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The implementation of an open source seed approach in *Parque de la Papa*, Peru: Innovation and knowledge from a community perspective

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Author's declaration

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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ABSTRACT OF THESIS submitted by
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Plant breeding and genetic resources are fundamental for agriculture and human existence. Since the beginning of the 20th century different legal regimes regarding breeders' rights, farmers' rights and biodiversity conservation have been implemented worldwide. However, none of these instruments have succeeded in providing balance between the interests of different stakeholders and the protection of agrobiodiversity. In this research I explore through qualitative methods an open source seed model to protect native varieties of plants as an alternative to the dominant legal regime on privatization of seeds. This research studies the potential compatibility and/or conflicts of an open source seed model for biocultural innovations developed by Quechuas' communities in the Potato Park, Peru. It takes into account the different stakeholders' perspectives on knowledge and innovation and the applicable current legislation in the field of intellectual property rights and agrobiodiversity conservation. The research revealed that an open source seed model could potentially be implemented in the Park. However, it is necessary to consider both benefits and drawbacks from an environmental, social and legal perspective in order to define how this model could affect knowledge systems and open innovations in the communities.

Keywords: plant genetic resources, seed legislations, Potato Park, indigenous traditional knowledge, biocultural innovations, agrobiodiversity

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Acronyms and Abbreviations

ABS	Access and Benefit Sharing
BHA	Biocultural Heritage Area
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
CIP	International Potato Center
FAO	Food and Agriculture Organization
INDECOPI	Peruvian Authority for Intellectual Property Rights *[Instituto Nacional de Defensa de la Competencia y la Propiedad Intelectual*]
IPRs	Intellectual Property Rights Regime
MTA	Material Transfer Agreement
Nagoya Protocol	Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization
OSSI	Open Seed Source Initiative
Plant Treaty	International Treaty on Plant Genetic Resources for Food and Agriculture
PPA	Plant Patent Act
PGR	Plant genetic resources
SK	Scientific knowledge
SPDA	Peruvian Society for Environmental Law [*Sociedad Peruana de Derecho Ambiental]*
TK	Traditional Knowledge
UPOV	Union for the Protection of New Varieties of Plants
US	United States of America
WIPO	World Intellectual Property Organization

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1. Introduction

1.1. Problem statement

Plant breeding and plant genetic resources are vital in a world where the population is substantially increasing and where about one billion people are still going hungry every day (FAO, 2015). In order to increase food production, plant breeding activities have been aiming to develop crop varieties that show superior traits for agricultural applications (Arteburn *et al.* 2010). However, at the hand of globalization and industrialization of agriculture more and more breeders rely on the same input of genetic material, or in other words, a few selected genes to exploit them massively and thus "recycle uniformity" rather than take advantage of the existing genetic diversity (Vellve, 1992). The problem with the modernization of agriculture is that genetic diversity is getting lost. Farmers have been pushed to grow fewer varieties in a more intense way, thus, leaving genetic variation and diversity of native varieties aside. In addition, a few powerful companies currently control the world seed sector, which means that the governing seed laws in terms of registration, certification and intellectual property rights (IPRs) have been favoring their interests rather than the conservation of genetic diversity (Vellve, 1992).

Industrial agriculture relies on a small number of specific crop species, and IPRs that restrict access to genetic resources have caused genetic erosion and has diminished the work and improvements that farmers around the world have been doing in adapting seeds to diverse climates and land (Rogers, 2010). "Without variation, some crops may cease evolving effectively and may eventually become extinct" (Aoki 2009, p. 126).

Yet, why is this an important environmental problem worth researching? Why should we care about the conservation of traditional varieties of plants and genetic diversity?

The specific problem that this research is trying to deal with is the global imposition of a dominant IPRs approach on seeds, in which only plant varieties that fulfill the legal and technical requirements imposed by these legislations are considered as real 'innovations,' while all the native varieties that have been conserved and developed through the years by farmers and indigenous communities are only considered as the raw materials that can be accessed for further research and 'scientific innovation'. This situation has been deeply problematic for indigenous communities and small-scale farmers that want to register their native varieties for commercial purposes or want to use protected varieties for breeding activities. Because seed laws require that varieties are distinctive, uniform and stable in order to be eligible for registration or protection through IPRs mechanisms, cultivars bred by indigenous communities are usually automatically disqualified (Kloppenburg, 2014). Furthermore, IPRs laws can restrict traditional practices based on seed exchange and sharing, which has negative impacts in agrobiodiversity conservation, food security and, consequently, constitutes a major environmental issue worth paying attention to.

This research will contribute to the field by exploring the possibility to implement an open source seed system as an alternative approach to the dominant IPRs regime, in which community-based innovations could fit and indigenous communities could be formally recognized as genuine breeders and not only as guardians of genetic diversity. I will argue that an open source approach could contribute to agrobiodiversity conservation in an important center of origin of potato as the Peruvian Andes, the place where I conducted my research fieldwork through qualitative research methods.

1.2. Case study: *El Parque de la Papa*

In order to study the above-stated problem, qualitative research fieldwork was done in the Potato Park in Peru, in cooperation with the Quechua-Aymara Association for Sustainable Communities (ANDES in Spanish), who in the year 2000 brought together six Quechuas communities- *Amaru, Chahuaytire, Pampallaqta, Paru Paru, Quyo Grande and Zaccaca* – to merge their 10,000 hectares of territory to designate a Biocultural Heritage Area (BHA) with the purpose of conserving the region's potato genetic diversity (CIP, 2008; ANDES 2015). The Park is located in the southern Peruvian Andes, in the Sacred Valley of the Incas, at altitudes between 3,400 and 4,600 m above sea level and contains a large diversity of domesticated and wild potato varieties, considered a secondary center of origin of the potato (CIP, 2008; ANDES 2015). According to Western scientific classification, the Park contains around 650 native potato varieties; however, the Quechuas' indigenous people work with a different classification system which is based on their traditional knowledge, "following sub-systems involving taxonomy, local descriptors, and nomenclature that even differs between communities within the park itself, and according to this system they are currently cultivating around 1,344 different varieties of potatoes in the Park" (ANDES, 2016, p. 10).

