Financing Options for Land Technology Transfer

Michael Koch, Consultant report for the UNCCD

THE GLOBAL MECHANISM
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to Combat Desertification

Financing Options for **Land Technology Transfer**

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Author: Michael Koch

Global Mechanism of the UNCCD

Platz der Vereinten Nationen 1
D-53113 Bonn, Germany
Tel: +49 (0) 228 815 2873
www.unccd.int/about-us/global-mechanism

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Introduction

Access to sound technologies and new technological practices is essential for sustainable development. Efforts to promote technology transfer can play a critical role to enable the access to suitable technologies in developing countries. This is particularly true when the objective is to boost the ability of stakeholders such as smallholder farmers to mitigate and adapt to climate change. According to the GEF, technology transfer is defined as: "...a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions..."[1]

Developing countries' needs for access to suitable technologies are great. Yet the international transfer of technology is often constrained by a variety of issues. As further shown in this note, these issues may include insufficient research and development, lack of market readiness, the offering of non-suitable technologies, lack of information about available technologies, lack of financial incentives for sharing of traditional and indigenous technological knowledge, insufficient technological education and an inability to define exact technological needs, and governmental barriers to technology export and import. There may also be insufficient legal, institutional and financial frameworks for the protection of intellectual property and the promotion of foreign direct investment.

The need for financing. Introducing new technology into a country and its subsequent diffusion within that country require investment. Specifically, imported technologies as well as indigenous technologies may require change and innovation in the relevant institutions to support their transfer. Financing is therefore often a critical bottleneck and necessary enabling factor in any technology transfer. Without the requisite financing, very little technology investment or transfer may take place in practice. The provision of financing depends upon the policy focus and available instruments of those who have the financial resources, whether national governments, the private sector, NGOs and foundations, or multilateral institutions.

Public finance has traditionally had a crucial role in supporting the transfer and development of technology. Public finance has a role different than private finance. For example, public funding is often essential for long-term and infrastructure investments. Traditionally governments have dominated investment in physical infrastructure and large-scale technology development.

Today there is substantial interest in opening public infrastructure development to the private sector, for example, by privatising state-owned companies, opening markets to competition and awarding projects under a Build-Operate-Transfer mode of financing. Through large-scale private investment, both in the physical and social infrastructure sector, private sector finance has become vital in offering prospects for national as well as international diffusion of technology. Designing specific financial instruments which will allocate appropriately the risk and provide the right incentives for all parties is a prerequisite for attracting more private capital in technology transfer.

Technology transfer to address land issues. An effective transfer of technology to address land-related issues in the UNCCD context can play out at two distinct levels:

a) Technology supply: The development and maturing of new technologies, the improvement of new technologies, and the assessment of the effectiveness of new technologies.

b) Technology demand: Improving the uptake of new and existing technologies in places where they contribute to addressing land-related issues.

[1] https://www.thegef.org/topics/technology-transfer

Financing mechanisms support technology supply and demand. Financing for innovators facilitates technology development and market readiness, while access to financing for buyers is a precondition for effective uptake, transfer and application of technologies where they are needed the most.

Scope of this paper. This paper deals primarily with the third dimension, i.e. options for the financing of land technology transfer. Since most environmental technology development as measured by patenting activity is concentrated in industrialized countries – yet with some middle-income economies such as China and Saudi Arabia also becoming major innovators in land-based technologies – this paper focuses primarily on the transfer of technology from industrialized countries to developing countries (North-South). In addition, the paper may also propose financing options that apply for technology transfer between emerging and developing countries themselves (South-South). The paper will not address the financing of technology transfer between industrialized countries (North-North) as it is assumed that there are sufficient market-based financing options available within developed countries for this purpose.

Underlying issues and financing needs. To increase the flow of technological solutions to address land-related issues in developing countries, the following set of issues can be separated and distinguished, leading to a range of different financing options and models to address these issues:

1. **Technological advancement**: To spur the development of new innovative land technologies, there is a need for seed capital to finance research and development. For instance, through cost-sharing agreements multiple countries can subsidize the joint development of promising new land technologies.

2. **Market readiness**: To help innovators prepare their new land technologies for the global market, there is a need for start-up financing to finance product development, production facilities, market access and commercialization. An appreciation of the benefits of the new technology will need to be generated through information sharing and marketing outreach so as to ensure a positive market reception on the demand side.

3. **Technology suitability assessments**: To evaluate the effectiveness, efficiency, viability and suitability of existing and proposed technical solutions to address land-related issues, there is a need for dedicated technology assessments. This includes assessing the appropriateness of such technology for adoption in developing countries.

4. **Information sharing**: To inform about existing and available land technologies and practices so as to match technology supply with demand, there is a need for investment into technology information databanks, demonstration sites and research facilities.

5. **Benefit sharing**: To promote effective and fair use of traditional and indigenous knowledge, often being held within developing countries, there is a need for financing models to allow holders of traditional technologies to benefit from sharing their knowledge openly while also documenting community best practices and indigenous technological solutions.

6. **Technology education and needs assessments**: To motivate and guide primarily small-scale farmers to adopt sustainable land management technologies and practices, there is a need to finance agricultural extension services and training. This includes financing for technology needs assessments in developing countries.

7. **Technology export promotion**: To further the commercial flow of land technology across borders, there is a need for financing models and incentives to promote the export of technologies. For instance, eliminating tariff and non-tariff barriers to trade and other market-based interventions by governments can help promote technology transfer between industrialized and developing countries.

8. **Technology import promotion**: To boost the demand from developing countries for the import of advanced land technology from industrialized countries, there is a case for domestic governments to support importing farmers financially so as to make imported technology more attractive and affordable in the country.

9. **Intellectual property protection**: To motivate technology transfer by way of technology licensing and knowledge sharing, there is the need to build effective systems to protect and enforce intellectual property rights. Governments play a key role to establish the necessary legal and regulatory frameworks in this area.

