

Technology Transfer Offices: Facilitating Intellectual Property Protection for Agricultural Innovation

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SYNOPSIS

Technology transfer is a critical process in transforming agricultural research innovations into applications for end users. The vast majority of agricultural innovations in developing countries arise from publicly sponsored research centers or universities, which typically are unprepared to engage in formal mechanisms of technology transfer. These mechanisms may require intellectual property protection and/or legal agreements for transferring intangible and tangible property rights to other public, commercial, or international partners. A sustained investment in capacity building is essential for technology transfer programs to have an impact. It is critical to assess whether an institution has a broad base of research assets and a culture that will support a technology transfer program. If so, investment in a technology transfer office requires paying attention to: (1) identifying an appropriate business model, (2) establishing an institutional policy framework consistent with national laws to clarify responsibilities of the institution and its employees, (3) building the capacity to address intellectual property protection and to negotiate legal agreements to transfer intangible and tangible property, (4) gaining experience to develop business strategies to effectively disseminate technology and work with private partners, and (5) communicating both internally and externally the aspirations (building appropriate culture) and successes of the institution in technology transfer.

BACKGROUND AND CONTEXT

Agricultural innovations reach farmers largely through direct transfers of knowledge, agricultural practices, devices, or seed from research centers to farmers. Extension services in many countries aim at bridging the gap between public researchers and farmers. These traditional approaches are

insufficient in strong market economies and for advanced technologies that may require a more formal hand-off to permit commercial development or may require regulatory approval from governmental authorities. Increasingly, more formal mechanisms of technology transfer are required, involving intellectual property (IP) protection and legal agreements to transfer both intangible and tangible property for further development and distribution. These new technology transfer requirements prevail within and between developed and developing countries.

Although it is clear that public research organizations play important roles in all countries, more developed countries have a strong private innovative sector that is virtually absent from developing countries. For this reason, public research organizations in developing countries remain a primary source of local innovation and are likely to play a role further along the innovation pipeline. They require internal capacity to deliver innovations to commercial partners either for further development or for dissemination through market channels. In most cases, public research institutions (centers, universities) have focused their programmatic development on scientific research capacity and not on the development of expertise to engage in the legal transactions needed to translate their research into applications. Moreover, many public research institutions have historically managed their technology transfer programs by passively waiting for potential licensees to knock on their door and seek out new technology.

International technology transfer can be particularly complex and is highly bi-directional. Advanced genetic technologies are increasingly transferred from multinational private companies to public research centers in developing countries, at the same time that germplasm or other genetic resources move in the other direction. These transfers require carefully balanced agreements to ensure that the

partnership achieves its objectives and that both parties receive appropriate recognition for their proprietary contributions. Developing this capacity is not easy and typically requires both educational as well as institutional investment.

This thematic note explores the steps in developing that capacity in public research institutions by establishing a technology transfer office (TTO) to assist in the legal transfer of technology. Investing in and building institutional capacity for technology transfer within a public organization may cover a broad range of activities. These activities may include the protection and licensing of IP but are more likely to focus on the support of public/private partnerships, the development of business strategies, or the transfer of tangible property directly to commercial channels such as seed companies or agricultural or veterinary product suppliers. These activities share a range of skills and experience related to an understanding of intangible and tangible property rights and transfers, of legal contracts and agreements, and of business activities and strategies that are relevant for the local region.

The technology transfer function may be addressed in different manners and must fit local needs and resources. The four main business models for TTOs are summarized in table 5.7. For developing countries, a TTO operated jointly among many institutions (a consortium/network TTO) may be the best solution to attain economies of scale

as well as a critical mass of research assets and expertise in technology transfer.

INVESTMENT NEEDED

An effective technology transfer program or department, based on a proper assessment and policy alignment (see “Lessons Learned”), requires major investments. The most important are staff, infrastructure, capacity, and governance.

Staff and site

A TTO will require a general director or manager (usually a scientist with extensive business experience rather than a lawyer) who is at a minimum responsible for business development, communication, and negotiation. The office will also require administrative personnel. The physical assets associated with a TTO can range from office equipment (IT, furniture, and so on), an IP library with access to online legal databases, to real estate encompassing sufficient space for the TTO.