Three years after the designation of the Park, the communities made an agreement with the International Potato Center (CIP) to implement a conservation project with the purpose of repatriating native varieties of potatoes through a combination of in situ and ex situ agro-biodiversity conservation strategies (Graddy 2013). CIP was interested in seed regeneration and multiplication of wild potato accessions, to compliment ex situ conservation strategies that were done since 1971, when they collected potato genetic resources from Bolivia, Colombia, Ecuador, Peru, Mexico and Guatemala, in order to preserve and prevent genetic erosion and losses, and "to secure worldwide access to these resources, and use them in breeding to increase potato productivity, especially in developing countries" (Huaman et al. 1999). Since then, CIP gene bank achieved to maintain the largest collections of potato and sweet-potato in the world holding over 80% of the world's native potato and sweetpotato cultivars and over 80% of the known species of wild potato (CIP). The agreement with the Park established that CIP would provide potato genetic material so the communities could repatriate hundreds of varieties of native potatoes back to their original fields in the Park (Graddy 2013). The condition was that CIP would respect and maintain the communities' governance system based on customary laws and traditional knowledge. Andean communities were interested in receiving disease free genetic material of potato cultivars and the CIP gene bank was interested in supporting on-farm conservation practices to increase the genetic material available in their collection (Huaman et al. 1999).

The main reason why the Park was picked as the ideal location to conduct this thesis fieldwork was due to the genetic and cultural diversity that it holds and the strong relationship that the indigenous communities have with the NGO and CIP gene bank. Several projects including participatory breeding programs and complementary economic activities including handicrafts, ecotourism, gastronomy and the production of natural products based on the local biocultural heritage, have been implemented in the Park, which helped me understand different perspectives on knowledge systems and innovation and to study the possibility to implement an open source seed approach for the innovations developed by the communities.

1.3. Aims and objectives

In light of the problem definition, and in cooperation with ANDES foundation, my aim was to understand the potential compatibility or conflicts with the open source seed approach and the applicable current legislation in Peru, in the field of IPRs and agrobiodiversity conservation. In order to accomplish that aim, my objectives were to understand how the NGOs and communities involved in the Park currently work with seeds and how the current legislation affects their traditional practices. Furthermore, my objective was also to explore and understand how open source seed initiatives work, and how they could apply to the work that has been carried out in the Park. The hope is that this study will help both the Park and ANDES:

- identify the major issues affecting the protection of their work and innovations,
- understand how an open source seed model could be implemented to improve the protection of these innovations and,
- establish a framework for future research.

1.4. Research questions

In order to achieve the objectives referred above, the following research questions were selected to establish the framework of this study:

1. How do the Quechua communities involved in the Potato Park value their seed-saving traditions and knowledge systems, and how has the situation changed after the designation of the Potato Park and cooperation with the NGO Andes?

2. How do farmers, policy-makers, and the NGO understand innovation in breeding, and how does this intersect with current legislation applicable in Peru?

3. How could an open source seed model to protect biocultural innovations be implemented in Parque de la Papa, under the Peruvian applicable laws, and how might it affect the knowledge and innovation systems of local communities?

1.5. Structure of the thesis

The first Chapter provides the introduction to the thesis by establishing the problem statement, aim, objectives and research question. Chapter 2 will provide an overview of the relevant literature and historical background of the appropriation of plant genetic resources in the Western civilization through the dominant IPRs regime. Chapter 3 will draw the theoretical framework on which the analysis of this research will be based. Then, Chapter 4 will provide the methodology and justification of the research approach and methods used to conduct and analyze the data. Chapter 5 will establish the current legal framework existing in Peru and the implications of the recent seed laws and IPRs laws that are currently being implemented in the country. This will help understand the current debates about the property regimes on living organisms which is the main topic of this thesis.

The last three Chapters (6, 7 and 8) will address each of my research questions. The aim is to portray the results of my fieldwork and at the same time, to analyze and discuss my findings through the lenses of the theoretical framework. Finally, Chapter 9 will provide a broad conclusion of the whole research study.

2. Plant genetic resources and its governing mechanisms

The purpose of this Chapter is to give a brief overview of the history of plant breeding and the appropriation of plant genetic resources over the time. It will also include the historical development of an international legal framework that goes from the restrictive Intellectual Property Rights Regime (IPRs) to the International Agreements in the environmental field and the alternative open source movements. This section will not explore deeply each of the regulations and treaties addressed; however, it intends to show the prevalent discourse behind the justification of the access and appropriation of genetic resources in five different periods: 1) beginning of agriculture to 20th century, 2) The "Green Revolution," 3) Plant genetic resources as "common heritage of humankind," 4) Farmers' rights and biodiversity conservation, e) Open Source movements.

2.1. The beginning of agriculture

About 10,000 years ago our ancestors started breeding plants and developing improved crops varieties for agricultural purposes. Back in time, the entire production and reproduction of genetic resources resided in the farmers' hands: "farmers collected the seeds from their fields after harvest and then used them for the next crop, for feed, for exchange, and for the breeding of new varieties of crops" (Borowiak, 2004, p. 513). Farmers used selection techniques based on the phenotype or physical aspect of the plants. Based on experiments they would select the most adaptive plants, save the seed, and re plant them on the next season (Arteburn *et al.* 2010).