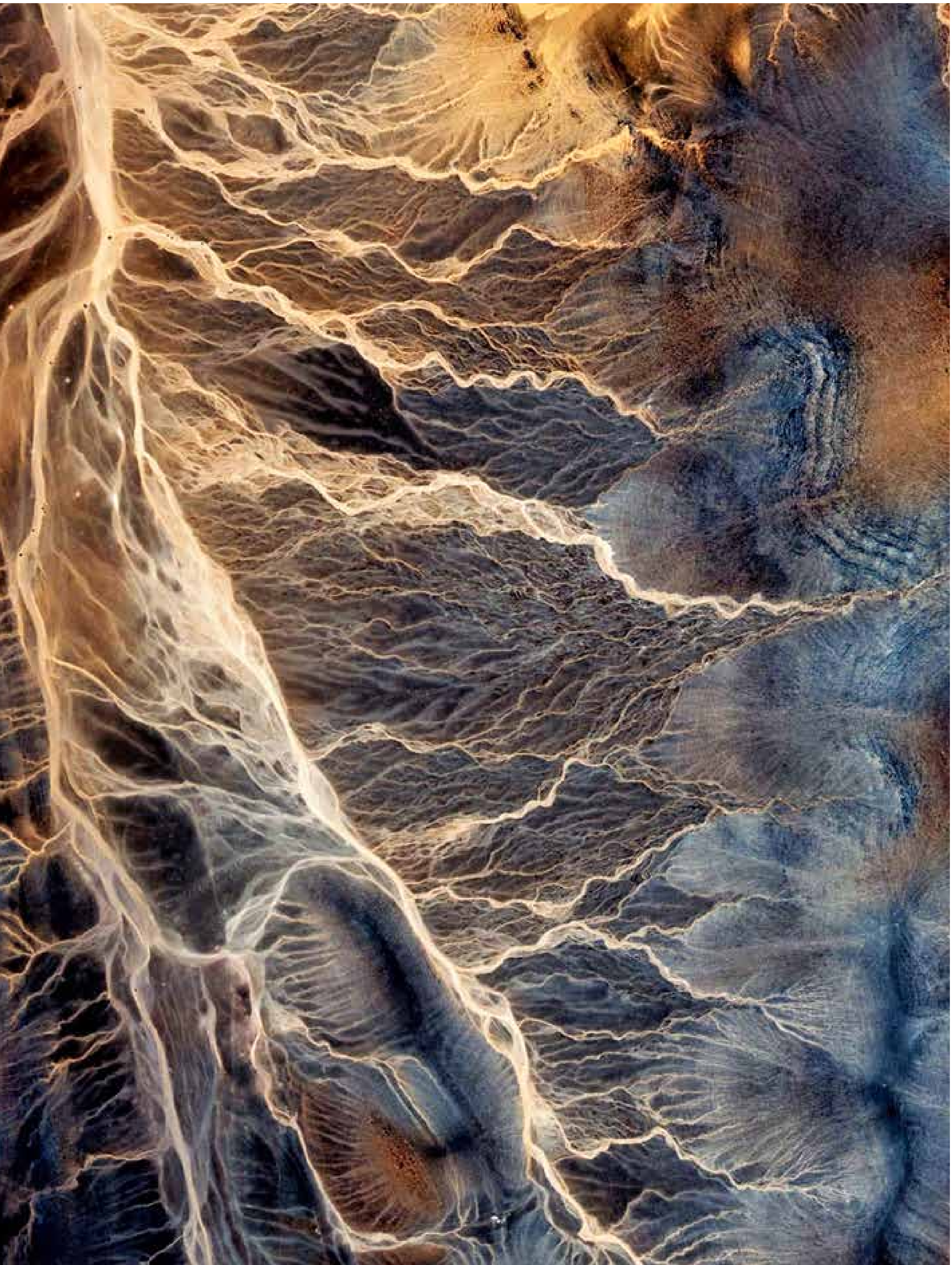
10. **Foreign direct investment**: Building up technical expertise abroad through foreign direct investment can help develop and commercialize new land technologies in developing countries, also circumventing possible restrictions on export or import of technology goods and services. Governments can provide financial incentives and advisory support to spur such foreign direct investment.

This paper will list and describe the range of financing tools and mechanisms that are available to promote the transfer of technologies that address land-related issues. Each of these will be assessed against their perceived effectiveness to address the underlying issues that have been identified above. Specifically, these financing options will include – but are not limited to – the following tools and approaches:

- Grants
- Loans (commercial and subsidized)
- Equity funding including venture capital
- Guarantees
- Public intervention in the form of tax incentives, state subsidies, and the removal of tariffs and of non-tariff protection, among other inventions

There are also non-financial instruments which have a direct financial impact on public and private actors involved in technology transfer. These include legal frameworks for patent protection, licensing frameworks, enforcement of intellectual property rights, as well as mechanisms for the sharing of benefits resulting from the transfer of technology, among others.

The paper will seek to provide examples of already existing financing mechanisms, some of them with direct relevance to land-related technology transfer. The paper will also develop proposals for new financial mechanisms that may be needed in the area of land-related issues and technology. One focus is on public sector intervention and public financing so as to inform government parties of the UNCCD about financing options available to them. There may also be a case for cross-border government collaboration so as to enable private sector engagement in technology transfer. In addition, the paper will point out areas where public-private collaboration in financing could lead to the promotion of innovative options.



Financing Options

ISSUE 1:
Technological advancement

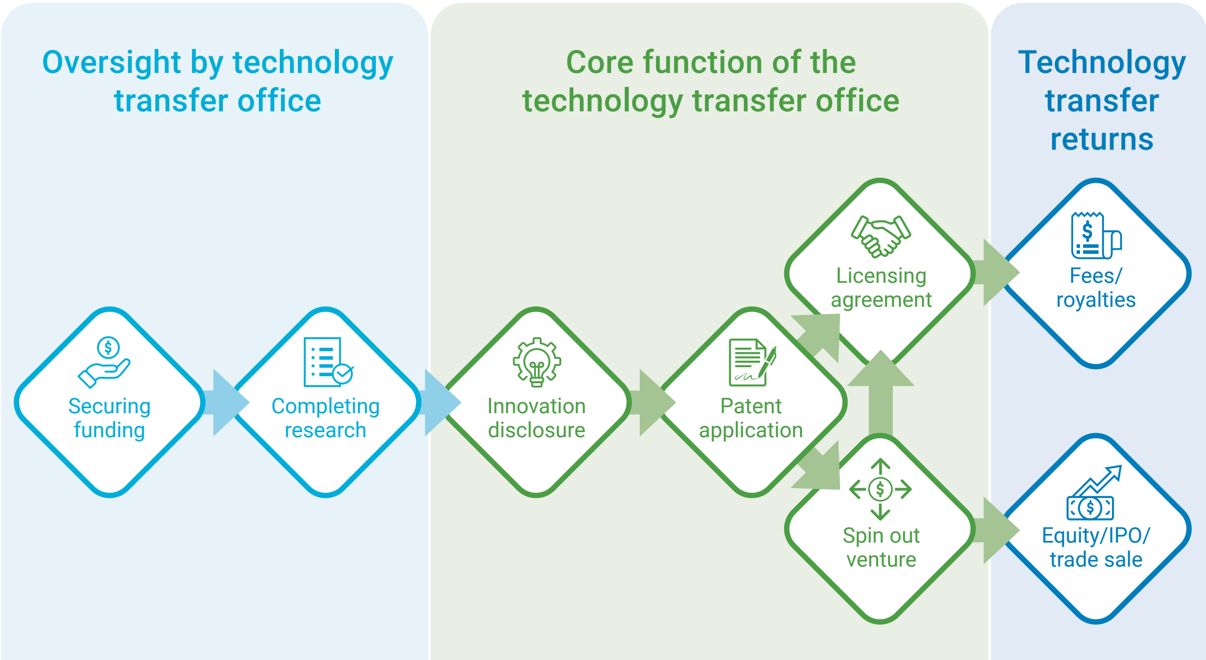
Broadly defined, beyond offering developing countries know-how for climate-related issues, technological advancement is the process of converting scientific findings from research organisations into useful products by the commercial sector. Technology transfer involves knowledge transfer and knowledge sharing. It is a process whereby an enterprise converts scientific findings from research laboratories and universities into products and services in the marketplace.