Minimum training and core skills

Table 5.8 describes the minimum training requirements for different groups in the institution and IP management

Table 5.7 The Four Main Technology Transfer Office (TTO) Business Models

	Independent TTO department within an institution	Network-based TTO	Subsidiary company	Outsourcing
When?	When prospects for technology transfer and commercialization are high within one institution and sufficient resources allow establishment	When individual institutions lack resources and critical mass (research base) but institutional culture is conducive for entrepreneurial activity	When research and resource base are sufficient but institutional culture is not conducive for entrepreneurial activity	Suitable particularly when institution(s) generate technology suitable for high-value, income generating opportunities
Key benefits associated with the option	<ul style="list-style-type: none"> – Alignment with institutional objectives – Revenue to institution 	Sharing of costs and expertise	<ul style="list-style-type: none"> – May encourage a positive perception of technology transfer and demonstrate seriousness – More operational flexibility and the ability to structure staff remuneration packages 	<ul style="list-style-type: none"> – Minimizes investments and risks for the institution – More operational flexibility and the ability to structure staff remuneration packages
Disadvantages	Investment requirements per institution may be high	Requirement for shared procedures and agreements on revenue sharing often challenging	Lack of alignment with institutional objectives and unresponsive to policy constraints of the institution such as publication or conflict of interest	Overhead costs (fees) reduce revenue to institution Less geared toward technology transfer for the broader public good

Source: Authors, adapted from Campbell 2007.

Table 5.8 Generalized Intellectual Property (IP) Training Needs of Different Groups of Staff in a Technology Transfer Office (TTO)

Group	Minimum training requirement
Researchers	<ul style="list-style-type: none"> – Maintaining good laboratory records – A basic understanding of the types of IP agreements, especially in the context of exchanging research material and information – The importance of confidentiality, especially with respect to publishing and delivering academic presentations – When to disclose IP guidelines and procedures
Research managers and institution directors	<ul style="list-style-type: none"> – The importance of IP management and management functions – IP protection processes and procedures; the investments required to manage IP effectively (including decisions required at different stages of IP and research development) – Implementing IP policies, processes, and procedures – An appreciation of the role of technology in addressing socioeconomic needs
IP managers	<ul style="list-style-type: none"> – Overview of IP management from the generation of IP property to its exploitation and application – Awareness building – Understanding of science (understanding of certain fields of science an added benefit)
Operations	<ul style="list-style-type: none"> – Finance: Understanding IP policy guidelines, namely, systems and processes to handle IP payments and receipts (for example, royalties); the administration of benefits to researchers and the institution – Human resources: IP policy guidelines and interface with other institutional policies such as conditions of service, recruitment, conflicts of interest and commitment, and contracting with clients – Legal services: IP policy guidelines, IP contracts and agreements, understanding what constitutes IP and the different forms of IP protection, and IP negotiation – Grant and contract research: IP contracts and agreements, especially clauses regarding IP ownership, and IP policy guidelines

Source: Pefile and Krattiger 2007.

office. Technology transfer programs will need the capacity to develop business strategies around new technologies. These strategies can serve as a tool to market innovative technologies to existing companies or become the basis for starting new companies to implement the strategy. The secondary role of a TTO is to establish and maintain connections to national and international investment communities as well as to other providers of services for business development. These connections facilitate the development of startup companies to commercialize technology. The TTO will also need the ability to communicate—internally and externally—its aspirations and successes in technology transfer. Consistent communication within the TTO is critical to develop and sustain a culture of entrepreneurship and engagement in the technology transfer process.

The TTO must have the core skills to manage IP protection and the capacity to negotiate and execute legal agreements to transfer intangible and tangible property. The main functions of TTO staff include: (1) evaluating invention disclosures and deciding whether to file patents or other forms of IP protection, (2) managing or monitoring patent prosecution, (3) developing, with business development staff, a commercialization strategy, (4) negotiating and executing technology transfer agreements ranging from options to licenses, and (5) once an agreement is concluded,

monitoring technology developments and compliance with the terms and conditions of the option or license.

Reporting and governance structure

A TTO requires reporting and governance functions. The TTO management will be accountable to a governing body that may consist of faculty or research center members, administrators, and external business leaders. An advisory group from inside and outside the institution is expected to bring new experience to the organization and act as internal and external champions.