Apart from being self-sufficient regarding their local food production, our farming ancestors had a complex relationship with nature, specifically regarding natural resources appropriation. Agriculture was practiced in a small-scale and, in general, in a more sustainable way, where diversity was valued and successfully preserved for different reasons. In large part this was due to their traditional knowledge and their observation and perception systems, which were used by farmers to select the most valuable crops genetic information to maintain it through the time (Altieri, 2004). Traditional knowledge also involved inter and intra generational community sharing, which was a huge contribution to biodiversity conservation.

With no doubt, agriculture is the base of the modern society. As said before, for many years, peasant farmers and indigenous communities have been contributing to the conservation and preservation of the existent genetic pool by selecting, exchanging and cultivating native varieties of plants. However, even if our ancestors used efficient and innovative techniques to domesticate plants, the genetic aspect of plant breeding was not formally studied until the work of Mendel, which was based on the concept of inheritance and traits (Arteburn *et al.* 2010). It is important to point out that even if Mendel's work dates from the 18^{th} century it was until the beginning of the 20^{th} century when it was re-discovered and used to increase crops productivity and change the way agriculture was practiced.

2.2. The Green Revolution: capitalism and the rise of the IPRs regime

Modern plant breeding practices were implemented in the mid-20th century, when the principles of inheritance promoted by Mendel were re-discovered and applied during the "Green Revolution." Borowiak (2004) points out the importance of this moment saying that it did not only strengthen the modern biotechnological science but that it also brought the belief that technology was the only engine for development and the only way to stop world hunger.

Public agricultural research centers and seed companies started to change the dynamics of food production. With the introduction of modern breeding techniques, instead of selecting different varieties within the mass, the farmer would select the desirable genes of a specific variety and then continue with in-breeding techniques that could be accomplished by forcing self-pollination in order to get high yielding crops (Arteburn et al. 2010). This system was based on genetically uniform high-yielding crop varieties, thus excluding native varieties because of their high heterogeneity and instability. Hence, the success of these agricultural programs put on risk valuable, traditional varieties (Peres, 2016; Lightbourne, 2009).

It is a fact that modern plant breeding techniques alongside with the introduction of fertilizers, pesticides and machinery in the fields, significantly improved productivity in agriculture but it also introduced new issues regarding plants genetic conservation and farmers' traditional practices. Frankel's (1974) view on this topic is that, even if the "Green Revolution" saved millions from starvation, it surely had negative consequences for the environment. Native varieties were not appreciated in this era because of their high heterogeneity, and thus low productivity. However, it was not taken into account the fact that these varieties had a great ability to adapt to different environmental conditions because of their continuous evolution over millennia. Native varieties are irreplaceable because of their genetic richness; unfortunately, as a result of the shift in agriculture practices, the genetic pool of the world has been increasingly narrowed causing severe genetic erosion. Vellve (1992) explains the concept of genetic erosion as the process of replacing diversity for uniformity; or in other words, the reduction in the number of cultivated species and the concentration of breeding efforts on few varieties in order to purify the seed and thus improve the yield and production systems.

Furthermore, Lightbourne (2009) explains that since World War II, farmers became reliant on public breeding centers and private seed companies for the supply of what he calls "quality seeds." Food self-sufficiency and freedom of choice concerning their food production system was restricted by the emergence of the capitalist economies. Lewontin (1998) observes that the capitalist process in the "agrifood" system is related to the transformation of farm outputs into consumer commodities. When the farmers lose control of their labor processes, the product of that labor (the seed) becomes alienated from them.

In this period, the relationship between humans and agriculture changed. With the help of technology agricultural inputs and outputs were turned into commodities. Moreover, a consumerist approach was encouraged to justify the extraction and exploitation of natural resources (Glenn, 2004). Specifically, plant genetic resources started to be valued in monetary terms. Thus, the varieties that were commercially desirable were the ones that were useful for industrial agriculture; in other words, the most adaptive, productive, stable and homogeneous.

With the expansion of the big multinational companies in the ‘agro-biotechnology’ sector and the materialization of modern breeding techniques, the productivity in the agricultural field increased exponentially. Small-scale farming started to be displaced by modern industrialized agriculture, which focused on stable and high yielding mono-crops and the extensive use of chemicals and other external outputs. With capitalism as the driving force of industrial agriculture, and the dominance of science, technology, development and political economy that was shaping the world at the time, collective biodiversity conservation was barely recognized (Borowiak, 2004).

However, despite of the capitalistic efforts to detach the intrinsic cultural value of the seed as the symbol of years and years of work, innovation, experimentation and conservation of genetic diversity, the process of commodification of the seed was still incomplete. The resistance of agriculture to the rapid development of a global, industrialized agrifood system was, in large part, due to biological reasons (Mascarenhas *et al.* 2006). On this topic, Vandana Shiva (2014) accurately points out that due to the regenerative nature of the seed, even technological means failed to prevent the farmer to reproduce their own seed. Precisely for that reason the biotech industry, specifically in the United States of America (US), started to lobby for a legal regime that would protect their investments and profits derived from the seed industry.

Kloppenburg (2014) points out that two paths were needed in order to commodify the seed. The first path involved technical plant breeding methods that would naturally restrict farmers from saving the seed and reproducing the same variety. A hybrid is an example of this naturally protected crops: in order to reproduce the same hybrid, the farmer must have the same parental lines or progenitors, otherwise the second generation would be more variable and thus, would lose yield, therefore forcing the farmer to go back to buy seeds from the seed company (Lewontin, 1998). However, seed companies were still facing the problem that not all varieties had these natural characteristics that ensured natural self-protection, for instance, the soybeans and wheat, which are very important crops from an economical perspective (Lewontin, 1998). Therefore, a second path to commodify the seed was needed, and it had to involve a special legal regime that would be able to protect the 'breeders' rights' and their innovations by maintaining the ownership and control over the improved or altered variety (Lewontin, 1998). This led to the introduction of the first IPRs regime implemented in 1930 in the US: The Plant Patent Act (PPA) and the subsequent treaties and legislations on the field of plant variety protection that would restrict farmers' traditional practices.

