agency's technology transfer program for the preceding fiscal year. The reports must also include the agency's ongoing plans for conducting its technology transfer function, including its plans both for securing intellectual property rights in laboratory innovations with commercial promise and for managing its intellectual property so as to advance the agency's mission and benefit the competitiveness of US industry. A copy of the report must be transmitted to the Secretary of Commerce and the Attorney General for inclusion in the annual report to Congress and the President. Agencies are encouraged to make their reports available to the public on their websites.

In addition to a description of agency technology transfer plans, the Technology Transfer Commercialization Act requires that annual reports must also include the following metrics:

- Number of patent applications filed;
- Number of patents received;
- Number of fully-executed licenses which received royalty income in the preceding fiscal year, categorized by whether they are exclusive, partially-exclusive, or non-exclusive, and the time elapsed from the date on which the license was requested by the licensee in writing to the date the license was executed;
- Total earned royalty income including such statistical information as the total earned royalty income of the top 1 percent, 5 percent, and 20 percent of the licenses, the range of royalty income and the median;
- What disposition was made of the earned royalty income;
- Number of licenses terminated for cause; and
- Any other parameters or discussion that the agency deems relevant or unique to its practice of technology transfer.

For the most recent fiscal year ending September 30, 2012 (FY 2012), ARS filed 108 patent applications, was granted 60 US patents, and had 363 active license agreements, including 31 new licenses granted during the reporting period. On average, it took about 6 months to negotiate each license agreement. The total license revenues received were approximately $3.8 million. Eighty percent of these license revenues were received in the form of earned royalties, resulting from the sale of licensed products and services. License revenues were used to pay incentive awards to inventors, to cover the costs of patent application filing, prosecution, issuance and maintenance, and to pay the salaries of some ARS technology transfer staff. In addition to the required metrics, ARS reported 243 active CRADAs, of which 53 were newly executed, 970 new material transfer agreements and 317 new confidentiality agreements. USDA's annual technology transfer reports for FY 2001 through FY 2012 are posted on the ARS website.

These metrics represent the technology transfer activities that are the easiest to count, but they only represent a small portion of such ARS activities. Meaningful performance metrics in technology transfer are often difficult for research agencies to obtain. OTT is continuing to work on defining better metrics for technology transfer within USDA. For example, successful outcomes may include improved agricultural practices, scientific information that enhances US competitiveness, increased awareness about pathogens to help prevent human and animal diseases, or findings that help corporations and universities make informed decisions in allocating their research resources. Many of these outcomes are not best achieved through CRADAs, patents or licenses.

Beginning in FY 2013, ARS will add some new metrics to its annual technology transfer report. These include, among others, the number of plant varieties released and amount of germplasm distributed, the number of CRADAs and licenses with small businesses, the number of inventions jointly owned with universities and small businesses, and examples of successful technology transfer transactions that did not involve patent licenses. ARS also plans to use its ATIP program (see below) to gather economic impacts of technology adoption by private sector partners. These metrics will include jobs created, impacts on regional economies, and research and development collaborations that match USDA technical expertise with companies that need such expertise to develop new products and services that benefit the public.

Technology transfer activities that promote technology-based economic development, small businesses, and entrepreneurs

Promoting technology-based economic development is an important goal for USDA's technology transfer program. To help achieve this goal, ARS established the "Agricultural Technology Innovation Partnership" program (ATIP), a network of nine select local/state/regional economic development organizations. The purpose of ATIP is to facilitate the transfer of USDA technologies to US businesses for their use in research, development, and production to meet agriculture requirements and to foster commercial applications. The overarching goals of ATIP are to increase the likelihood that USDA research outcomes are adopted by private sector firms and to increase impact and recognition of USDA research programs. Current patenting, licensing and CRADA polices and processes are not affected by this program.

Membership in ATIP is formalized with a Partnership Intermediary Agreement (PIA) executed by OTT on behalf of ARS. PIAs are specifically authorized by federal statute as a technology transfer instrument. The term "partnership intermediary" means an agency of a state or local government that assists, counsels, advises, evaluates, or cooperates with small business firms, universities or educational institutions that need or can make demonstrably productive use of technology-related assistance from a federal laboratory. ATIP members are selected for their knowledge of industry, technology, and market sectors. ARS has broad flexibility in selecting intermediaries that are best able to meet the needs of the agency by providing complementary services both to ARS and to its industry partners.

ATIP members assist USDA labs and research institutions in locating potential industry partners for the purpose of collaborating on technology innovation and maturation. Ultimately, they do those things best done by industry: translating technology into products for the market. In addition, they assist in making companies aware of USDA patents available for licensing and USDA's research capabilities for solving problems of the agriculture sector. ARS utilizes the ATIP members (a) to co-sponsor events whereby ARS technologies and research capabilities will be showcased, thereby increasing the opportunities for technology transfer partnerships; (b) to provide technology-readiness assessments and business plan development of select existing technologies in ARS (protected intellectual property) to create "Partnering Opportunity" documents for distribution and action among ATIP members; and (c) to link to entrepreneur schools (colleges and universities) and small business development centers to facilitate partnerships with

ARS. All members are expected to have direct or indirect to fiscal resources that can support the research partnerships of businesses with ARS.

The future of USDA technology transfer

On October 28, 2011, the White House issues a Presidential Memorandum entitled, "Accelerating Technology Transfer and Commercialization for Federal Research in Support of High-Growth Businesses." This memorandum requires all federal agencies with laboratories to submit five-year plans for accelerating technology transfer and commercialization of federal research in partnership with non-federal entities. USDA's report in response to the Presidential Memorandum is available on the OTT website.

ARS has proposed an ambitious plan for both strengthening its current technology transfer program and launching some new initiatives. Progress towards meeting these goals will be reported annually to the USDA Science Council and will be included in the USDA Annual Report on Technology Transfer. Some of the specific proposals in the ARS plan are explained below.

ARS will establish new technology transfer metrics in addition to those already required by law. These metrics will enable ARS to better track its partnerships with small businesses, to document successful technology transactions that do not involve CRADAs or intellectual property licenses and to better quantify some activities specific to ARS and USDA technology transfer.