Technology transfer can take three main channels:

- The creation of new companies (spin-outs), which often involves some transfer of personnel;
- Collaboration between universities, research organisations and industry notably via research contracts; and
- The licensing of intellectual property.

Technology transfer often involves a formal transfer of rights to use and commercialise new discoveries and innovations resulting from scientific research to another party. The process also covers funded research, innovation disclosure, patents, licensing and sometimes new start-up ventures. Returns on technology transfer are primarily in the form of licensing royalties, but also include sponsored research, one-off transactional fees and new venture equity. Figure 1 summarises the technology transfer process from the securing of funding to the generation of returns.

Figure 1:
Technology Transfer Process



Source: "Financing Technology Transfer", EIF 2009, available at https://www.eif.org/news_centre/publications/eif_wp_2009_002_financing-tt_fv.pdf

The technology transfer "funding gap" describes a situation in the life-cycle of a start-up/project whereby typical sources of early-stage funding dry up while late-stage sources of funding are not yet available. This funding gap thus generates a disconnection between early basic research and downstream development.

Typically basic research and early target discovery are mainly funded by government grants and sometimes also through philanthropic research funds. Once a technology has reached the proof-of-concept stage, for instance in late preclinical testing in the case of biotech, venture capital and licensing funds become available from private sources and are supplemented by private equity, public offerings and late stage licensing as the technology progresses towards commercialisation. The technology transfer funding gap arises in between, the point where government and philanthropic funds begin to run out but the technology's risk profile still discourages venture capital and licensing investments.

In the past it could be argued that the technology transfer funding gap was particularly prominent for green technologies. With the global focus on green technology development and application following the Paris Climate Agreement of 2015, however, much more public and private funding has been allocated to address this gap. Nevertheless, it is questionable whether land-related challenges and required innovations are sufficiently reflected and included within the promotion of green technologies, in particular when it comes to land technology issues arising in the context of developing countries.

To adequately quantify the value of patents and patent portfolios, the licensing potential needs to be analysed. Initial investment is needed to screen and identify a licensee, an outlay which patent holders are rarely willing to make due to uncertainty on their licensing potential. Patent Value Funds attempt to uncover both the financial gaps faced by the intellectual property holders and their licensing potential. These are institutional funds that invest in patent portfolios, acting as intermediaries, making intellectual property sellers and buyers meet and pulling off contracting easier to both parties. The development of innovation networks linked to major companies and of technology markets, primarily around exchange platforms for intellectual property, creates new opportunities for adequate intermediary structures for innovation.

Financing options. Governments have three basic options to support the development of new technologies, which applies also to the advancement of innovative land-related technologies:

- *Early-stage seed funding* for research and development so as to advance scientific discovery by public and private institutions such as research institutes and universities. Often, this is done through government grants and low-cost loans. Multiple governments can also cooperate to subsidize the joint development of promising technologies.

- *Bridge funding* to close the funding gap between initial scientific discovery and subsequent product development, including to assess the licensing potential for intellectual property holders of the innovative technology. The objective is to advance promising new technology from the research phase to the proof-of-concept stage so as to attract private funders. Such bridge funding can come from public sources, possibly to be administered by a Technology Transfer Office within the government. If bridge funding is provided by developed country governments, it can be targeted at those technologies that address the specific challenges in developing countries, thereby making a tangible contribution towards economic development and possibly climate adaptation in the developing world.

- *Venture capital funding and licensing investments*, leading to initial product development. While such funding is typically provided by the private sector, governments can incentivize the flow of this private risk capital such as by offering first loss guarantees to the private equity providers. Governments can also become venture capital co-investors, through so-called "hybrid" venture capital funds, thus leveraging substantial amounts of private venture capital investments.[2]

[2] For a recent evaluation of the effectiveness of public venture capital, refer to: https://mpra.ub.uni-muenchen.de/104389/1/MPRA_paper_104389.pdf

Examples

- The *Global Innovation Fund* is a non-profit innovation fund headquartered in London with an office in Washington D.C. that invests in the development, rigorous testing, and scaling of innovations targeted at improving the lives of the world's poorest people.[3] It receives financial support from numerous ODA-providing donor governments and private industry supporters. The Fund believes that the best ideas for solving some of the world's most critical problems can come from anyone, anywhere. Through grants and risk capital, the Fund helps breakthrough solutions to global development challenges from for-profit firms, non-profit organizations, researchers, and government agencies. Its focus is on solving major development problems in low- or lower-middle income countries. The Fund seeks solutions that can scale up commercially, through the public/philanthropic sector, or through a combination of both in order to achieve widespread adoption.

- In an effort to take advantage of emerging technologies and platforms, the *World Food Programme* developed its in-house Innovation Accelerator, which uses new technologies to improve food security.[4] The intention is to adapt technological innovations that the WFP discovers for the benefit of the people that the WFP serves. The model is based on startup accelerator Y-Combinator, which invests USD 150,000 in each startup selected (alumni include Airbnb, Dropbox, and Stripe) and then spends three months working with the startup to refine its product and attract additional investors. Similarly, WFP awards up to USD 100,000 to build out proofs-of-concept for promising ideas to a point where they can qualify for outside funding.

Implications for land-related issues. Governments in developed countries could work together to establish a dedicated, multilateral *Land Innovation Fund* to finance research and development of innovative land-related technologies. These technologies would be targeted to deliver tailored, cost-effective solutions for land issues in developing countries. The Fund would provide grants for early stage research and development, finance assessments of the licensing potential for intellectual property holders of the innovative technology and become an equity co-investor along with private venture capital investors. Establishment of the Land Innovation Fund could be accomplished as a public-private partnership involving developed country governments and private firms in the agro-industry, food production and food retail sectors.