The PPA was the result of the strong lobbying from part of seed companies. These companies were investing huge amounts of money in research in order to develop more productive varieties, thus they needed an IPRs regime as a shelter for their innovation and investment on the biotechnology sector (Rogers, 2010). As part of their lobbying strategies, they insisted that they were contributing to the social welfare by improving productivity of crops and consequently by providing more food for the people. However, until now, world hunger has not been defeated; on the contrary, since the moment the IPRs regime was instituted farmers lost sovereignty over seeds and have been facing even more issues regarding nutrition (Kloppenburg, 2010). Parayil (2003, pp. 981,982) affirms that currently "new plants and crops are being developed not to solve problems of hunger and deprivation, but mostly to increase shareholder values of companies that have invested heavily in R&D [research and development] efforts in the biotechnology sector."

Since the PPA act, IPRs took a very important role in agriculture. Many other legal documents, reforms, international treaties, conventions and trade agreements were issued in order to ensure IPRs protection all around the world. In Europe, the Union for the Protection of New Varieties of Plants (UPOV) was implemented in 1961 as a *sui generis* legal framework for IPRs protection. Although UPOV promoted a less restrictive approach, (compared to the US patent system) by introducing the term 'breeders' rights,' it also restricted the farmers' practices by not recognizing them as breeders and instead providing that their practices regarding seed exchange and saving were only an exemption to the breeders' rights (Borowiak, 2004; Kloppenburg, 2010; Aistara, 2012). In that way, breeders achieved recognition for their scientific contribution to the development of improved crops by getting exclusive commercial rights over the genetic material and, as a result, the seed became more and more a commodified object, a product subject to the value given by the market forces. The IPRs not only gave the agrifood companies control over the seeds but also free benefits from the plants genetic material that had been preserved and protected by millions of farmers over the time (Rogers 2010).

2.3. Plant genetic resources as "common heritage of humankind"

The paradox of IPRs is that in order to get high yielding crops, seed companies, mostly located in the global North, need as 'raw material' the genetic resources available from the 'free' gene pool, mostly located in the global South. Developing countries or the global South countries, are usually gene-rich but technology-poor, whereas developed countries often lack genetic diversity in their territory, but have all the means and power to access this diversity from other countries (Odek, 1994). Although this gene pool is the result of many years of work and innovation on behalf of the farmers, native varieties are not subject of IPRs protection, mainly because they are not genetically homogeneous, uniform or stable, and therefore they do not fulfill the legal and technical requirements to be protected by the IPRs regime. Therefore, the patented genetic resources are sold as new and improved varieties to the countries where these the genetic material originally come from. Thus, farmers are restricted to use and save the seed that was produced from the genetic material that they have been preserving and improving for years (Odek, 1994).

The justification used by seed companies to extract genetic resources from developing countries was that these resources were part of the "common heritage of the humankind" and therefore could not be subject of private property (Odek 1994). But then, the same companies would protect their 'improved' varieties through a IPRs regime, not only restricting farmers from re-using and saving the seeds, but also indirectly causing the loss of valuable genetic diversity. Especially considering that these genetic material, or 'raw material,' as it is called has a value per se, even if the utility for industrial or commercial purposes is still unknown (Odek, 1994). Farmers have been making improvements on genetic material over millennia; therefore, it should not be freely appropriated.

"Internationally, Northern capitalist nations and multi-national seed companies have attempted to retain free access to the developing world's storehouse of genetic diversity, while the South has attempted to have the propriety varieties of the North's seed industry declared a public good" (Mascarenhas *et al*. 2006, p. 125). Aoki (2009) refers to this relationship as a genetic interdependence of the global North and South regarding germplasm flows.

The Food and Agriculture Organization (FAO) supported the concept of "common heritage" and in 1983, established a Commission on Plant Genetic Resources as the first permanent intergovernmental forum devoted to germplasm conservation and development (Sullivan, 2004). The Commission's first and most important action was to adopt a nonbinding resolution known as the International Undertaking on Plant Genetic Resources, which sought to ensure that plant genetic resources of economic and social importance, particularly for agriculture, will be preserved, protected and made available for plant breeding and other research purposes (Sullivan, 2004). But the assumption of this whole Undertaking was that, because plant genetic resources were "common heritage of mankind" they should be available without any restriction. "The common heritage principle, however, was obnoxious to many developing countries, whose leaders felt that the principle implied that technologically advanced enterprises could continue appropriating and exploiting a country's natural resources, without compensating the country of origin or even seeking its consent to remove the materials" (Sullivan, 2004, p. 11).

Following the same idea Odek (1994) argues that an international classification of plant genetic resources as "common heritage of mankind" and as a universal resource that is not subject to private property, would only justify the extraction of these "free" resources. Moreover, Aoki (2009, p. 84) contend that "in the intellectual-property context, "common heritage" is a misnomer because it implies common ownership, but resources characterized as such are available for entrepreneurs to use as the 'raw materials' for intellectual property, which is anything but held in common with others."

It is important to understand that in the field of plant genetic resources the typical 'tragedy of the commons' scenario posed by Hardin (1968) do not apply as with other natural resources. The PGRs field has different norms, rules and values that make 'the commons' an inefficient form of property management. Because agricultural genetic resources are in the public domain and have been improved by individual farmers over the time without any sort of private management, they have been also available for private companies to effectively appropriate and capitalize them through the imposition of IPRs (Aistara, 2012). As Chapell *et. al.* (2017) stated, the case of germplasm is different from other public goods due to the fact that the depletion if its availability can be more related to a lack of use rather than overuse.