Often a departmental TTO reports to a senior university staff member, whereas a TTO company will be responsible to a board, which may be chaired by a university senior staff member. Because the TTO represents a linking function between a university or research institute and business, governance and advisory arrangements to support both its internal linkage to the university or research institute and its external linkage to the business community are important. The TTO can also become the “face” of the research organization to the business community and as such needs to have strong governance and advisory relationships to ensure that it maintains a high degree of integrity and credibility with the outside. The TTO will be expected to produce at least annual reports of activity which provide

financial information to its governance board(s) and also provide accounts of nonfinancial public benefits that may have been realized, such as development of a new medicine or SME.

POTENTIAL BENEFITS

Investment in technology transfer and IP management capacity for public research institutions and universities will almost certainly have an impact on the way the institution looks at its research outcomes and the extent to which it can partner with companies to either codevelop or commercialize its research results. In developed countries where universities have adopted robust technology transfer programs, the resulting impact of those universities on the adoption of new technologies, rise in entrepreneurship, synthesis of new medicines and other products, develop-

ment of jobs, and increased prosperity through regional and national economic development is legendary.

In contrast to developed countries, where most research capacity resides in private companies, the vast majority of the research capacity in developing countries resides in public research institutions and universities. For this reason, one might expect an even greater relative impact of technology transfer from the public sector in developing countries.

Within universities (see box 5.26 on China), robust technology transfer programs also have many important benefits that are quite separate from royalty income, such as (Campbell 2007):

- **Productive interaction** with the industrial community. Ideas shuttling back and forth between the academy/research institute and private sector often increase the quality of research.

Box 5.26 Intellectual Property Management at Tsinghua University, China

Intellectual property (IP) is a relatively new legal and social concept in China. Formal legislation was introduced in the 1980s and subsequently strengthened. Universities now usually own the IP emanating from government-funded research, but technology transfer and commercialization remain low. Most universities lack IP policies and independent offices for IP management.

Tsinghua University is an exception. Its IP Office develops IP policies and manages university IP, which includes patents, trade secrets, know-how, trademarks, copyrights, and any related rights. The university's IP policy clearly states what constitutes employee work. The policy requires an investigator to disclose all results of a finished project to the administrative department, which then decides whether to apply for a patent. If results appear to have commercial value but are not suitable for a patent, they remain a trade secret. An industry-sponsored research agreement must have a clause on ownership of resulting IP, allocation of patent costs, and sharing of revenue made from the IP, among other arrangements, and the IP Office examines the contract before it becomes effective. When a faculty member or other employee goes to another domestic or foreign university or institute to conduct research, any resulting IP should be assigned, or at least jointly

assigned, to Tsinghua University, unless another agreement takes precedence. Under the university policy, at least 25 percent of revenue generated by a piece of IP is shared with the inventor(s) as cash or equity.

Tsinghua University spared no effort to educate its faculty members and students about IP and the university's IP policy. It implemented procedures for examining collaborative research agreements and sponsored research agreements between the university and other institutions or companies, for which it designed a standard contract. A special fund covers patent costs, including application fees, examination fees, agency fees, and maintenance fees for the first three years after a patent is issued.

Together, these measures caused Tsinghua University to own more patents than any other Chinese university. From 1985 to 2000, Tsinghua University filed 1,587 patent applications. Since 2001, the average annual growth rate of the university's patent filings has been 26 percent. In 2004, the university filed 43 foreign applications (including Patent Cooperation Treaty filings). The numbers of patents issued to the university rose from 121 in 1999 to 537 in 2004. Other universities with a similar level of IP management include Peking University (University of Beijing) and the Chinese University of Technology.

Source: Heher 2007.

- **Increased industrial support** of research at universities or public research facilities.
- **More willingness from central and local governments** to support research for economic development.
- **Students' or public researchers' exposure** to the world of industry and the commercial opportunities of research (including training in entrepreneurship), which influence their career aspirations and the national economy.
- **Financial support** from grateful alumni and other entrepreneurs who have grown wealthy from companies started from university/institute research.