3 https://www.globalinnovation.fund/who-we-are/about-us/
4 https://www2.deloitte.com/us/en/insights/industry/public-sector/government-venture-capital.html

ISSUE 2:
Market readiness

New technologies that are demonstrating early evidence of a scalable, repeatable business model serving an identified demand in their market are in need to attract financial resources in order bring the new technologies to the global market. There is a need for start-up financing to finance product development, production facilities, market access and commercialization. Investors typically fund start-up companies to further their early-stage commercialization and support their growth into a scalable business. Adoption capacity on the demand side can be improved through marketing outreach on product features and benefits. Moreover, start-up financing for joint ventures in receiving countries can help support further product take-up and its adaptation to local conditions and needs.

Financing options. Governments can finance start-up enterprises in order for them to gain market readiness. This can be done through public sector grants, loans, equity investments and guarantees. Often, governments establish dedicated funds that become co-investors along with private investors.

Examples

- The *Market Readiness Co-Investment Fund* in Ontario, Canada is a bilateral platform that supports business development, economic growth and scalable impact across all technology sectors.[5] The Fund invests directly in academic affiliated start-up companies to further their early-stage commercialization and support their growth into a scalable business. On behalf of the Government of Ontario, the Fund supports early-stage companies that are raising pre-seed and seed investments. It is a competitive co-investment fund. With more than 300 companies considered for funding each year, the Fund completes 20 investments a year. Companies will be evaluated based on their potential long-term competitiveness, strong intellectual property, unique value proposition and momentum/capacity to scale. Preference will be given to companies that exhibit a unique offering that differentiates them in the marketplace.
- The *Partnership for Market Readiness* (PMR) is a multilateral forum for collective innovation and action and a fund to support capacity building to scale up climate change mitigation.[6] It is hosted at the World Bank Group. The PMR provides support to prepare and implement climate change mitigation policies—including carbon pricing instruments—in order to scale up GHG mitigation. Serving as a platform to share lessons, countries work together to shape the future of cost-effective GHG mitigation.

Implications for land-related issues. In addition to supporting early-stage technological research with grant funding, a dedicated multilateral *Land Innovation Fund* could also finance start-up enterprises in order for them to gain market readiness. This would include funding for product development, production facilities, market access and commercialization of land-based technological solutions that are suitable to address specific land-related issues in developing countries. The Fund would become a co-investor along with private investors.

5 https://marketreadiness.oce-ontario.org/
6 https://www.thepmr.org/

ISSUE 3:

Technology suitability assessments

Technology assessment is the study and evaluation of new technologies. It is a scientific, interactive and communicative process that aims to contribute to the formation of public and political opinion on societal aspects of science and technology. It is a means of judging new technology after it was first developed and before it is potentially accepted by the public and authorities for further use.

Technology assessments are a form of cost-benefit analysis and involve policy research to examine the short- and long term consequences (such as societal, economic, ethical, legal) of the application of technology. Technology assessments are usually carried out by experts; yet they can also be participatory in nature and involve various kinds of social actors as assessors and discussants such as civil society organizations and government representatives.

Financing options. Governments can provide public funding for technology assessments by creating dedicated public institutions for this purpose or by funding research carried out at academic institutions. In some countries there are dedicated groups or committees in national Parliaments dealing with science and technology assessments under advice from scientific experts.

Examples

- The *Panel for the Future of Science and Technology* (STOA) is a committee of members of the European Parliament devoted to all issues related to science and technology assessment.[7] Its task is to carry out expert, independent assessments of the impact of new technologies and identify long-term, strategic policy options useful to the Parliament's committees in their policy-making role. STOA's work is carried out in partnership with external experts. These can be research institutes, universities, laboratories, consultancies or individual researchers contracted to help prepare specific projects.

- The *Institute for Technology Assessment and Systems Analysis* (ITAS) is a research facility of the Karlsruhe Institute of Technology in Karlsruhe, Germany.[8] ITAS is the largest and longest standing scientific institution in Germany dealing with technology assessment and systems analysis in theory and practice. ITAS investigates scientific and technological developments with a focus on their impacts and possible systemic and unintended effects. It produces analytical knowledge and assessments of socio-technical developments in order to provide policy and design options for decision-makers. The research covers ethical, ecological, economic, social, political-institutional, and cultural questions. Major goals are advice for research and technology policy, provision of knowledge for the design of socio-technical systems, and the organization and observation of discursive processes on open and controversial questions of technology policy.

Implications for land-related issues. UNCCD as an intergovernmental convention could be well placed to establish a *Panel on Land Technology*, to be funded by government members to the convention. Such a Panel would be composed of independent subject matter experts. The terms of reference for the panel members would be drafted by UNCCD in consultation with land technology experts and be reviewed and approved by UNCCD members. The primary goal of the Panel would be to assess the suitability of different land-related technologies in view of the specific needs and challenges in different developing countries and regions. The Panel would prioritize requests for land technology assessments according to their expected cost-benefit relationship. Requests for assessments could be brought forward by members of the UNCCD convention as well as by outside organizations, both public and private.

7 https://www.europarl.europa.eu/stoa/en/home/highlights
8 https://www.itas.kit.edu/english/

ISSUE 4:
Information sharing

Matching the existing supply of innovative technological solutions to the potential demand by users of such technological applications can be accomplished by offering information about available technologies and practices in a dedicated online space. This reduces the cost of searching for relevant information for market participants, especially if suppliers and users are located in different countries and continents.

Information databanks complemented by demonstration sites help create access to information and knowledge on innovative technologies. Such facilities can also provide technical assistance at the request of developing countries on technology issues. Moreover, information hubs can promote global collaboration among technology stakeholders by building up networks of regional and sectoral experts.

Financing options. Governments can provide public funding for investment in technology information databanks and demonstration sites, often hosted at research sites in developed and developing countries. This can include grant funding for technical assistance to advise potential users of innovative technology about the range of available technologies and practices.

Examples

Within the UN Climate Change process, countries have confirmed the importance of enhancing technology development and transfer to developing countries. To facilitate this, in 2010 the Conference of the Parties established the *Technology Mechanism*. The Technology Mechanism consists of two bodies: the Technology Executive Committee and the Climate Technology Centre and Network.[9]

- The *Technology Executive Committee* is the Technology Mechanism's policy body. It analyses issues and provides policy recommendations that support country efforts to enhance climate technology development and transfer. The committee consists of 20 technology experts representing both developed and developing countries. It meets several times a year and holds climate technology events that support efforts to address key technology policy issues.

