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Patent portfolio-based indicators to evaluate the commercial benefits of national plant genetic resources

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ABSTRACT

According to property rights theory, national plant genetic resources (PGRs) are sovereign properties rather than resources belonging to the common heritage of humankind. Consequently, provider states can claim compensation from users of their national PGRs, leading to the need for bilateral or multilateral agreements to share national PGRs' commercial benefits. However, as benefit-sharing agreements are made exante, estimating the potential profit is difficult. Thus, issues around asymmetric information about the commercial value of such resources have emerged. In this paper, we use a patent portfolio as a proxy to estimate the potential commercial benefits of national PGRs and propose new evaluation indicators. We propose a comprehensive evaluation process that covers constructing a patent portfolio for each PGR, establishing indicators in terms of marketability, technology, and exclusiveness, and assigning weights to the indicators using fuzzy analytic hierarchy. In addition, we illustrate this process using a case of Korean national PGRs based on the opinions of stakeholders and experts. This research is expected to help promote national PGR transactions with equitable access and benefit sharing agreements.

1. Introduction

The diversity of genetic resources is a key component of biodiversity. Moreover, rich genetic resources are associated with potential commercial uses, as they are essential ingredients for research and development (R&D) in the pharmaceutical, botanical medicine, agriculture, and industrial biotechnology industries (Swanson and Göschl, 2000). Consequently, firms in these industries have endeavored to secure diverse genetic resources worldwide.

Genetic resources were traditionally regarded as the common heritage of humankind (Kloppenburg, 2005). However, as Raustiala and Victor (2004) noted, that viewpoint changed drastically once their commercial benefits became apparent. In keeping with property rights theory, governments now view national genetic resources as sovereign rather than as common resources. National genetic resources are those that fall within the jurisdiction of a provider state under the Convention on Biological Diversity (CBD) and the Nagoya Protocol,[1] including those that originate within that provider state and legitimately accessed ex-situ collections. The protocol includes a provision that asks member states to secure legislative, administrative, or policy measures to support equitable access and benefit sharing (ABS) through domestic legislation.

Despite provider states' and users' Nagoya Protocol compliance, information deficiencies can be an issue at the early stages of negotiation. In genetic resource transactions, provider states are limited in acquiring sufficient information about the factual uses of genetic resources and the expected values therefrom. Users may also lack

Abbreviations: CBD, Convention on Biological Diversity; ABS, Access and benefit sharing; COP, Conference of the Parties; PIC, Prior informed consent; MAT, Mutually agreed terms; ITPGRFA, International Treaty on Plant Genetic Resource for Food and agriculture; MTAs, Material transfer agreements; UNED, United Nations Conference on Environment and Development; WG-ABS, Working Group on ABS; IP, Intellectual property; TRIPS, Trade Related Aspects of Intellectual Property Rights; IPC, International Patent Classification; SITC, Standard International Trade Classification; PCT, Patent Cooperation Treaty; UPOV, Union for the Protection of New Varieties of Plants; AHP, Analytic hierarchy process.

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[1] Articles 15.1 and 15.7 of the CBD adopted in 1992 outlined states' sovereign rights over national genetic resources as well as the necessity of sharing the commercial benefits of their use. In October 2010, the Nagoya Protocol, discussed at the tenth Conference of the Parties (COP) meeting, reiterated the general rules for ABS, along with prior informed consent (PIC) and mutually agreed terms (MAT). The Nagoya Protocol develops the genetic resource transaction process outlined vaguely in the CBD. Accessing genetic resources for their use is subject to PIC, enabling the user to obtain permission from the provider. After granting PIC, the provider state and user establish specific benefit-sharing arrangements under MAT.

information about the quality and exclusivity of the provided genetic resources. This information deficiencies may negatively affect ABS or reduce international genetic resource transactions or conservation efforts (Richerzhagen, 2011; Richerzhagen, 2014). The Nagoya Protocol addresses the necessity of identifying the expected benefits, monitoring use, and protecting biodiversity. However, in the early stage of negotiation for granting prior informed consent (PIC) and establishing mutually agreed terms (MAT) the expected commercial benefits have not yet been determined as their market value is estimated ex-ante (Trommetter, 2005), and the protocol presents no specific evaluation guideline.

Thus, this paper proposes an evaluation framework and specific indicators to estimate the expected commercial value from using genetic resources in the biotechnology industry to support equitable ABS by reducing information deficiencies. Most previous studies on genetic resource evaluation attempted to estimate the potential benefits of using genetic resources in breeding to supply desirable agronomic products (Tienhaara et al., 2015). These studies relied on local stakeholders' preferences to determine which genetic resources to prioritize based on the opportunity costs of sustaining certain species using limited resources, such as territory. However, these studies are limited in their capacity to reflect the potential preferences of stakeholders in other countries. Moreover, while the expected commercial benefits stemming from genetic resources in diverse industries are well-known to practitioners and scholars (Ten Kate and Laird, 1999; Laird, 2010), specific indicators to evaluate genetic resources have not yet been proposed, to the best of our knowledge.