ARS plans to expand ATIP efforts to enhance access to complementary business assets by USDA partners. ATIP members will provide prospective and current ARS commercialization partners with access to business mentors, to entrepreneur schools, and to seed and venture capital funding sources.

OTT will expand its outreach efforts to ARS scientists and engineers. OTT is developing a series of training events and webinars that are organized around a specific ARS National Program. This approach will result in training activities that are more targeted to the needs of specific research projects. Scientists will learn from technology transfer case studies that are relevant to a specific field of agricultural research.

ARS will initiate a nationwide series of regional forums to identify issues and deliver solutions. Working with its ATIP partners, ARS has held several forums to address specific topics of regional interest to farmers, agri-business professionals, extension service personnel, rural development personnel, and funding and regulatory agency personnel. Forum roundtable discussions are focused on issues that either have an existing research-based solution, or that represent researchable problems that could be addressed by ARS.

ARS will work with the USDA National Institute of Food and Agriculture (NIFA) to provide opportunities for applicants to the USDA Small Business Innovation Research (SBIR) program to partner with ARS scientists to further develop science necessary for business success. NIFA manages the USDA SBIR program for USDA and is already working with ARS to provide information about partnering with ARS. This initiative will reach out to all SBIR applicants, whether or not their proposals are funded. Applicants will also receive information regarding ATIP member resources. ARS will continue to encourage its small business CRADA partners to submit SBIR grant proposals.

ARS plans to partner with the the North American branch of the International Life Sciences Institute (ILSI North America). ILSI is a public, non-profit scientific foundation that advances the understanding and application of science related to the nutritional quality and safety of the food supply. The purposes of the partnership will to be expand the USDA food compositional databases by collecting data from sources outside of USDA-ARS, carefully appraising data for accuracy, reliability and validity, and storing and maintaining data in a manner that allows for easy access by multiple search terms as well as linkage to relate databases. ILSI will assist with bringing food industry partners together and developing guidelines for success.

OTT will evaluate various options for reducing license negotiation transaction costs. The OTT Licensing Section is currently reviewing several proposals for establishing standard pre-commercialization license terms for CRADA Subject Inventions and for licenses with small businesses. The goal of this initiative is to increase transparency, to reduce transaction costs, and to retain the flexibility to be able to tailor license business terms as needed to meet the needs of a wide variety of technologies and commercialization plans. OTT will develop and deploy a Material Transfer Research Agreement (MTRA) as a new instrument to promote development and commercialization of materials from USDA. The MTRA was created by combining the Material Transfer Agreement and the Trust Fund Cooperative Agreements authorities. This new agreement will permit the parties to conduct joint research on the USDA materials transferred. It is intended as an early stage opportunity for proof of concept that may lead to a more extensive research project conducted under a CRADA.

USDA has been very successful in utilizing technologies to enhance agricultural production. However, it is critical for USDA to provide targeted, technology-based solutions in a timelier manner while continuing to reduce costs for producers, processors and consumers. This can be accomplished by deploying effective and innovative technology transfer programs, such as ATIP.

Web links and resource materials

The information in this chapter was abstracted from the following US Government documents:

Federal Technology Transfer Legislation and Policy, *Prepared by the Federal Laboratory Consortium for Technology Transfer*, http://www.federallabs.org/pdf/FLC_Legislation_and_Policy.pdf

Presidential Memorandum -- Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses http://www.whitehouse.gov/the-press-office/2011/10/28/presidential-memorandum-accelerating-technology-transfer-and-commerciali

USDA Plans for Technology Transfer 2013-2017, A Departmental Response to the Presidential Memorandum https://www.ars.usda.gov/sp2UserFiles/Place/01090000/USDA%20Plans%20for%20Accelerating%20Technology%20Transfer%20and%20Commercialization%20FY%202013-2017%20(OMB%20Clearance%209%2013%2012)v3.pdf

U.S. Department of Agriculture Technology Transfer Annual Reports, http://www.ars.usda.gov/Business/docs.htm?docid=17236

Agricultural Technology Innovation Partnership Program (ATIP) , https://www.ars.usda.gov/sp2UserFiles/Place/01090000/ATIP%20Partnership%20Intermediaries%20of%20USDA.pdf

USDA Agricultural Research Service Website, www.ars.usda.gov

Chapter 16. Agricultural Technology Transfer at the Wisconsin Alumni Research Foundation

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Introduction

The Wisconsin Alumni Research Foundation (WARF) was established in 1925 as the designated technology transfer office for the University of Wisconsin–Madison. While UW–Madison is a public institution, WARF is a private, nonprofit organization. WARF's mission is clear and specific: 1) support scientific research at UW–Madison by moving inventions developed at UW–Madison to the marketplace for the benefit of society; and 2) invest the returns in further research. When successful, the system rewards the investigators for their discoveries and perpetuates a cycle that generates further innovation. University technologies by nature are very early and require significant development and investment if they are to be commercialized. The end product often is quite different from the technology that was created in the laboratory.

While WARF and UW–Madison work closely to preserve their core principles and dedication to commercializing the university's discoveries, technologies in the agricultural space present unique challenges. As a land-grant institution, agriculture is a strong research focus at UW–Madison and also played a key role in WARF's formation. This chapter will describe WARF's founding, its mission and how it addresses intellectual property protection and licensing in agriculture and related industries.

WARF history and mission

Professor Harry Steenbock founded WARF in 1925 along with eight other alumni after receiving commercial interest in one of his major discoveries. Steenbock had developed a method for irradiating foods to increase the Vitamin D content. Rickets, a crippling bone disease, was a common affliction at that time. Based on the experiences of others before him, he firmly believed the best way to ensure that the technology was developed for the betterment of society was to patent it and license it to companies intending to use it. Decades earlier, Steenbock's adviser, professor Stephen Babcock, developed a method for testing the butterfat content in milk to ensure that farmers were not supplementing their milk with water or other additives. Babcock chose not to protect his invention in any way, preferring to give it freely to the world. The "Babcock Butterfat Test" was in fact adopted worldwide and still remains the industry standard for determining the fat content of milk. However, without any intellectual property protection, Babcock had no means to control the use and accuracy of the test, nor did he or UW–Madison receive any of the financial benefits from its adoption.