- The *Climate Technology Centre and Network* is the implementation body of the Technology Mechanism. It accelerates the development and transfer of technologies through three services:

    - Providing technical assistance at the request of developing countries on technology issues
    - Creating access to information and knowledge on climate technologies
    - Fostering collaboration among climate technology stakeholders via its network of regional and sectoral experts

    The centre is hosted by the UN Environment in collaboration with the United Nations Industrial Development Organization, and is supported by 11 partner institutions. It also has a network of national, regional, sectoral and international organizations which support it to undertake its services.

Implications for land-related issues. UNCCD as a non-commercial, intergovernmental party could be well placed to establish a Land Technology Centre and Network, possibly modelled along the climate-related technology centre and network hosted by UNFCCC. At the request of developing countries the Land Technology Centre would offer technical assistance on land issues, create an online hub for facilitating access to information and knowledge on land technologies, and it would provide a global forum for information sharing and exchange among land technology stakeholders and experts. Among other types of information, the Land Technology Centre could collect a database of land technology demonstration sites available for visit.

[9] https://unfccc.int/ttclear/support/technology-mechanism.html

ISSUE 5:
Benefit sharing

Much of the type of technology and knowledge needed to address land-related issues in developing countries may already be available within the region itself or it may be readily known and applied in developing countries in other regions. Therefore, rather than having to invent new technological solutions from scratch, or to facilitate the transfer of technological innovations from developed countries into the developing world, there is a need to incentivize holders of traditional and indigenous knowledge within developing countries to release and share their information with other interested parties in the global South.

Such incentives can be provided by suitable financing models which aim at sharing the expected economic benefits to be derived by users of indigenous knowledge with the providers of such traditional knowledge. Moreover, these mechanisms to incentivize the sharing of benefits can involve the documentation of community best practices when applying such traditional technological solutions.

Financing options. Governments can create the legal and financial frameworks for an international benefit sharing mechanism on traditional technology and indigenous knowledge in a given sector, including also for a land-related issues. This involves public funding of extensive consultations necessary with stakeholders, funding for the drafting of required treaties and legal documentation, and funding of subsequent negotiations to reach an international agreement among governments, organizations representing the holders of the indigenous knowledge, and stakeholders from among potential users of such knowledge.

Examples

- In 2001 the *International Treaty on Plant Genetic Resources for Food and Agriculture* established a global network of seed banks which provides facilitated access to crops for plant breeding purposes while aiming that the resulting commercial benefits are shared fairly and equitably. To this effect a *Benefit Sharing Fund* has been established under the auspices of FAO.[10] The Fund is meant to collect a share of the future revenue generated by commercial plant breeders, who are mostly located in developed countries, when using the seeds of indigenous food crops held in national and regional seed banks, which originate mostly from developing countries. Such revenue collected by the Fund will finance farming communities in developing countries in order to improve their food security by helping them cope with climate change and other threats to food production.

- This Benefit Sharing Fund was set up in consultations will government stakeholders that are members of the International Plant Treaty and FAO. However, despite high initial expectations, the Fund has to date failed to mobilize significant financial resources from commercial plant breeders in developed countries. Rather than accessing the indigenous seeds held in the global network of public-access seed banks, commercial breeders often prefer to collect their own plant generic resources and maintain seeds banks on their own so as to avoid the future financial obligations under the Benefit Sharing Fund. This example illustrates the importance of including intended users of the physical or intellectual capital in the stakeholder discussions leading up to the establishment of a benefit sharing fund mechanism. That is a prerequisite for understanding the needs and motivations of the parties involved so as to design an effective mechanism for benefit sharing.

Implications for land-related issues. UNCCD could establish a working group together with FAO experts in the field of plant genetic resources and land issues to explore the feasibility and expected merits of a benefit sharing fund for traditional land knowledge and indigenous land technology. This could be followed by inclusive consultations with all concerned stakeholders, including member governments of UNCCD, organizations representing farmers in developing countries, NGOs, and also private providers of innovative land technology. Such consultations could lead to a proposal to set up a *Benefit Sharing Fund for Indigenous Land Technology* under the auspices of UNCCD.

10 http://www.fao.org/documents/card/en/c/2ee42229-a18f-4f79-a967-bd94d08fb7c9/

ISSUE 6:

Technology education and needs assessments

Modern farms and agricultural operations work far differently than those a few decades ago, primarily because of advancements in technology, including sensors, devices, machines, and information technology. Today's agriculture in developed economies routinely uses sophisticated technologies such as robots, temperature and moisture sensors, aerial images, and GPS technology. These advanced devices and precision agriculture and robotic systems allow businesses to be more profitable, efficient, safer, and more environmentally friendly.

In the context of developing countries, however, the needs of smallholder famers are often less about introducing advanced technologies than about hands-on training in sustainable land management techniques and practices. Typically, such training is delivered by agricultural extension services and related training programs, funded by national governments. Agricultural extension provides non-formal education and learning activities to farmers and other residents of rural communities. It emphasizes taking knowledge gained through research and education and bringing it directly to the people to create positive changes.

Extension empowers farmers, ranchers, and communities of all sizes to meet the challenges they face, adapt to changing technology, improve nutrition and food safety, prepare for and respond to emergencies, and protect the environment. Extension support covers farm operations, crop selection and management, proper use of agricultural machinery, irrigation and the application of fertilizer, among many other topics. The objective is to remove knowledge and cultural barriers to the inclusion of locally proven technology and practices in agricultural production.

Often, extension services include assistance with technology needs assessments of smallholder farmers. Such assessments can also be carried out at the national level so as to identify systematic needs concerning the introduction of new land-related technologies in a given country.

Financing options. National governments are the main source of funding for technology education in agriculture through public farm extension services, delivered by state-run agencies or by private extension providers under a government-funded contract. Public funding can also support cooperative extension services within rural communities which are sometimes co-funded by beneficiaries themselves, including through membership-financed farmer associations. Other possible funding sources include commercial suppliers of farm inputs and equipment as well as NGOs. These funding sources can also contribute to the financing of technology needs assessments of farmers in developing countries.

Examples

- In New Zealand, the Ministry for Primary Industries (MPI) funds farmer-led projects to help farmers transition to more sustainable land use.[11] Extension projects provide farmers the opportunity to learn from one another and use specialist advice to make decisions that will improve their environmental and economic resilience and improve overall wellbeing in their communities. Extension services help primary producers to access knowledge, expertise, and tools to support sustainable land management decisions; improve peer-to-peer and cross-sector learning opportunities that support on-farm decision-making and build community cohesion; and find out about other investment opportunities that could complement their own efforts. Extension services serve to improve on-farm performance allowing farmers to get greater value from their farmland and improve their sustainability.