POLICY ISSUES

A critical and well-understood caveat is that the positive economic and public benefits of technology transfer programs take many years or even decades to be fully realized. Sustained investment in capacity building is essential to achieve the potentially broad impact that technology transfer programs are very likely to have, and sustained support—fiscal and otherwise—is needed from senior administration to set the program's mission, policies, and priorities.

Technology transfer is a multifaceted process with important policy, economic, and managerial ramifications. The public sector's role is particularly to address issues related to the enabling environment, such as the removal of technical, legal, and administrative barriers to technology transfer, sound economic policy, regulatory frameworks, and transparency, which have implications for transferring private and public technology and the success of a TTO. A public subsidy to establish a TTO may also be an appropriate incentive in developing countries where experience is limited (Fernandez 2007).

LESSONS FOR IMPLEMENTATION

The general lessons for implementing TTOs have evolved in many contexts. They involve the need for long-term institution building, the prerequisite of a robust research base, the choice to develop a TTO for a single institution or adopt a network approach, the value of an institutional framework for technology transfer, and the skills, cultural environment, and incentives to support a TTO.

Long-term institutional building

Building capacity for technology transfer requires serious programmatic planning and a long-term institutional commitment to the activity. The early investment may yield

financial returns, but only after several years. The immediate returns are measured in terms of increased PPPs, an enhanced capacity to engage international partners, and an enhanced capacity to deliver research results to commercial channels. Nelson (2007) describes five economic “lessons” for institutions to consider before deciding to establish a technology transfer program:

- **Technology transfer will not make your university rich.** A successful program will make a small profit but will not support the university. It will, however, provide many other benefits to the institution and the community.
- **Building a robust technology transfer program takes sustained financial investment.** Investments are required to develop a patent portfolio, attract expert talent, and train office professionals.
- **It will likely take eight to ten years before your program stops losing money**—and it may never make your institution any substantial amount. It takes time to build an IP portfolio, establish contacts, and develop skills in technology transfer. Once these conditions are met, the TTO *may* begin to make money.
- **It may take two decades or more** before a university technology transfer program (including entrepreneurial spinouts) substantially affects the local and regional economy. Expecting substantial returns in a few years leads to underinvestment and disappointment.
- **The ultimate impact may be very large**, however—both economically and culturally—for the university, its graduates, and the community.

A robust research base

Technology transfer programs require a robust research base, with the capacity to develop new technologies with significant commercial applications. As mentioned, a good practice prior to investing in technology transfer programs is to assess the research assets. This assessment should include the research assets and research capacity to supply a steady stream of innovations to be “transferred.” This assessment should consider the scientific staff of the institution, its laboratories and facilities, its existing and potential base of research funding, and its existing or potential international collaborations. In addition, this assessment should look at the culture of the institutional leadership, its scientists, and students (if applicable). If measured only by royalty income, an institution with a smaller research base will have a more difficult time breaking even. Less research means fewer inventions. An example of successful

TTO at a large university with a large research base is Unicamp Brazil (box 5.27).

Individual or network-based technology transfer office

If an institution has sufficient research assets to develop a steady stream of innovations and a culture that would support an active technology transfer program, it can move forward and establish a TTO. If the research base or institutional culture is weak, it may be useful to broaden the assessment to encompass a set of regional research institutions. Building a technology transfer program to serve a cluster of institutions is the more difficult option, however,

and requires several institutions to agree formally on strategies. In many cases it may be the only way to assemble a sufficiently large research base to justify the investment. An assessment in Chile concluded that an effectively staffed technology transfer office should receive somewhere between 20 and 30 innovation disclosures per year (Fernandez 2007). In Chile, this level of activity could be achieved only if TTOs served a cluster of universities.

An institutional policy framework

Another good practice, following the research base assessment, is to assess and to develop an institutional policy framework for technology transfer. The framework must

Box 5.27 From University to Industry: Technology Transfer at Unicamp in Brazil

Brazil has dramatically increased technology transfer and innovation through Inova, the technology transfer office established by the State University of Campinas (Unicamp) in 2003 and the first technology transfer office established in a Brazilian university. A multidisciplinary university with more than 31,000 students and 20 research units, Unicamp pursues a variety of technologies in many fields. By 2007, Inova had become the most frequent patentor and licensor in Brazil. In only two-and-a-half years it signed 128 technology transfer agreements, licensed 45 technologies to private companies and the government, and applied for 153 new patents, 22 trademarks, and 24 software registrations. Its technology transfer agreements will last for more than ten years, and they have already generated royalties for the university ranging from 1.5 percent to 10 percent of the net income from the licensed technology. Unicamp grants inventors 33 percent of royalty and licensing income. The greatest contributor to the patent and licensing portfolio is the Chemistry Institute (48 percent); the corresponding figure for agribusiness and food is 16 percent. Inova's patent database is available online.