Therefore, in the early 1920s, when Steenbock's work with Vitamin D irradiation processes led to a significant discovery that promised significant public health benefits, Steenbock was determined to see the technology commercialized to its fullest potential with licensing royalties returned to the inventors and the university. UW–Madison did not have any infrastructure for managing such activities and despite support from a team of administrators, the university's general counsel had no interest in venturing into such functions. Steenbock shared his vision for a private, nonprofit foundation with several other alumni and convinced each person to contribute $100 to establish WARF's endowment. WARF then filed a patent on Steenbock's method. Cumulative royalties from licensing the first patent surpassed $14 million and by 2012, WARF's endowment totaled approximately $2 billion.

Since making an initial grant of $1,200 to the university in 1928, WARF has contributed more than $1 billion to UW–Madison, including monies to fund research, build facilities, purchase lands and equipment and support several faculty and graduate student fellowships each year. Throughout its history, WARF also has provided vision and leadership for the evolving technology transfer industry. In particular, WARF was directly involved in crafting and leading the passage of the 1980 Bayh-Dole Act, which gave U.S. universities and small businesses the right to own their federally funded intellectual property and license it to companies for commercial development, with the returns shared between the university and the inventors. Howard Bremer, WARF's patent counsel, believed that if the results of government sponsored research were to reach the marketplace and fulfill WARF's and the university's missions, the university technology transfer offices needed to protect their discoveries and coordinate with industry to facilitate the transfer of intellectual property. This legislation involved numerous partners and required almost 20 years to come to fruition. It also has served as a model for other countries and has led to similar laws being enacted, particularly across Europe.

WARF structure and processes

Relationship to UW

The fact that WARF is separate from the university and not a state organization allows WARF to maintain its endowment. It also means that WARF is not subject to open records laws and therefore, its agreements and their terms are confidential. Also, as a separate entity, UW–Madison cannot bind WARF, nor can WARF bind UW–Madison. Having separate leadership teams also means that WARF can negotiate agreement terms with fewer external political influences. As the university's intellectual property management group, the university regularly consults with matters involving existing intellectual property, as well as projects that have the potential to generate intellectual property in the future, e.g., industrial-sponsored research agreements. UW–Madison's research expenditures in 2011 were over $1 billion dollars. Approximately 2 percent of UW–Madison's research funding is from industry sponsors. While this is a small proportion, the industry relationships can be quite beneficial for the purposes of commercialization and help students network with potential employers. The university has standard terms it affords such sponsors. If a university researcher solves a problem, the scientist and the university should be compensated for that intellectual contribution. It would not be appropriate for a sponsor to treat an academic researcher as a company employee and assume that the company owns any intellectual property that arises from a project funded by that company. For one, a license requires the company to develop the technology. The transfer of ownership would not require a company to develop the technology, which is counter to the university's and WARF's missions to ensure the inventions are commercialized to their fullest potential. In addition, ownership would allow a company to enforce the intellectual property as it chooses. This means the company could bring the university researcher and possibility administrators into a frivolous lawsuit. The company might also enforce the patent against a company that has a positive relationship with the university.

Leadership

WARF is led by a managing director, who reports to WARF's board of trustees. The board consists of approximately 15 alumni who have had successful careers in various fields and have volunteered their time to university-related interests. The full board meets several times a year to review and discuss the organization's overall licensing and investment performance while providing advice on current situations and the future vision. UW–Madison's Chancellor attends board meetings to speak to the specific needs of the university. The board determines the amount of the annual gift to the University and also approves special funding requests.

WARF's executive management team consists of the general counsel, who oversees legal affairs and intellectual property; the director of investments, who manages the endowment and private equity, the chief technology commercialization officer, who oversees WARF's licensing activities and the chief financial officer, who oversees WARF budget and leads WARF's operational functions.

Structure

Patenting and licensing

WARF's patent and licensing functions are managed by a bifurcated team assigned by industry expertise. The intellectual property strategy and functions are coordinated by intellectual property managers with experience in related fields; marketing activities and licensing negotiations are managed by licensing managers focused on a specific portfolio. Therefore, each invention has one intellectual property manager and one licensing manager. When a researcher makes a discovery, he or she informs WARF of the technology. Once an invention is formally disclosed to WARF by a UW–Madison researcher, WARF's patent and licensing staff evaluates the discovery for patentability and commercial value. The decision on whether to proceed in seeking in intellectual property protection for the invention can be affected by many factors, including obligations to the funding agency, stage of development, geographic considerations, market size, the type of protection available and the ability to enforce patent claims. If WARF accepts the invention into its portfolio, the foundation hires an outside attorney to work with the researcher and intellectual property manager to determine the appropriate type of protection and if necessary draft and prosecute the patent application (or plant variety protection application, copyright, etc.). The researcher also agrees to assign the invention to WARF. Once an application is filed, WARF's licensing staff starts its marketing efforts and contacts companies considered appropriate matches for the technology if the proof of concept has been demonstrated.

The licensing team markets its technologies to potential licensees through several channels. Inventors often have connections to technical representatives of the companies in their industries. Large companies often have business development professionals responsible for identifying future opportunities. Technology transfer is a long-term undertaking, for both the intellectual property owner and for the licensee. For technologies developed at a university, a potential licensee must be willing and able to invest in the development required to turn the invention into a product. Some large companies are willing to take this risk, while other large companies leave this work to smaller companies. If the smaller company makes a significant accomplishment, it becomes an acquisition target, or it can license the technology to other companies. As the technology becomes more developed and proven, the risk decreases, and therefore, the value increases. This is one of the many reasons why the financial license terms for university technologies vary greatly.

Royalty distribution

The revenue WARF receives from licensing activities is divided among three groups. The inventors receive 20 percent of gross revenues. This share is split equally among inventors unless they agree among themselves to an alternative distribution and provide to WARF, in writing, specific direction as to how the inventors' shares should be allocated. The inventors' department(s) receives 15 percent of licensing revenues. The department then determines how those funds are used; some departments allocate a portion of the funds to the inventors' labs. The remaining 65 percent is included in WARF's annual grant to UW-Madison, which is intended to fund projects and programs the university could not pursue otherwise.