- Under the UNFCCC, countries undertake *Technology Needs Assessments* (TNAs).[12] Understanding climate technology needs is the starting point for effective action on climate change. By understanding these needs countries can determine how to reduce greenhouse gas emissions and adapt to the adverse impacts of climate change. A TNA supports national sustainable development, builds national capacity and facilitates the implementation of prioritized climate technologies. Since 2001, more than 85 developing countries have undertaken TNAs to identify their technology needs for mitigation and adaptation. Since 2010, as part of their TNAs, developing countries have also developed technology action plans (TAPs), which are concrete action plans for the implementation of their prioritized technology needs. The GEF provides support for developing countries to undertake TNAs through its Poznan Strategic Program on Technology Transfer.

Implications for land-related issues. Extension services are the norm in most developing countries and contribute to more sustainable land management. ODA donors can assist developing country governments to improve the efficiency of their extension programs, learning from experiences gained in other countries. In collaboration with FAO, UNCCD could sponsor international best practice learning in this area. Moreover, UNCCD could facilitate the delivery of *Land Technology Needs Assessments* at the national level in developing countries. Such a program would build national capacity in sustainable land management and facilitate the implementation of suitable land technologies adapted to local land conditions and farmers' needs.

[11] https://www.mpi.govt.nz/funding-rural-support/farming-funds-and-programmes/productive-and-sustainable-land-use/extension-services-programme-for-farmers/

[12] https://unfccc.int/ttclear/tna

ISSUE 7:

Technology export promotion

Many countries rely heavily on exports as an essential component of their economic competitiveness. Within a globalized world, promoting exports is a common strategy to boost economic growth. Exports of environmental technologies represent a particularly promising window of opportunity for economic growth and a contribution to global sustainability. With this in mind, national governments routinely design initiatives that aim to promote exports within this sector. To address their objectives, governments provide initiatives to promote foreign commerce with their environmental technology sector.

Financing options. Governments can actively promote the export of domestically-generated technology. This can include public financial assistance for export-oriented firms such as through loans and guarantees, the provision of information and advice about foreign markets, and the reduction or elimination of tariff and non-tariff barriers to trade.

Examples

- The German Federal Ministry of Economic Affairs and Energy maintains a *German Trade and Invest* (GTAI) information service.[13] Its goal is to help Germany's export-oriented SME sector compete successfully in the global marketplace. This requires knowledge out foreign markets, applicable import regulations and characteristics of target countries. GTAI experts analyze trends and developments in strategic growth markets. They offer standardized information to facilitate foreign business planning and export implementation so as to open new markets for German businesses.

- *Germany's government-owned KfW promotional bank* has been supporting the export economy of Germany for 60 years. KfW's medium and long-term financing solutions are tailored to the specific needs of our customers who range from internationally oriented large companies to medium-sized enterprises. On behalf of the German federal government KfW currently implements three export promotion programs:[14]
  - the ERP Export Financing Programme to finance German exports to developing and emerging countries
  - the CIRR Ship Financing Programme to support the German shipbuilding industry
  - the Africa CIRR Export Financing Programme which supports loans to finance German exports in African buyer countries

- Like most developed countries, the US Government maintains a set of export control rules pertaining to the transfer of technology to foreign buyers. The *U.S. Department of Commerce's Bureau of Industry and Security* (BIS) administers U.S. laws, regulations and policies governing the export and reexport of commodities, software, and technology falling under the jurisdiction of the Export Administration Regulations. The primary goal of BIS is to advance national security, foreign policy, and economic objectives by ensuring an effective export control and treaty compliance system, and promoting continued U.S. strategic technology leadership. BIS also enforces anti-boycott laws and coordinates with U.S. agencies and other countries on export control, nonproliferation and strategic trade issues. To the extent that the BIS decides to lift export controls on technology, this will open the access of foreign countries to US technologies.

Implications for land-related issues. Governments of developed countries can assist their domestic innovators in land-based technology in accessing foreign markets. They can offer specific export promotion programs aimed at environmental technology in agriculture and sustainable land management. This can include financing and export guarantees as well as information on foreign markets and their import regulations. Trade regulations regarding the export of land-related technology can be streamlined to remove any regulatory or tariff-related barriers to the export of such technology.

[13] https://www.gtai.de/gtai-en/meta/about-us/what-we-do/export-promotion#

[14] https://www.kfw-ipex-bank.de/International-financing/KfW-IPEX-Bank/About-KfW-IPEX-Bank/Unsere-Rolle-in-der-Au%C3%9Fenwirtschaftsf%C3%B6rderung/?redirect=349376

ISSUE 8:
Technology import promotion

Promoting imports of technology as a means of boosting technology transfer is less common than promoting technology exports. Governments are often reluctant to increase an economy's imports as this will worsen the country's balance of trade and it will increase the dependency on foreign technology. In the long run, however, the benefits of increased production and productivity may well outweigh the short-term costs of promoting imports, hence laying the foundation for sustained domestic growth by adopting innovative technology from abroad.

Financing options. Governments wanting to increase the import of foreign technology can provide domestic firms with financial assistance through loans and grants to reduce the cost of such imports. This can be complemented by providing information about available foreign technology. Domestic governments can also liberalize their trade regimes by removing import tariffs and non-tariffs barriers to imports of technology.

Examples

- *The Import Promotion Desk (IPD) in Germany* is an example for promoting exporters in developing countries and emerging markets who may struggle to get a foothold in the German and in the European market.[15] The IPD is an initiative of the Federation of German Wholesale, Foreign Trade and Services in cooperation with NGOs and Germany's GIZ. The IPD is funded by Germany's Federal Ministry for Economic Cooperation and Development (BMZ). While IPD illustrates how government-supported import promotion can be organized, it focuses on providing assistance for exporters abroad rather than at supporting importers at home.

Implications for land-related issues. Governments of developing countries can boost the demand for the import of advanced land technology from industrialized countries. Governments can support importing farmers financially through grants and loans so as to make imported technology more attractive and affordable in the country. Through their agricultural extension services and tailored needs assessments, governments can provide farmers with information about advanced land-related technologies that are available from abroad. National trade regimes can be adjusted to ease imports of land-related technology.