Under Brazilian law, Unicamp owns 100 percent of its professors' and researchers' results. The law permits public institutions to give up ownership to the inventor, but Inova has not taken this route; its inventors lack commercial expertise and find it more attractive for Inova to commercialize the technology and give the inventor part of the licensing fee. Unicamp also

commonly practices sponsored research. In such cases, ownership rights are normally split 50/50.

Factors in Inova's success include:

- ***Inova is driven by market demand.*** Instead of selecting Unicamp's technologies and offering them to the market, Inova examines market demand and seeks solutions inside the university.
- ***The technology transfer team comes from private institutions and has business skills.*** They are not researchers.
- ***The government provides many incentives to companies,*** such as tax benefits to companies that pay royalties; tax benefits to companies that invest in research and development, within or outside the company; compensation for taxes on royalties paid abroad during the execution of technology transfer contracts; tax exemptions for fees paid to maintain patents, trademarks, and cultivar registrations abroad; and sponsorship/subsidy of 60 percent of the salary of a scientist hired by a company.

These coordinated efforts will increase patenting and technology transfer in Brazil, strengthen the relationship between public institutions (where Brazilian research is mainly concentrated) and private companies, and contribute strongly to innovation. Other public universities and research centers have been studying Inova's model to emulate it.

Source: Di Giorgio 2007.

be consistent with national employment and IP laws and any exemptions that may exist for public researchers or for universities and their faculty. This framework can clarify the responsibilities of the institution and its employees prior to investing in the TTO.

The first step is to assess the national legal framework, including the IP policy, and ensure that the institution's IP policy and objectives for its technology transfer program are consistent with the national legal framework as well as its own mission and policies. The institution's IP policy should provide the basis for structuring the technology transfer program as well as the basis for transferring tangible property developed within the institution.¹ Support from senior administration is critical (Nelson 2007). Clear mandates will help technology transfer professionals choose among competing priorities and the ever-present trade-offs between private sector and public sector values. A well-understood review and appeal process needs to be put in place early.

In addition to establishing the broad aspirations and objectives, an institutional IP policy must address several key issues (box 5.28). (See module 6, TN 3). These issues are ownership, researchers' obligations, the institution's obligations, and administrative responsibilities.

Importance of core skills to manage IP protection and capacity to manage legal agreements

The required expertise is complex. Technical knowledge is needed to clearly understand a range of new innovations and how they might meet standards of patentability; legal skills must be sufficient to craft complex legal agreements. Many TTOs have found that technical expertise is indispensable and difficult to learn, whereas legal knowledge can be acquired "on the job" and supported by the judicious use of external legal counsel. Many staff members are not needed to support this activity, but their skills should reflect the major scientific disciplines of the institution.

Importance of business skills and communications strategy and skills

The long-term success of the TTO will depend on its ability to expand the impact of the institution's research by effectively transferring technologies (either intellectual or tangible property) to commercial partners and by supporting new research partnerships. Its long-term success will also depend on its ability to effectively communicate the

results of its activities to the institutional stakeholders, including its leadership and sponsors. The profile for staff in this area includes business training, such as a master's degree in business administration, significant work experience in business development in private companies, and preferably experience in starting a company. Overall, staff in this area must have the interpersonal skills to interact easily with a range of business professionals and have experience in selling new ideas in a wide range of contexts. The number of staff needed in this area is small. For most operations, one person is enough, but that person must be skilled and experienced.