WARF's agricultural licensing

The ideal license is a structure that satisfies both goals of maximizing the potential of the technology and returning licensing revenue to the university. Just as it would be inappropriate for a licensee to accept a flat fee for an exclusive license that does not require the company to commercialize the technology, disseminating a technology for free will, in most cases, fail to maximize a technology's value and offer no compensation to the university. Valuing early stage technologies is an art that has been the subject of many extensive texts and routinely evolving models. There is no perfect answer, and terms are based on the market, pricing structures, stage of development, and comparable technologies, though these factors usually are not completely understood at the time the license is being negotiated. Therefore, technology transfer officers make educated decisions based on the best information they have available at the time. This is a skill that is only gained by experience. It is not unusual for license terms to be amended years down the road when the previously negotiated terms are no longer appropriate, whether because of a change in company direction or a shift in the market. Technology transfer professionals learn from each other and their experiences. Similar to many industries, a technology transfer professional's networks are extremely valuable and affect all aspects of the position, from learning from others' deal experiences, to maintaining relationships with potential licensees. Many people also benefit from a mentor relationship with an experienced professional who can help them learn the basics factors of patenting and licensing, but also challenge them to devise creative solutions. Participating in associations such as the Licensing Executives Society and the Association of University Technology Managers is an easy way to meet professionals in similar positions and build networks. These organizations also make available to members libraries of data and articles, which are tremendous sources of information.

With the constant improvements in biotechnology, researchers are developing platforms for screening for particular traits and introducing specific genes into new varieties. While developing a genetically modified crop currently can require a decade or more of research and expenditures that rival those of a pharmaceutical, the margins likely are much thinner. Examples of traits in demand currently include drought tolerance, insect/pathogen resistance, increased yield and increased nutrient production. Licensing terms for such technologies fluctuate greatly and often are a balance between the risk and reward. In many situations, it can be financially advantageous to apply the royalty to sales as far down the chain as possible. For example, cumulative royalties on a $500 million product with a 0.25% royalty will be higher than a 5.0% royalty on $10 million in sales of an intermediate material. This is where understanding the technology's market and manufacturing structure is essential to form educated license terms.

When universities began establishing their own technology transfer offices, most of them focused on utility patents. Major agronomic crops, including oats, corn, wheat and soybeans, were released publicly, with little or no return to the university. The need to supplement university research funding and the increased focus on local economic development have led to new models for commercializing university technologies in agriculture. As such, more university technology transfer offices are securing intellectual property protection for agricultural technologies and licensing them to commercial entities. While some argue this interferes with the scientific exchange of genetic material, others believe this maintains the integrity of the university material and promotes further improvements through recurring funding to the academic breeding programs.

Plant varieties

Types of protection

The type of protection pursued, if any, is based on the market, the cost of filing and the ability to enforce the intellectual property. For example, WARF files for plant variety protection for its potato varieties and plant patents for cranberry varieties. Plant variety protection (established in the Plant Variety Protection Act) is specific to sexually produced varieties and provides 20 years of protection for a variety. Plant variety protection requires the technology transfer office and breeder to disclose the origin and breeding history of the variety, as well as the breeding method and selection criteria. The application must also show that the variety is distinct, stable and uniform. Varieties that are protected under a plant variety protection certificate can be sold or for seed purposes only and by the owner or with the owner's permission (via a license agreement). The owner of the certificate can also enforce the plant variety protection certificate against infringers and pursue damages. The strength of an intellectual property system is based, in part, on the authority it affords intellectual property owners to enforce their rights. (Figure 1)

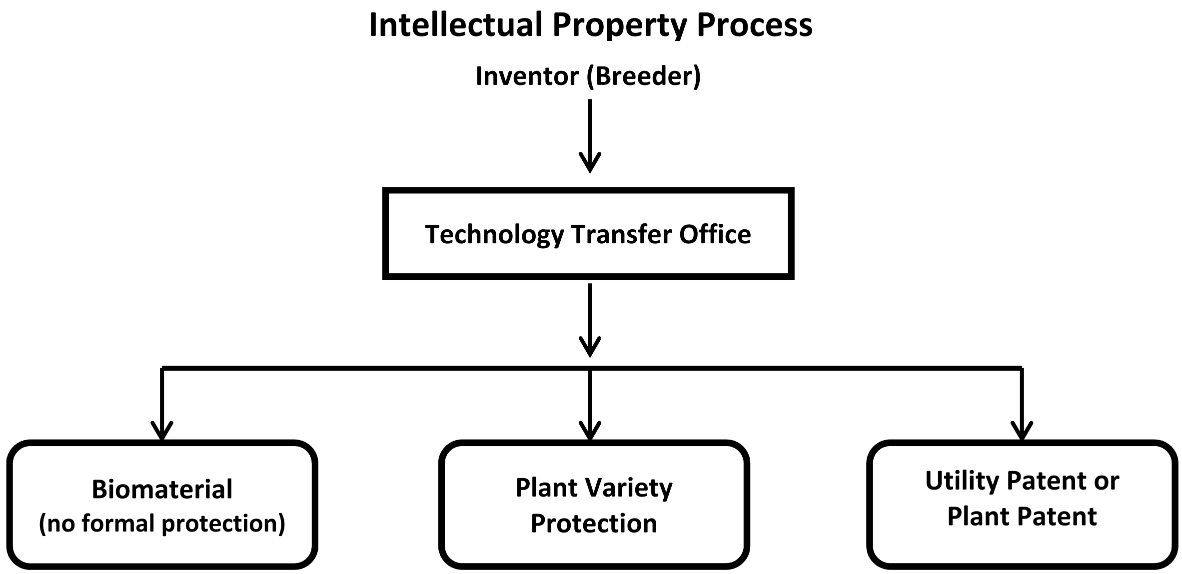

Figure 1: The typical intellectual property flow for a plant variety developed at a university