2.4. Farmer's rights and biodiversity conservation

After the agricultural shift to monocultures and massive exploitation of only few crops, scientists and academics started to be worried about genetic erosion and biodiversity losses. Frankel expressed his concerns in relation to this topic stating that even if the gene pool existent at the time (taking into account that his research was published in 1974) contained a large collection of varieties and crop species, most of the genes preserved have been subject to natural selection, hybridization or genetic drifts having as a consequence several genetic losses (Frankel, 1974).

As a response to worldwide concerns regarding climate change and the threat of diseases and pests as a consequence of dramatic changes of temperature (Montenegro de Wit, 2016), several conservations strategies started to be implemented in different places to prevent future genetic losses. In the beginning these strategies were mainly *ex situ:* genetic material is kept somewhere different than the original environment. These strategies were mainly performed through collection of genetic traits be Research Centers or Gene Banks. *In situ* practices, on the other hand, were not considered as important as ex situ collections.

2.4.1. *Ex situ* conservation strategies

Seed banks or gene banks emerged in the decade of the sixties as a response to genetic losses and as part of the conservation strategies to preserve seeds in repositories and to protect agrobiodiversity against genetic erosions of native or wild varieties (Peres, 2016). Gene banking was seen as the most convenient method of *ex situ* conservation due to the fact that the majority of seeds can survive in dry, cold conditions. Therefore, these banks were able to store the seeds and genetic material in repositories with low temperatures and the necessary characteristics to ensure that the seeds were protected from moisture.

Several gene banks were instituted in the seventies, varying in terms of scope, specialization and storage capacity. The largest public gene banks were the Consultative Group on International Agricultural Research (CGIAR), the International Rice Research Institute in Philippines, and the International Centre for the Improvement of Wheat and Maize in Mexico (Peres, 2016).

The task of the gene banks was to collect genetic resources and conserve the germplasm of seeds, that is to say the genetic material that served as the physical basis of inherited characteristics to be passed on to the next generation of the plant or crop through seeds (Aubry *et al.* 2015). Banks operations included maintaining essential data associated with the genetic resources collected (Leon-Lobos *et al.* 2012). The banks generally organize the resources by crop and geographical area; they contain a “systematized representation of the variation at the genetic level, and within crop populations" (Peres, 2016, p. 98). The main objective of these banks is to preserve the variation at the genetic level through storage of genetic material (Peres, 2016).

According to Peres (2016) there was a common interest to preserve genetic diversity in the international community. Seed banks saw this opportunity and start offering an alternative way to access crop diversity and at the same time to protect and preserve genetic material through ex situ collections. Peres argued that gene banks were implemented with the utilitarian perspective of having access to a diversified gene pool for unpredictable future requirements. However, these practices started to be questioned in many ways. On the one hand, ex situ collections were seen as an urgent measure to avoid more genetic erosion and, as Frankel (1974) pointed out, gene banks represented a conceivable solution that would promote the creation evolutionary records of a crop in the form of a seed. On the other hand, other authors expressed their concerns in this topic, arguing that gene banks in general were not the ideal solution for the preservation of genetic material. Bennet (1968), for instance, expressed his concern regarding genetic material stored in a bank saying that if you take out the resources from the environment where they have been interacting for years, you would stop the natural evolution of these resources. He claimed that seeds also required cultural or biological context in order to be adequately conserved.

However, nowadays seed banks constitute approximately 90% of contemporary gene bank holdings (FAO, 2010) and ex situ strategies continue to be the most supported in financial terms, from several governments, foundations, and private sector (Montenegro de Wit, 2016).

2.4.2. *In situ* conservation strategies

As stated before, in situ practices for conservation were not considered as relevant as ex situ practices. Frankel (1974) explains that it was difficult to preserve traditional varieties in situ due to the rapid shift of agricultural practices to modernization and consequently, traditional farming systems were slowly disappearing. The author explains that there was a social and economic impossibility to protect traditional cultivars in situ, mainly because farmers where already pushed to cultivate high-yielding varieties and it would have been difficult to push them back to abstain from cultivating these varieties for the sake of continuing to grow landraces.

However, after the signature of the Uruguay Round of the General Agreement on Tariffs and Trade in 1994, many organizations and groups representing farmers and indigenous communities started to express concern about food security and cultural autonomy (Desmarais, 2008). Issues regarding dependence of farmers on the new improved seeds, control of food production by few companies and biodiversity loss were also exposed during this period (Borowiak, 2004). Therefore, the role of indigenous communities in conservation of wild biota or traditional species started to be valued as an essential part of in situ genetic conservation. Likewise, practices involving traditional knowledge and informal seed supply systems where exchange of seeds took place (sometimes as a simple barter o even as a gift to the neighbor) started to be recognized as an important contribution not only to biodiversity conservation but also to the preservation of a social network that implicitly protects genetic resources and biodiversity (Montenegro de Wit, 2016).

2.4.3. The CBD and Plant Treaty

The term 'farmers' rights' was introduced in the international arena as a way to recognize farmers' contribution to genetic biodiversity (Borowiak, 2004). According to Borowiak (2004) the concept can be traced to debates over biodiversity at the United Nations' Food and Agriculture Organization in the late 1970s and early 1980s, when developing countries started questioning about the proprietary system, which allowed multinationals to freely access to the genetic resources of other countries, to then go back and collect royalties with the help of the IPRs legal mechanisms.