Culture and incentives for technology transfer and commercialization

A passionate interest in technology transfer within the institution, the TTO management, but particularly the most senior management of the university or institute is a prerequisite for success. An essential ongoing activity is to identify and foster relationships with stakeholders, including academics, representatives of the business and user community, and regional and governmental offices. The most important group at the outset is the internal community that must be supported and encouraged to engage in technology transfer and entrepreneurial behaviors (Campbell 2007). Faculty reward systems such as professional advancement or revenue for engaging in technology transfer, along with removing cultural barriers and staffing the TTO, are key factors for success in technology transfer (Campbell 2007). For details, see Siegel et al. (2003).

Critical steps in establishing a TTO

The following minimal activities should be undertaken *once a decision is taken to establish a new TTO* (Young 2007):

- **Assist researchers in identifying results that have commercial value and document the discoveries through a disclosure process.** The disclosure-of-invention form should be simple (a complex form deters disclosure). More detailed information can be obtained through subsequent interviews with the inventor.
- **Evaluate the commercial potential of disclosed innovations.** A TTO exists to find commercial applications for technology and partners to realize the commercial potential, not to judge the value of the science. Such evaluations may be the most difficult of all tasks for a TTO.

Box 5.28 Key Issues to Be Addressed by an Institution's Intellectual Property Policy

Ownership. An institution's intellectual property (IP) policy should clearly address who owns IP developed in the institution (for example, the inventor/researcher owns the IP; the research institution owns it; a company providing research funds owns it; the government agencies providing research funds own it; or no-one owns it, and all IP is committed to the public domain). In most cases, institutions cannot manage IP effectively unless they own all IP developed within their walls regardless of funding source, but this condition may not always be possible. Whatever is decided regarding IP ownership, it must be very clear to prevent any ambiguity over who has the legal ability to transfer technologies.

Researchers' obligations. The policy needs to clearly describe the obligations of research staff. When the institution owns all IP, its researchers typically are required to

disclose possible inventions before publication, to assign ownership to the employer/institution, to assist in evaluation and patenting, and to report potential conflicts of interest.

The institution's obligations. The policy also needs to clearly describe the institution's obligations in managing IP. When the institution owns the IP, it typically is required to manage IP effectively, to pay patenting costs, and to share revenue with inventors. Of particular interest to researchers is the actual share of revenue that will go to the inventors, which can range widely from place to place but is typically 25–50 percent of net revenue after expenses.

Administering the policy. The policy should identify who in the institution is responsible for administering the policy and procedures for compliance.

Source: Authors.

There are many approaches to invention evaluation. The evaluation process lays the foundation for future decisions about IP protection and marketing.

- **Determine whether to protect IP in the innovation.** If needed, secure funding for filing patent, trademark, or copyright applications, and manage the protection process. The challenge of securing funding for IP protection internationally—especially when seeking protection in highly industrialized countries, where the primary markets for the expected products lie—is often overwhelming and perhaps even impossible in many developing economies because of the tremendous expense. Yet there may be very small or nonexistent commercial markets for the innovation in the country of origin, which can present a serious dilemma. The only solution in many cases is to secure protection in the country of origin first, thereby “buying time” under the requirements of the Patent Cooperation Treaty to find a corporate partner to pay the patent costs internationally as a business expense in the license agreement.
- **Conduct market research** to identify potential industry partners, and then market the innovations. Research has shown that in the United States, the primary source for identification of licensees is the inventor. In industrialized countries, inventors typically are familiar with the marketplace in their area of scientific expertise; through professional networking, they may even know their counterparts in industry (potential licensees) on a personal basis.
- **Once one or more industry partners are identified for an innovation, negotiate legal contracts** (license agreements) with these industry partners to transfer IP rights in the innovation in exchange for royalties or other considerations. The goal is to negotiate a fair arrangement that facilitates and assists the commercial partner in successfully developing and marketing the product, rather than simply seeking to negotiate the absolute highest fees and royalties in the agreement. Developing industry partnerships can lead to many unexpected benefits, such as sponsored research, student employment opportunities, consulting opportunities, and even philanthropic donations to the institution.
- **Maintain and manage administrative functions in support of the primary functions of IP protection and technology transfer.** These functions can include accounting, royalty distributions, licensee performance management, and patent application management.
- **If the TTO decides not to pursue IP protection and commercialization of an innovation, implement a process** to ensure that others have an opportunity to pursue protection and commercialization if they choose. The “others” will most often be inventors.