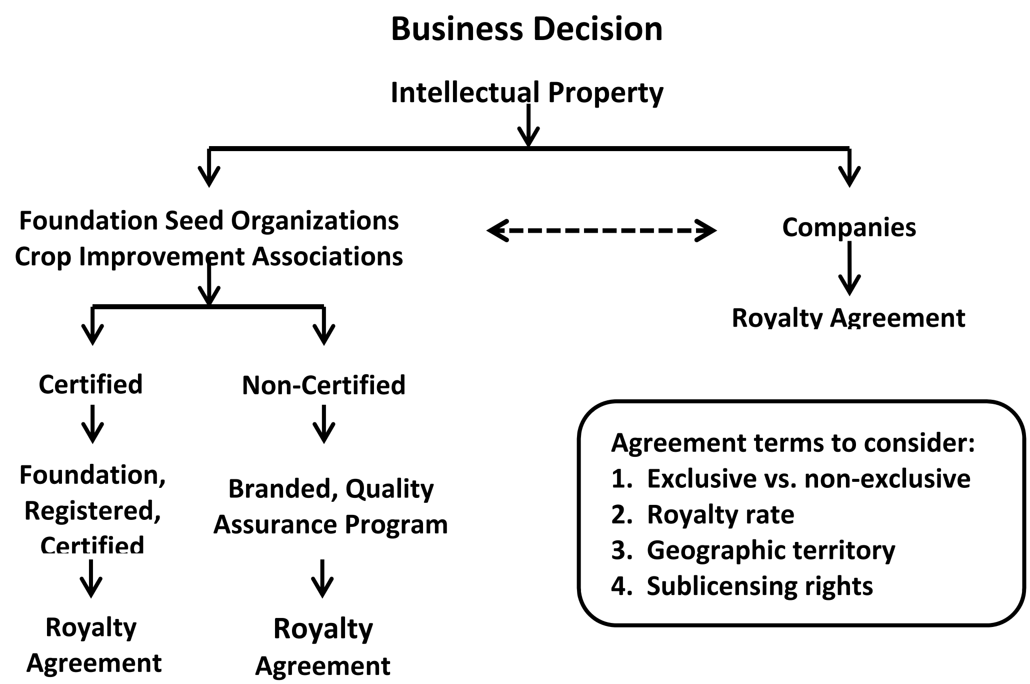

Figure 2: The typical licensing options for a plant variety developed at a university

Plant patents are available through the US Patent and Trademark Office (described in Title 35 United States Code, Section 161) to protect a distinct, asexually produced variety. The term of protection is 20 years from the date of filing. The plant patent submission requires much more detail than a plant variety protection application, including a complete botanical description of the plant and a listing of relevant prior art. The application is more comparable to that of a utility filing; however, the plant patent allows for only one claim. It is critical to note that when filing for a plant patent, the applicant should use the specific varietal name (which is usually a code). Using the trade name in the plant patent application precludes the applicant from later trademarking the trade name. Registering a trademark for a successful variety can extend the intellectual property owner's revenue stream beyond the term of the plant patent. In general, WARF does not file utility applications or plant plants for most varieties unless an interested licensee emerges that sees value in such protection. WARF's typical costs (including attorney's fees) are $5,000 for a plant variety protection filing, $10,000 for a plant patent and $25,000 for a utility patent. These costs escalate if international filing is pursued.

Licensing plant varieties

The release of new varieties from a university involves a collaboration well beyond the university laboratory. Before determining the best licensing strategy for a variety, an adequate supply of materials must be available for trialing. At many land-grant institutions, this work is managed by agricultural experiment stations associated with the colleges of agriculture. WARF does not handle materials itself but does facilitate the transfer between different parties and, in select cases, partially funds the development of such materials. It is common for a university, particularly a land grant university, to be affiliated with a crop improvement association or foundation seed organization. This entity can be within the university, or managed as a separate, private entity. The goal of these entities is to work with their respective universities in cultivar development, evaluation and commercialization for both the public and private sectors.

Because of the extended development process and unique growing conditions in each region, as well as many other variables that are not represented in a university plot, a company rarely is willing to license a variety based on the university's data. Therefore, WARF will enter into limited trialing agreement with select parties to give them an opportunity to evaluate the variety in specific conditions. Materials must only be shared with legitimate partners who are 1) capable of maintaining the material's quality and turning it into a product and 2) willing to sign the appropriate material transfer agreement or trialing agreement. Such an agreement must clearly state:

- What is being transferred? This should be documented clearly. The recipient also covers materials and shipping costs.
- The purpose of the trial – what is the company going to do with the materials and where?
- The time period – when will the trial start and when are the first results expected? This should be limited to one or two growing seasons.
- Reporting requirements – The company should report results and updated plans to the intellectual property organization regularly, most likely semi-annually or annually. The intent of this provision is to ensure the company is tracking the university's materials and using them appropriately.

Licensing germplasm brings with it unique challenges and many terms to negotiate: non-exclusive vs. exclusive, royalty vs. flat fee, development requirements, etc. Appropriate terms are based on the technology's stage of development, the market, the portion of the final product that represents the university's intellectual property and the ability to enforce the intellectual property. For example, a variety with plant variety protection could garner a royalty as a percent of sales, while a population of inbred lines that will be crossed with several other lines over the next five or more years before reaching a finished product might call for a one-time fee or an annual fee.

With the exception of small grains, which WARF usually licenses exclusively to the Wisconsin Crop Improvement Association, WARF's default strategy for licensing plant varieties is to license non-exclusively. Standard terms include a nominal upfront fee, as well as a royalty based on either sales or the number of acres grown in a growing season (regardless of successful harvest). WARF will license a variety exclusively if a company presents a solid case for doing so, AND if exclusive licensing appears to be the best way to get the variety to the market. The reason for the non-exclusive standard is that WARF strongly prefers to license its technologies broadly rather than unnecessarily restrict other parties from using them. (Figure 2)

Another factor to consider is how the material will be used. WARF has several beet varieties that are intended for the table beet market, but also have very intense pigments that can be used in many other applications. To address this situation, the license agreements WARF executed for table beet production specifically state that such a license does not allow the grower to sell the pigment.