The main point of the recognition of the farmers' rights was to implement a legal framework that would counterpoint the IPRs protecting breeders' rights and that, theoretically would allow farmers to receive compensation or benefits for their biodiversity conservation practices (Aoki, 2009). Through several political negotiations in 1992, the United Nations hosted the Earth Summit in Rio de Janeiro and adopted the Convention on Biological Diversity (CBD) with the specific objective of biodiversity conservation, sustainable use of resources and fair and equitable sharing of the benefits from the utilization of genetic resources (CBD article 1). With the implementation of the CBD, the concept of 'common heritage' to refer genetic resources ended and shifted to 'common concern of humankind.' The Convention also emphasized that the nations had sovereign rights over their natural resources, therefore, the access and extraction of these would require permission of the nation where these resources were located (Sullivan, 2004). Thus, there was a clear difference between the CBD and the FAO Undertaking; while the CBD allowed governments to impose conditions and controls over the access of natural resources, the FAO Undertaking promoted the common heritage principle in which no restriction to access was established (Lightbourne, 2009).

Lightbourne (2009) explains this shift of perception saying that developing countries became aware of the market value of their biological resources. The fact that 80 percent of the world biodiversity resided in developing countries and that 90 percent of commercial seeds (controlled by the industrialized countries), used germplasm that could be traced to the genetic material developed by farmers in developing countries, helped to change the international perception of traditional varieties and farmers' in situ conservation practices. As Borowiak (2004) argued, it was simply unfair that farmers were not getting legal recognition for their contribution to the preservation of genetic resources.

Even if the CBD did not focus explicitly on plant genetic resources for food and agriculture, it addressed general concerns related to biological conservation in the world (Aoki 2009). Finally, traditional seed collection was recognized as an important activity for biodiversity conservation. According to Odek (1994) the provisions of the CBD showed an international agreement of reciprocity where countries would sacrifice a portion of their profits to conserve natural species by recognizing farmers' contribution and sharing their benefits derived from the utilization of genetic resources. However, this recognition was only in the 'moral' or 'good faith' sense. In other words, even if the CBD provided that developing countries were entitled to receive a share in the benefits derived from biotechnology it did not provide any mechanism to implement this sharing. "Reactions to the CBD in the international community were mixed. Some nations hailed the Convention as a long-overdue measure of partial justice for developing countries. For some observers, the CBD seemed to raise as many questions as it answered, since many of its provisions are conceptual in nature, and it fails to provide practical guidance on how to achieve specific results. Others have criticized the Convention for its 'circularity,' in assuming that simply declaring that sovereign rights and mandatory benefit-sharing are consistent with intellectual property rights makes them so" (Sullivan, 2004, p. 13).

The CBD did not provide legal mechanisms to enforce the benefit sharing and thus, left many questions unanswered. Therefore, even if there was more environmental awareness, there was still the need to have a binding agreement specifically to regulate issues regarding seed access and exchange (Lightbourne, 2009). The FAO helped reaffirm, in the international venue, the right of the farmers to have benefits from the contribution they have made over the years. In 2001 this International Organization approved an International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty), which entered into force in 2004, and had as main objectives: a) to encourage conservation of plant genetic resources; b) to provide access to PGR for food and agriculture; c) to provide fair and equitable benefits to farmers by creating the Multilateral System of Access and Benefit Sharing (Sullivan, 2004).

For the first time there was a legally binding international agreement that explicitly recognized the term of "farmers' rights" as the precondition for the maintenance of crop genetic resources (Scurrah, 2008). "There is also wide agreement that retaining biodiversity is valuable for the global community, perhaps intrinsically, but also in terms of providing resources for further innovation and in terms of protecting against genetic vulnerability" (Borowiak, 2004, p. 524). In theory, with this convention the farmers would be entitled to receive compensation from an international genetic conservation fund, or Multilateral System, to be administered by the FAO (Aoki, 2009).

The Plant Treaty also contemplated a Material Transfer Agreement (MTA) as the mechanism to share benefits arising from the commercialization of products accessed form available plant genetic materials from the Multilateral System (Sullivan, 2004). With the MTA and the Multilateral System farmers would be protected from any form of intellectual property rights or any limitation to access to their resources for food and agriculture. The aforementioned is stated by article 12.3.d of the Treaty: “Recipients shall not claim any intellectual property or other rights that limit the facilitated access to the plant genetic resources for food and agriculture, or their genetic parts or components, in the form received from the Multilateral System.” However, it is still uncertain if this restriction will reach only the material on the received form, or also the derivatives of such material, or even to the possibility of isolating and patenting the gene; but at least is clear that the material in the received form will remain available for use (Sullivan, 2004; Fowler, 2003).

Another important thing to say is that, under the Plant Treaty, each Nation was obliged to protect farmers’ right but free to choose the measures that considered appropriate to their own needs. The problem is that the Treaty did not give particular directions for the Nations on how to protect farmers’ traditional practices. Moreover, even if in the Plant Treaty was stated that there was no intention to oppose the IPRs regime, some provisions could still be contradictory to IPRs laws. In these cases, the interpretation has been that the IPRs legislations would remain unaffected in case of contradiction (Sullivan, 2004).

Lastly, in 2010 the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (Nagoya Protocol) was adopted as a supplementary agreement to the CBD. This Protocol has as a main objective to set an international, legally binding framework to promote an effective implementation of the “access and benefit sharing” (ABS) concept at the local, regional and national level, in accordance to the third objective of the CBD which focus in the fair and equitable sharing of the benefits arising out of the utilization of genetic resources as a prerequisite for biodiversity conservation and sustainable use of resources (Greiber *et al.* 2012). The reason why it was considered necessary to negotiate this Protocol was that since the CBD adoption, the most controversial and unclear issue was the ABS regime, its scope and implications. However, according to Greiber *et al.* (2012) since the CBD there has not been an efficient implementation of the ABS regime.