[15] https://www.importpromotiondesk.de/en/

ISSUE 9:

Intellectual property protection

Intellectual property (IP) rights, protected and enforced under patent and trade secret laws, enable inventors to bring new technologies to the market without ceding control of the valuable knowledge or know-how behind them. By temporarily conferring exclusive rights in those jurisdictions where granted, patents permit companies to capture the value of their inventions and the investments made in developing and bringing them to market. In addition, quality patents and robust IP strategies can help innovative businesses signal the value of their inventions to the market. Predictable and well-enforced IP frameworks contribute to technology diffusion by facilitating IP management strategies such as licensing agreements.

Effective IP regimes that allow for timely, high-quality patents help facilitate technology transfer. This may require both substantive and procedural reforms to patent administration, including provisions to reduce patent pendency. Policies that ensure IP rights are available and enforceable at reasonable cost are valuable instruments. These should be balanced with modern trade secret laws and complemented by competition policies with clear and enforceable provisions. Finally, practical IP management training for companies, in particular SMEs, can facilitate job creation, as well as the sale and acquisition of technology.

The benefits that flow from patents, trademarks, copyrights and trade secrets are prerequisites for "open innovation", which may become the dominant approach to innovation in the twenty-first century. Rather than developing and commercializing processes exclusively within the boundaries of a single company, companies work with external actors in order to enhance the innovative process. They therefore need to simultaneously disclose and protect their know-how. Given the complexity of the technology involved and the global nature of climate change, open innovation is of particular relevance for environmental innovation.[16]

Financing options. Intellectual property refers to intangible property or intangible assets such as inventions, formulas, ideas, designs, industrial processes, and other creations that are protected by national law. IP protection is therefore a local concept. Governments in developing countries can promote the import of technology by granting domestic IP protection to international patent applications of innovative foreign firms. Public funding for drafting the necessary national legislation is therefore required. With such national legislation in place, foreign providers of innovative technology have a legal basis to protect the exclusivity in their domestic markets by making use of licensing agreements with their international partners.

Examples

- *The World Intellectual Property Organization (WIPO) maintains the Madrid System*, an international trademark system.[17] The Madrid System is a convenient and cost-effective solution for registering and managing trademarks worldwide. By filing a single application and paying one set of fees, companies can apply for protection in up to 124 countries. Companies can also modify, renew or expand their global trademark portfolio through one centralized system. Companies can use the Madrid System if they have a personal or business connection to one of the System's members. Companies must either be domiciled, have an industrial or commercial establishment in, or be a citizen of one of the 124 countries covered by the Madrid System's 108 members.

Implications for land-related issues. Governments in developing countries should work towards including innovative land technology patented abroad by foreign suppliers into their national IP protection frameworks. That way they can boost the supply of imported advanced land technology from industrialized countries for licensing and use within their national economy. Developing countries should also consider becoming members of WIPO's Madrid System. This would also help contribute to secure the benefits of sharing indigenous technology with other countries.

[16] See: https://www.wipo.int/edocs/pubdocs/en/wipo_brief_gc_2014_1.pdf
[17] https://www.wipo.int/madrid/en/

ISSUE 10:

Foreign direct investment

Foreign direct investment (FDI) can be an effective conduit for international technology transfer through technology spillovers to domestically owned firms in the host country. For instance, a study in 2016 found that foreign firms in Kenya have played a major role in enhancing economic growth in the agriculture sector, especially in floriculture and horticulture. Over a long period of time, FDI has been found to create many externalities in the Kenyan economy in the form of benefits available through transfers of general knowledge, specific technologies in production and distribution, industrial upgrading, work experience for the labor force and the establishment of finance-related and trading networks, and the upgrading of telecommunications services.[18]

In 2018, a global study investigated the impact of foreign direct investment on economically developed and developing countries, and also on transition economy countries as far as technology transfer is concerned. The results show a significant foreign direct investment influence on the economic growth of developing countries and transition economy countries.[19]

Financing options. Attracting foreign direct investment has become a central component of industrial policy in developed and developing countries across the world. Governments often use fiscal resources to fund investment promotion agencies to improve their effectiveness in attracting foreign direct investment and maximize the benefits for their local economies. Successful investment promotion agencies may use an integrated investment promotion strategy that combines marketing and company targeting with after-care and product development. Beyond providing advice and information, developing country governments can also offer financial incentives such as tax breaks or investment subsidies to foreign investors.

Examples

- The World Bank Group, OECD, UNCTAD and UNIDO alone offer in total over 50 instruments to stimulate FDI.[20] The *Multilateral Investment Guarantee Agency* (MIGA), part of the World Bank Group, maintains a Foreign Direct Investment Promotion Center.[21] It is an online service which brings together knowledge resources for easy access and in-depth learning, at no charge. The FDI Promotion Center is designed to support the efforts of investment promotion professionals to attract and retain foreign direct investment. It offers resources to research prospective investors, tools to create an effective promotional strategy, case studies to help structure the operations of investment promotion agencies, and best practice examples.
- *Canada provides different monetary incentives* to foreign investors.[22] Companies of any size that invest in research and development in Canada can take advantage of a special tax incentive program. Moreover, financial incentives are provided through an enhanced capital cost allowance on equipment purchases and full expensing in the first year for clean energy equipment purchases. There is also a Strategic Innovation Fund which is open to foreign investors.

Implications for land-related issues. Governments in developing countries should seek to promote foreign investment by firms developing and supplying land-related technologies. This could include offering public land for installation of research and production facilities as well as for land technology demonstration sites, tax breaks, and other forms of financial support.

18 https://innovation-entrepreneurship.springeropen.com/articles/10.1186/s13731-016-0059-3

19 https://www.researchgate.net/publication/327787130_Prospects_of_foreign_direct_investments_in_technology_transfer

20 https://www.somo.nl/wp-content/uploads/2008/11/Promotion-of-Foreign-Direct-Investment.pdf

21 https://www.miga.org/sites/default/files/archive/Documents/FDIguide_1.pdf

22 https://www.investcanada.ca/programs-incentives?creative=491153928229&keyword=%2Bfdi&matchtype=b&network=g&device=c&gclid=Cj0KCQjwh_eFBhDZARIsALHjIKcfNCn86jUg9knqOIOCEJEyhTEk_ZQc0EtgJxwAOW_I-zQoofRpYsUaAiLEEALw_wcB

Conclusions

As outlined in this paper, technological advancement is the process of converting scientific findings from research organisations into useful products by the commercial sector. Technology transfer involves knowledge transfer and knowledge sharing. It is a process whereby an enterprise converts scientific findings from research laboratories and universities into products and services in the marketplace.

When more narrowly oriented at the specific challenges facing developing countries due to the impact of climate change, technology transfer refers to processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research and education institutions.