Example: Potatoes

UW–Madison's potato breeding program has maintained relationships with farmers and processors for more than a century and has developed numerous varieties that have been commercialized around the world. The success of this program is due in part to the high quality of the breeding material and the expertise of the breeders, but also to the many parties involved in the various stages of development. The majority of breeding is conducted at one of UW–Madison's Agricultural Research Stations, which produces early generation seed potato stocks from tissue culture. Based on several years of early trial data, a team of growers, processors, and university breeders decides which varieties to move to larger scale production at the state farm. Tubers are produced from the plantlets in greenhouses on the farm and then multiplied in the field. Both greenhouse-grown and field-grown tubers are available for growers to purchase. The Wisconsin Seed Potato Certification Program (WSPCP) program began as a collaboration between growers and UW–Madison faculty and now is managed by UW–Madison, with input from the Wisconsin Seed Potato Improvement Association and the Wisconsin Department of Agriculture, Trade and Consumer Protection. The goal of the WSPCP is to provide Wisconsin potato growers with seed potato planting stock that is clean and free of disease and other contaminants. This is achieved through visual inspections and laboratory testing of the seed potato crop by the WSPCP staff and through the expertise of Wisconsin seed potato growers. By the time a new potato variety is disclosed to WARF by the UW researchers, it has been vetted and endorsed by this program. Because WARF's licensing is dependent on the availability of quality, pure materials, WARF contributes $1,500 to the virus eradication for each variety pursued.

WARF's standard non-exclusive seed potato license was drafted with input from numerous growers and the Wisconsin Plant and Vegetable Growers' Association. The license requires the grower to pay an upfront fee, as well as royalty based on acres grown, regardless of success or amount sales. The per acre royalty is easier for growers to report, but the major disadvantage is that this fee is static and does not reflect increasing prices in the market. Therefore, a grower may be paying the same per acre rate for 15 years, despite the increased value in the variety. Growers must report their acreage for each variety at the end of the calendar year based on that variety's acreage on September 1st of that year.

Animal health

The animal health industry is very broad, covering everything from animal feed and supplements to vaccines and therapeutics. The industry has been dominated by a number of players over the years, though mergers and acquisitions have also been frequent. Some major pharmaceutical companies have their own subsidiaries to handle animal health research; some spin them out into completely separate entities when they are large enough. Some companies have gone away from conducting their own basic research and are looking to universities and small companies to perform the initial steps, thereby increasing the success rate of the pipeline. WARF and UW-Madison have dealt with a number of start-up companies in animal feed and vaccines. They also have developed partnerships with companies in the industry that have led to sponsored research collaborations and revenue-generating license agreements.

Example: Animal health licensing

In the early 2000s, a major animal health company suspected that one of its most successful dairy products was causing problems for processors downstream. After some initial investigation, they identified a UW-Madison professor as a world-renowned expert in dairy chemistry and cheese production. He identified the culprit in their formulation, and through a sponsored research project that spanned several years, he developed an alternative formulation. The project involved testing different formulations on a population of dairy cattle, which could not have been completed without participation from UW-Madison's Extension program. The Extension program has greater space resources and allowed the principal investigator to gather the necessary data on an acceptable number of cows.

As noted earlier, because WARF is separate from the University, WARF cannot bind UW, nor can UW bind WARF. However, UW seeks WARF's input on IP terms in sponsored research agreements because WARF will be the party managing any resulting patenting and licensing activities under the agreement. In this case, the sponsored research agreement, which was executed prior to the project, included intellectual property terms dictating a range of licensing terms that would be used if the company decided to license any intellectual property that arose under the project. WARF and UW cannot set terms for IP that does not yet exist, partly due to federal law, and partly because the principle would be inappropriate. Therefore, the parties were able to agree to a bulleted list of ranges for fees, royalty rates, and a timeline, if the project were successful and resulted in new intellectual property within a defined field of use. Defining the field of use is imperative when granting any IP rights, especially when the licensee is being granted exclusivity. The technology could have unknown applications, and if the technology is licensed overly broad, the licensor must renegotiate the license to limit the field of use if the licensor wants to license the technology for other fields.

WARF's Accelerator Program

In 2009, WARF established its Accelerator Program to direct funding to specific projects with significant potential. By 2012, WARF had identified five market focus areas to receive such funding, one of which involves food and agriculture. The field is increasingly of interest to investors and biotechnology companies as resources become limited while the world's population grows. WARF's licensing team recruited experienced advisors from industry to offer feedback as to which projects are answering industry needs, and help the investigators structure research plans that satisfy a potential licensee's key requirements. The focus of the program is to drive to commercialization, whether it means the technology funded through this program is licensed to an existing company or used as a foundation for a start-up company. The funds are directed to projects that would not be fundable through other federal grants because they extend beyond the basic research usually conducted in a university setting. Several universities, including Harvard and MIT, have their own funding mechanisms to fill this need.

Conclusion

An effective technology transfer system in agriculture is dependent on several factors. These include: a solid academic program; an office to facilitate the interactions between the university and industry; partnerships to manage trials and the production of the initial germplasm; and commercial partners to bring the end products to market. It is a long-term endeavor with high risks and obstacles along the way. However, when successful, the model becomes sustainable and the developments that were initiated in a university laboratory become products that satisfy a societal need. This commercialization generates revenues to the university, which funds future research of the next great discovery.

Chapter 17. United States - India Science and Technology Endowment Fund: Commercializing Technologies for Societal Impact

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Background on the Endowment

The governments of the United States of America through the Department of State and India through the Department of Science and Technology have established the United States - India Science and Technology Endowment Fund for promoting joint activities that would lead to innovation and entrepreneurship through application of science and technology. The fund's aim is to support and foster joint applied research and development (R&D) to generate public good through commercialization of technology achieved through sustained partnerships between U.S. and Indian researchers and entrepreneurs.

Activities under the endowment fund are guided by an endowment board and implemented through the bilateral Indo-US Science and Technology Forum (IUSSTF) as its executive secretariat.

Goals and objectives

To strengthen and expand science and technology cooperation between the U.S. and India with focus on applied R&D; to promote sustained partnerships for innovation between scientists, technologists and entrepreneurs towards economic development and public good of both countries; and to encourage entrepreneurial activities that have significant potential towards commercialization of joint technologies. To begin with, grants are awarded to financially promising joint US-India entrepreneurial initiatives. These initiatives can originate from government, academic, non-governmental or commercial entities, and any combination thereof provided they focus on applied R&D, incorporate a business plan and proof of commercial concept, and have significant sustainable commercial potential.