2.5. Open source movements

The main problem with all of the mechanisms provided by the different international legislations stated before is that they were mostly based in a market system in which private bilateral agreements had to be made in order to ensure a fair balance between farmers and breeders’ rights, and access and benefit sharing. Hence, it has been difficult for the countries in the Global South to implement these regulations and policies, mainly due to the reason that farmers’ practices and contributions to genetic diversity will not always be compatible with this market system or the supported IPRs regime.

Even if the ABS regime provided by the Nagoya Protocol had the aim of answering questions led by the CBD, there is still a debate on several topics regarding the implementation of the regime. For instance, who should receive the benefits from the utilization of genetic resources if there has been a collective participation on the breeding activity? How should these benefits be calculated? According to Kloppenburg (2014) the effort to recognize farmers' rights, either through the CBD, the Plant Treaty or other bilateral agreements has not been successful. The same author suggests that these instruments have all failed in providing significant benefits to the farmers, and on the contrary, have caused social disruption in the communities.

As an alternative to the IPRs regime, to the bilateral agreements proposed by the Plant Treaty, and to all other mechanisms based on property rights that tend to separate farmers from the autonomous reproduction of the seeds, the Open Source Seed Initiative (OSSI) was launched in the US by a group of public plant breeders, private breeders, non-governmental organizations and sustainable food system advocates (Kloppenburg, 2014). Inspired by the open source software movement this initiative encourages the principle of sharing rather than privatizing; it promotes a developing a community of users and contributors with no restriction for further breeding.

OSSI is based in a platform for germplasm exchange where cultivars are released under the 'OSSI Pledge' which means that they can be freely used for any purpose on the condition that all derivatives of the seeds (and the seed itself) retain the same freedoms. However, it is important to say that this pledge do not work as a license that can be legally defended, but rather in the terrain of moral norms and ethics (Kloppenburg, 2014). Therefore, OSSI-Pledged seeds can be used, sold, shared, or reproduced as long as the derivatives from those seeds carry the same freedoms (Lubby *et al.* 2016). This initiative advocates a "mechanism for germplasm exchange that allows sharing among those who will reciprocally share, but exclude those who will not" (Kloppenburg, 2014, p. 13, 14). The way this system works is simple; the plant breeder releases a cultivar under the OSSI Pledge and has the option to make arrangements with a seed company that is interested in selling the cultivar. Of course, these arrangements can include monetary royalties but would never limit the further use of that seed (Lubby *et al.* 2016). In that way, community seed saving and germplasm exchange is preserved. The farmer or the breeder receives the packet of seeds which contains a printed Pledge with the following statement:

> *"This Open Source Seed Pledge is intended to ensure your freedom to use the seed contained herein in any way you choose, and to make sure those freedoms are enjoyed by all subsequent users. By opening this packet, you pledge that you will not restrict others' use of these seeds and their derivatives by patents, licenses, or any other means. You pledge that if you transfer these seeds or their derivatives you will acknowledge the source of these seeds and accompany your transfer with this pledge" (OSSI).*

The founding member of the movement, Kloppenburg (2014), addresses the need to recreate a 'protected commons' instead of the open-access commons used by the companies as a justification to freely get genetic resources. This means that the plants genetic materials released under the OSSI-Pledge will not be freely available to everyone in the form of 'raw material' for further research and IPRs protection. It is rather a space or a network to trade free seeds and at the same time to maintain an open access to genetic resources worldwide ensuring that the seed that is already freed will always be freed.

As said before, OSSI follows the open source principles that started with the free software movement. The objective of open source is to allow users to access and modify the code (in the case of software) without restricting others to benefit from the improvements achieved. Besides, it provides a legal framework that ensures access to the original source and subsequent modifications (Kloppenburg, 2014). "Following open source principles, OSSI seeks to maintain fair and open access to plant genetic resources worldwide to foster innovative plant breeding, develop productive and resilient cultivars, and provide an alternative to other forms of IPR" (Lubby *et al*. 2016, p. 3, 4).

Open source mechanisms have the objective to make a balance between community-sharing scientific developments. According to Lubby *et al.* (2016) there is an economic incentive for breeders to participate in the open source movement because it provides marketing strategies directed to those who are interested in purchasing or selling open-source seed. Open systems rely on non-market based incentives, both extrinsic (such as enhancing reputation and developing social networks) and intrinsic (such as creating a sense of social belonging). Additionally, it considers monetary rewards and recognition for the innovative practices performed by the breeders (Lubby *et al.* 2016).

3. Theoretical Framework

3.1. Overview

The purpose of this Chapter is to outline the theoretical framework used throughout this study. Three main sections will form the structure upon which this Chapter and the rest of this research will be built on. In order to understand the approach that I will be using according with the three objectives introduced in the first part of this study I will start the first section by addressing the concepts of traditional knowledge (TK) and scientific knowledge (SK), as different 'knowledge systems,' each of which has emerged from its own set of conditions and assumptions. In the next section I will address perspectives from different authors on the concept of innovation, including the concept of 'biocultural innovations' which will be the one that I will be using throughout the analysis section of this research. The purpose of the last section will be to interrelate the main concepts used. For that, I will outline some of the theory on alternative property rights regime for innovation systems in the field of plant breeding, which may respond to the limitations portrayed by the existent dominant IPRs regime on knowledge and innovation. This framework will allow me to introduce the concepts that will be used to analyze the results of my research.