An effective transfer of technology to address land-related issues in the UNCCD context can play out through technology supply by innovators and technology demand from places where innovations contribute to addressing land-related issues. Financing for innovators facilitates technology development and market readiness; for buyers of technology, access to financing is a precondition for effective uptake, transfer and application of technologies where they are needed the most.

The paper has identified ten distinct issues and related financing needs so as to increase the flow of technological solutions to address land-related issues in developing countries. From these issues and their implications, **the following specific recommendations are being made to use financing options to promote land technology transfer:**

1. **Technological advancement**: Governments in developed countries could work together to establish a dedicated, multilateral *Land Innovation Fund* to finance research and development of innovative land-related technologies. These technologies would be targeted to deliver tailored, cost-effective solutions for land issues in developing countries. The Fund would provide grants for early stage research and development, finance assessments of the licensing potential for intellectual property holders of the innovative technology and become an equity co-investor along with private venture capital investors. Establishment of the Land Innovation Fund could be accomplished as a public-private partnership involving developed country governments and private firms in the agro-industry, food production and food retail sectors.

2. **Market readiness**: In addition to supporting early-stage technological research with grant funding, a dedicated multilateral *Land Innovation Fund* could also finance start-up enterprises in order for them to gain market readiness. This would include funding for product development, production facilities, market access and commercialization of land-based technological solutions that are suitable to address specific land-related issues in developing countries. The Fund would become a co-investor along with private investors.

3. **Technology suitability assessments**: UNCCD as an intergovernmental convention could be well placed to establish a *Panel on Land Technology*, to be funded by government members to the convention. Such a Panel would be composed of independent subject matter experts. The terms of reference for the panel members would be drafted by UNCCD in consultation with land technology experts and be reviewed and approved by UNCCD members. The primary goal of the Panel would be to assess the suitability of different land-related technologies in view of the specific needs and challenges in different developing countries and regions. The Panel would prioritize requests for land technology assessments according to their expected cost-benefit relationship. Requests for assessments could be brought forward by members of the UNCCD convention as well as by outside organizations, both public and private.

4. **Information sharing**: UNCCD as a non-commercial, intergovernmental party could be well placed to establish a Land Technology Centre and Network, possibly modelled along the climate-related technology centre and network hosted by UNFCCC. At the request of developing countries the Land Technology Centre would offer technical assistance on land issues, create an online hub for facilitating access to information and knowledge on land technologies, and it would provide a global forum for information sharing and exchange among land technology stakeholders and experts. Among other types of information, the Land Technology Centre could collect a database of land technology demonstration sites available for visit.

5. **Benefit sharing**: UNCCD could establish a working group together with FAO experts in the field of plant genetic resources and land issues to explore the feasibility and expected merits of a benefit sharing fund for traditional land knowledge and indigenous land technology. This could be followed by inclusive consultations with all concerned stakeholders, including member governments of UNCCD, organizations representing farmers in developing countries, NGOs, and also private providers of innovative land technology. Such consultations could lead to a proposal to set up a *Benefit Sharing Fund for Indigenous Land Technology* under the auspices of UNCCD.

6. **Technology education and needs assessments**: Extension services are the norm in most developing countries and contribute to more sustainable land management. ODA donors can assist developing country governments to improve the efficiency of their extension programs, learning from experiences gained in other countries. In collaboration with FAO, UNCCD could sponsor international best practice learning in this area. Moreover, UNCCD could facilitate the delivery of *Land Technology Needs Assessments* at the national level in developing countries. Such a program would build national capacity in sustainable land management and facilitate the implementation of suitable land technologies adapted to local land conditions and farmers' needs.

7. **Technology export promotion**: Governments of developed countries can assist their domestic innovators in land-based technology in accessing foreign markets. They can offer specific export promotion programs aimed at environmental technology in agriculture and sustainable land management. This can include financing and export guarantees as well as information on foreign markets and their import regulations. Trade regulations regarding the export of land-related technology can be streamlined to remove any regulatory or tariff-related barriers to the export of such technology.

8. **Technology import promotion**: Governments of developing countries can boost the demand for the import of advanced land technology from industrialized countries. Governments can support importing farmers financially through grants and loans so as to make imported technology more attractive and affordable in the country. Through their agricultural extension services and tailored needs assessments, governments can provide farmers with information about advanced land-related technologies that are available from abroad. National trade regimes can be adjusted to ease imports of land-related technology.

9. **Intellectual property protection:** Governments in developing countries should work towards including innovative land technology patented abroad by foreign suppliers into their national IP protection frameworks. That way they can boost the supply of imported advanced land technology from industrialized countries for licensing and use within their national economy. Developing countries should also consider becoming members of WIPO's Madrid System. This would also help contribute to secure the benefits of sharing indigenous technology with other countries.

10. **Foreign direct investment**: Governments in developing countries should seek to promote foreign investment by firms developing and supplying land-related technologies. This could include offering public land for installation of research and production facilities as well as for land technology demonstration sites, tax breaks, and other forms of financial support.

The above conclusions apply to all stakeholders involved in land-related technology, including governments, multilateral institutions, private sector actors, and also members of civil society.

Based on these recommendations, the **UNCCD Global Mechanism** could choose to focus on encouraging developed countries to collaborate and finance basic research and development of innovative land-related technologies by creating a multi-lateral *Land Innovation Fund*. Beyond supporting research, this Fund could also finance start-up enterprises in land technology in order for them to gain market readiness for their products, and the Fund could help showcase such new technological developments.

Moreover, the Global Mechanism could consider establishing a group of experts under a *Panel on Land Technology* to assess the suitability of and-related technologies in view of the specific needs and challenges in different developing countries and regions.

In addition, the Global Mechanism could set up and host a new *Land Technology Centre and Network*. At the request of developing countries the Land Technology Centre would offer technical assistance on land issues, create an online hub for facilitating access to information and knowledge on land technologies, and it would provide a global forum for information sharing and exchange among land technology stakeholders and experts. Among other types of information, the Land Technology Centre could collect a database of land technology demonstration sites available for visit.

Through the Land Technology Centre, the Global Mechanism could also facilitate the delivery of *Land Technology Needs Assessments* at the national level in developing countries. Such a program would build national capacity in sustainable land management and facilitate the implementation of suitable land technologies adapted to local land conditions and farmers' needs.

United Nations Convention to Combat Desertification

P.O. Box 260129
D-53153 Bonn, Germany

Tel: 00 49 228 815 2800
Email: secretariat@unccd.int

www.unccd.int

United Nations
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Desertification

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