Program areas

A. Healthy individual: Affordable biomedical devices, diagnostic / preventive / curative measures, or food and nutrition products to improve health (drug development and clinical trials are not eligible activities in this category).
B. Empowering citizens: Reducing the digital/technology divide. This could include amongst others, information and communication technologies with societal impact in areas such as water, agriculture, financial inclusion, and education.

"Societal impact," for the purposes of the endowment board, could involve ideas that help poorer or underserved sections of society. Technologies might significantly reduce the cost of a product or service, benefitting the poor or citizens in remote areas (either in the U.S. or India). Or they might create new solutions that improve the quality of life for people in either country.

Eligibility criteria

Proposals must include a minimum of one partner from each country. Bi-national teams applying to the endowment will work together to commercialize technologies for societal impact. The bi-national teams may be composed of:

- Start-up companies; or
- Incorporated companies; or
- Non-incorporated entities; or

- Individuals or consortia from academia, government laboratories, non-government R&D institutions.

Each bi-national team must include at the time of application an entrepreneurial (small-scale as opposed to large-scale) entity that will receive a portion of the grant and take the technology to the market. If partners are planning to form a new venture to commercialize the technology, the proposal should also include planned incorporation date and the amount of grants requested for the new entity.

Relationships between the U.S. and Indian partners must be clearly defined, including ownership of intellectual property rights for the technology proposed to be jointly developed and commercialized.

The proposed technology must have the potential to be commercialized within two to three years.

Funding

The size of each award is Rs. 2.50 Crores (equivalent U.S. $450,000 approx., subject to dollar exchange rate).

The extent and quantum of support would be decided by the Executive Secretariat based on the Endowment Board recommendations. Proposals outside this range may be considered under exceptional circumstances at the discretion of the US-India Science and Technology Endowment Board.

The program is coordinated and administered through the bi-national Indo-US Science and Technology Forum (IUSSTF)

Examples of funded projects

- *A fair price for healthy fruits and vegetables: Helping farmers access cold-storage technology.* Rustom Irani (Icelings Chirag Ice Factory Pvt. Ltd., India) and Sorin Grama (Promethean Power Systems, Inc, USA)
- *Mobile phone based HbA1c analyzer.* Sidhant Jena (Janacare Solutions Private Limited, Bangalore) and Stephen Chen (Teco Diagnostics Anaheim, CA)
- *A novel way to manage fecal incontinence in non-ambulatory patients.* Nishith Chasmawala (Consure Medical Pvt. Ltd., Surat) and Matt Durack (Lunar Design San Francisco, CA)
- *Affordable and User-Centric Knee Joints to Remobilize Above-Knee Amputees in India and Globally.* Krista Donaldson, (D-Rev (Design Revolution), San Francisco, USA) and Pooja Sandeepan (Bhagwan Mahaveer Viklang Sahayata Samiti (BMVSS) Jaipur), India
- *Solar Electric Tractor- Agriculture and Power.* Keith Rutledge (Solectrac LLC, CA, USA) and Parimal Shah (Lovson Enterprises Pvt. Ltd, Ahmedabad, Gujarat, India)
- *Affordable, clean cook stove and electric power sources for rural India.* Aleksandr Kushch, (Hi-Z Technology Inc. San Diego CA, USA) and Neha Juneja (Greenway Grameen Infra Pvt. Ltd., Navi Mumbai, India)

Key constraints and areas where capacity building is needed

The main constraint is shortage of good applications. Although about 200 applications are received in each call for proposals, quality is still a problem. Another constraint is considerable lack of pre-proposal interactions between Indian and U.S. partners. There is a need to build networks between Indian and U.S. technology-based startups and entrepreneurs.

Lessons learned and a way forward

The awarded projects are yet to complete their terms. Once a project completes its term, an assessment of success in achieving the approved objectives in projects is carried out. Till now, based on the project progress, the first three project teams have been successful in attracting various angel funds for their ventures.

Web links

www.usistef.org

Chapter 18. Synthesis and Way Forward

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There is no doubt about the role, value and importance that new technologies can play in both India and the U.S. and the rest of the world to enhance food security, economic growth, improved livelihood. Along with public-run extension systems, the IPR-led technology transfer and commercialization is now embraced by public institutions in both the countries. The chapters of this handbook highlight recent efforts invested in the development and implementation of the IPR-led technology transfer and commercialization systems.

The governments and private sectors in both countries have been investing a large pool of resources for agricultural research. It is important that the new knowledge and research results from these efforts are transferred and that they benefit the society. Although the US has had a longer experience, the public institutions are still learning, and the systems of technology transfer and commercialization are still evolving. The agricultural systems and socioeconomic cultures are different in the US and India. The scale of agriculture and socioeconomic and cultural aspects must be considered in the development and implementation of policies for technology transfer and commercialization. Although the systems and cultures in India and US are different, both countries can learn and benefit from each other's experiences and best practices for mutual benefits.

Lessons learned

Technology transfer should not be viewed as just generating revenues, but focus should be on transfer of technology so that society can benefit. The applied research and technology transfer program should be demand driven to meet the market and societal needs. Intellectual properties should be seen as a tool for facilitating public good.

Having an institutional policy and centralized support system or focal point is critical to provide support to scientists and innovators in IP management, technology transfer and commercialization activities. The technology transfer programs should involve multiple stakeholders and require sustained institutional support and commitment for de-risking, scaling-up and commercialization and market access.

Given that the IPR-led technology transfer and commercialization is relatively new areas for public institutions in India and the U.S. and is evolving very rapidly, the education, training and awareness of everyone engaged in technology transfer and commercialization is very important.

The experience in the U.S. indicates that the royalties generated from licensing on an average is very low compared with the overall investments in research and development.

Technology management operations have been growing. As these systems grow and expand, they should remain user-friendly, service oriented and less bureaucratic. Scientists should be provided with appropriate incentives and support mechanisms to take their ideas and innovations from laboratory to the market place. Inventors should be involved in the discussion for patenting and marketability. Very often, inventors have a better feel of the market demand. Administrative procedures should be minimized to make timely decisions and process of technology transfer and commercialization efficient.