We find that using patent information can shed light on how to estimate the value of national genetic resources ex-ante because patents reflect technological innovation and increased market interest (Grupp, 1994, 1998). Thus, researchers commonly use patents to measure the economic and technological importance of a product, service, or technology (Breitzman and Thomas, 2002; Hall et al., 2005). Using the patent portfolio as a proxy, we find potential commercial benefits of genetic resources, focusing on plant types among plants, animals, and microorganisms. Biotechnology industries also use other genetic resources, though we focus on indicators for PGRs because of their importance in agriculture and food security and their observed usefulness in several biotechnology industries.

The remainder of this paper is organized as follows. In Section 2, we discuss relevant studies on genetic resource valuation. Next, we present our evaluation procedure, largely based on previous valuation studies on both genetic resources and patent portfolios. In Section 4, we illustrate our new evaluation procedure applied to national PGRs in South Korea and compare their relative commercial values. Finally, Section 5 provides a conclusion along with a discussion and suggestions for future research.

2. Plant genetic resource valuation

2.1. Related studies

In recent decades, ecosystems worldwide have been losing genetic resources due to climate change and human appropriation of environmental resources (FAO, 1996; Naeem et al., 2012). PGR biodiversity conservation impacts the food and agriculture industries, and thus protecting them has become important.

There are two types of genetic resource values: use and non-use (see Table 1). Use value includes direct and indirect value, such as breeding and recreating genetic resources in the former case and option and biodiversity value in the latter case. Option value reflects the future use of genetic resources (Krutilla, 1967) and biodiversity value reflects the ecological health of diverse species. Non-use value concerns the value of its existence, including aesthetic, religious, and socio-cultural values (Ahtiainen and Pouta, 2011; Rao, 2012). Similarly, Baum (2012) categorized the value typology into intrinsic value and extrinsic value, the former covering indirect and non-use value and the latter relates to direct use value.

Table 1
Types of genetic resource values.

Use value		Non-use value
Direct use value	Indirect use value	
- Productive activity - Use in breeding	- Option value - Biodiversity value	- Existence value (aesthetic, religious, socio-cultural)

The use/non-use value distinction created a framework for estimating the value of PGRs and designing efficient genetic resource conservation programs. Thus, academics and practitioners require information about the costs and benefits of conservation (Artuso, 1998; Wale, 2008). Products use PGRs as inputs for products that are traded in a market, and the contributions of single genetic resources in each product are not readily apparent. Moreover, PGR prices do not indicate their real value (Brown, 1990; Evenson et al., 1998; Drucker et al., 2001). Therefore, PGR value has been assessed through economic analyses such as hedonic analysis, willingness to pay or contingent valuation methods, and option values (Brown, 1990; Evenson et al., 1998; Poudel and Johnsen, 2009; Ahtiainen and Pouta, 2011).

2.2. New ground in plant genetic resource value

The International Treaty on Plant Genetic Resource for Food and agriculture (ITPGRFA) ensures the conservation and sustainable use of PGRs for food and agriculture, along with the CBD. However, although the treaty provides guidelines for PGR conservation and access for food security and encourages benefit sharing through material transfer agreements (MTAs), it neglects PGRs' prominent commercial values obtained from developing chemical compounds in the pharmaceutical industry and enzymes in industrial biotechnology.

The CBD was opened in 1992 for signature at the United Nations Conference on Environment and Development (UNCED) with a focus on conserving biodiversity, using its components sustainably, and fair and equitable benefits sharing from the use of genetic resources. The CBD's 1998 Conference of the Parties (COP) established a Panel of Experts on ABS to define the regimes related to ABS. Furthermore, the Ad Hoc Open-ended Working Group on ABS (WG-ABS) was established at COP 5 in 2002 to develop ABS guidelines, and the WG-ABS proposed the Bonn Guidelines adopted at COP 6 in 2002. The Bonn Guidelines stipulate that stakeholders should participate in the PIC and MAT for ABS and outline the possible monetary/non-monetary benefits. The WG-ABS develops the international ABS regime based on the Bonn Guidelines from COP 7; the final text was delivered in Cali, Colombia, during the ninth meeting of the WG-ABS in March 2010. Finally, the text was adopted as the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization in the CBD. The protocol rearticulates the principles of PIC and fair and equitable benefit sharing/MAT (Nagoya Protocol, Articles 5, 6), with national genetic resource rights conferred upon provider states.

The Nagoya Protocol is expected to have a broad impact on various fields and address issues related to inequitable genetic resource use, such as bio-prospecting. The Protocol also provides a formal process and documents enabling users and provider states to agree upon ABS and propose specific monetary/non-monetary benefits in its annex.