The patenting and intellectual property protection should not become a barrier for exchange of research tools, germplasm, biological materials and other enabling technologies. The system should continue to foster easy access so that new innovations and technologies can be continued.

The scale of agriculture and socioeconomic and cultural aspects vary from country to country and from region to region. These aspects must be considered in the development and implementation of policies and practices for IP management, technology transfer and commercialization.

Patenting is expensive. In many instances, the contract research and funding from private sector dictate the focus of research. Careful attention should be given to the role of private funding verses public good.

Key recommendations for future capacity building in technology transfer and commercialization

Based on the suggestions and recommendations made at the joint workshop and continued interactions between scientists, administrators, and technology transfer communities in India and the U.S., the following recommendations were made by the participants for future capacity building in IP management, technology transfer and commercialization.

1. Continued support for capacity building to establish new or enhance existing IP management and technology transfer cells/offices, and business planning and development units.
2. Current extension system should be strengthened. The IPR-led technology transfer system is more conducive for technologies and products that private sector has interest and can generate profit for the private sector. The public extension system can and should play a continuing role for transfer of technologies that are less interest to private sector.
3. Continued training of research scientists and administrators in the use of material transfer agreements, license agreements, confidentiality, negotiation skills, and valuation of technologies.
4. Develop a comprehensive web portal containing technology transfer and commercialization resources and successful case studies.
5. Provide opportunities for scientists and technology managers from India for short-term and long-term visits to technology transfer offices at various U.S. universities and other research institutes with a focus on valuation of technology, negotiation skills, licensing, marketing and business development.
6. Curriculum enhancement for introducing technology transfer and commercialization courses at agricultural universities and business management institutions through training of trainers (ToT) programs.
7. Establish a public sector platform or professional association/societyin India for providing networking opportunities for technology transfer managers for facilitating exchange of knowledge, skills and experiences, and for interactive fora on public-private sector partnerships for technology commercialization. Using such a platform or professional association, develop one-on-one mentoring program for technology managers in India to learn from the experiences from the technology managers in the U.S. public systems.

Appendix 1. Information, Educational and Networking Resources for Intellectual Property Management, Technology Transfer and Commercialization

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U.S.-based resources

Association of University Technology Managers (AUTM)
http://www.autm.net/Home.htm

Biotechnology Industry Organization
http://www.bio.org/category/intellectual-property

Franklin Pierce Law Center
http://law.unh.edu/franklin-pierce-ip-center

International Association for Management of Technology (IAMOT)
http://www.iamot.com/

Licensing Executives Society International (LESI)
http://www.lesi.org/

Public Interest
http://piipa.org/

Public Intellectual Property Resource for Agriculture (PIPRA)
http://www.pipra.org/

USDA Plant Variety Protection Office
http://www.ams.usda.gov/AMSv1.0/PVPO

U.S. Patent and Trademark Office
http://www.uspto.gov

USDA Office of Technology Transfer http://www.ars.usda.gov/business/docs.htm?docid=763

World Technology Access Program (WorldTAP) – Michigan State University
http://worldtap.msu.edu/

India-based resources

Agri-Sciece Park@ICRISAT – International Crop Research Institute for Semi-arid Tropics (ICRISAT)
http://www.icrisat.org/what-we-do/satrends/mar2005.htm#1

Intellectual Property &Technology Management (IP&TM) Unit – Indian Council of Agricultural Research (ICAR)
http://www.icar.org.in/en/node/372

AgrInnovate India Limited – A Government of India Enterprise
http://www.agrinnovate.co.in/

Institute Technology Management Unit of IARI – Indian Council of Agricultural Research (ICAR)
http://ztmbpd.iari.res.in/itmu.jsp

Indo-US Science and Technology Endowment Fund
http://www.usistef.org/

National Academy of Agricultural Research Management (NAARM) – Indian Council for Agricultural Research (ICAR)
http://www.naarm.ernet.in/

Society for ***Technology*** Management (STEM)
http://www.stemglobal.org/

Small Business Innovation Research Initiative (SBIRI) – Department of Biotechnology (DBT)
http://dbtindia.nic.in/uniquepage.asp?id_pk=136

Global resources

International Service for the Acquisition of Agri-Biotech Applications
http://www.isaaa.org/resources/publications/pocketk/9/default.asp

International Union for the Protection of New Varieties of Plants (UPOV)
http://www.upov.int

PIPERS Virtual Intellectual Property Library: Gateway to IP offices across the world:
http://www.piperpat.com/

Strategic World Initiative for Technology Transfer
http://www.swiftt.cornell.edu

The International Association for the Protection of Intellectual Property (AIPPI)
https://www.aippi.org/

World Intellectual Property Organization (WIPO)
http://www.wipo.int/portal/en/index.html

Books, journals and newsletter

Association of University Technology Managers Journal
http://www.autm.net/Journal.htm

Erbisch, Frederic H., and Karim M. Maredia, eds. *Intellectual property rights in agricultural biotechnology*. No. 28. CABI, 2004.
http://bookshop.cabi.org/?page=2633&pid=1659&site=191

Innovation: Management, Policy & Practice
http://pubs.e-contentmanagement.com/loi/impp

Intellectual Property Rights: Open Access
http://www.esciencecentral.org/journals/intellectual-property-rights.php

International Journal of Intellectual Property Management
http://www.inderscience.com/jhome.php?jcode=ijipm

International Journal of Technology Management
http://www.inderscience.com/jhome.php?jcode=ijtm

International Journal of Technology Transfer and Commercialization
http://www.inderscience.com/jhome.php?jcode=IJTTC

Journal of Innovation: Management, Policy and Practice
http://pubs.e-contentmanagement.com/loi/impp

Journal of Intellectual Property Rights
http://nopr.niscair.res.in/handle/123456789/45

Journal of Technology Transfer
http://link.springer.com/journal/10961

Journal of World Intellectual Property
http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1747-1796

Rothschild, Max Frederick, and Scott Newman, eds. *Intellectual property rights in animal breeding and genetics [electronic resource]*. CABI, 2002.
http://bookshop.cabi.org/?page=2633&pid=1599&site=191

Technovation
http://www.journals.elsevier.com/technovation/

World Patent Information
http://www.journals.elsevier.com/world-patent-information

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