3.2. Knowledge systems

What is 'knowledge' and who are the knowledge producers? Why is it important to define? According to the Oxford Dictionary, knowledge is defined as: "facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject." This definition seems to be clear and simple, however throughout human history there have been different approaches and perspectives on the meaning of knowledge and a vast literature on the topic. Nevertheless, in this section I will be more precise and talk about different 'knowledge systems,' where we will contrast TK with SK.

Why am I making this separation? It is a fact that from a Western perspective, knowledge has been more related to science than any other source of learning, creating and understanding, especially since the emergence of modern sciences or scientific and technological revolutions in the late 18^{th} century (Capel, 1989). I do not attempt to state that the Western view is the unique frame of reference to define these concepts, however I acknowledge the fact that this is the view that dominates the present world. Along the same line of reasoning, more recently some authors have started to question the domain of science in knowledge production and the whole Western perspective of this concept. Bruno Latour (1987) started questioning the way modern society understand nature (and consequently, produce knowledge from this starting point), which has been mainly through the practice of natural sciences. According to him, the process of producing knowledge by modern society has been through a separation of 'nature' and 'society,' where no one questions the methods of producing science from an outsider perspective: "… what they say about their trade [scientists] is hard to double check in the absence of independent scrutiny" (Latour, p. 15). Furthermore, science scholars have the notion that scientific knowledge does not simply represent nature but also the social interests of people and institutions; therefore, the task, according to scientists, has been to uncover or reveal this interest wrapped up in knowledge (Hayden, 2003, Latour, 1987).

In the 1960s and 1970s, knowledge and technology systems were an important part of the Science, Technology and Society (STS) studies; however, in the 1980s, other social studies like anthropology, postmodernism, feminism and environmentalism, started to gain recognition and thus, different knowledge systems started to be recognized as ways of understanding the world, not necessarily by the means of science (Watson *et. al.* 2005) However, according to Watson *et. al.* (2005), in this past cross-cultural works, scholars were still referring to the Western 'rationality' and 'scientificity' as the bench mark criteria to define and evaluate what knowledge systems were. This is when the concept of TK started to be used and disseminated. Hayden (2003) criticizes the politically convenient introduction of this concept to refer different knowledge systems, by saying that this is part of the 'knowledge economy' and the 'capitalization of knowledge.' She contests the aforementioned saying that since TK (together with the concept of biodiversity) became global concerns (or as I stated in the previous Chapter: "common heritage of the humankind") they have been extremely politicized, to the extent that every single thing has to be inscribed and has to fit in categories with specific accountabilities, social relations and potential property claims.

This is part of what Nadasdy (1999) calls "integration of knowledge" to science. According to this author there has been an attempt to integrate TK to SK knowledge system, but so far this has not been successful for two main reasons (or excuses, as he points out). First, there is a technical obstacle when talking about two different types of knowledge systems that are incompatible: whereas TK is qualitative, intuitive, oral and holistic; science is quantitative, analytical and literate. Second, because there is an assumption that TK is already lost but the use of the concept is politically convenient to get communities' support when needed:

e.g. for different environmental or resource management projects. Moreover, Hayden (2005) has contested the way TK has been used and collected as a codifiable thing and as an object to serve specific scientific purposes. According to Nadasdy (1999) even when recognizing the existence of TK as a different knowledge system, it has been implied that aboriginal culture is static and therefore people cannot adapt to new conditions without abandoning their TK; when in reality these people might possess distinct cultural perspectives on modern industrial activities that has been disregarded.

However, in order to understand the concept of TK we have to first define the concept of 'traditional.' According to Morrow *et al.* (1992) this concept has been mainly used and understood by people that in fact do not possess TK. As a consequence, this has given scientists the power to decide and judge what is "authentic" or "non-authentic" and to dismiss practices or local beliefs that do not serve determined scientific or political purpose. While Western thought draws a clear line between nature/humans, scientific knowledge system/any other knowledge system; indigenous people may not have these distinctions. For these people knowledge can be a way of life, "… not simply as a product of the human intellect, but as one aspect of broader cultural processes that are embedded in complex networks of social relations, values and practices which give them meaning" (Nadasdy, 1999, p. 5). The result is that the hegemonic Western culture has imposed the standards of relevance to decide what TK is, assuming that this TK is frozen and can be codified and SK is devoid of context.

In this work I will use the concept of TK as a parallel knowledge system, which has emerged from different conditions and circumstances than the Western SK. I will also use the concept of TK in the broader sociopolitical process in which knowledge is embedded.

As Goldman *et al.* (2011) accurately point out: TK (nor SK) cannot be distinguished from the social activity that constitutes its production and circulation, meaning that we cannot ignore the whole knowledge-production process that in every knowledge system has been shaped through social, economic and political agendas.

3.3. Innovations

In the same way that the Western society has tried to fit what is called TK in a square box containing categories with codifiable knowledge, the concept of 'innovation' has also been shaped so it could fit into the dominant property regime, specifically the IPRs that I referred in Chapter 1 of this research. Now, in order to explain the concept of innovation, it will be important to emphasize the Western separation of nature and culture that I explained in the previous section. According to the IPRs regime in order to be eligible for a patent or any other kind of IPRs in this field, there must be a proof that the individual creator produced something 'new' and 'useful' for humanity. Yet, as Van Dooren (2008) questioned: how much 'intervention' on the part of humans makes something 'unnatural' enough to be protected by IPRs (of plant genetic resources)? Who will determine what is 'enough' human intervention to remove something from the sphere of nature and produce something 'new' that can be legally protected? On this issue, Ingold (2000) argues that, actually, when referring to genetic resources, there is nothing that is strictly human made.

At this point it will be important to differentiate two models of innovation: a) the traditional model, which is related to scientific knowledge and IPRs, and b) the open or social model, which has been identified with the open source movements described in Chapter 2. On the scientific model, Latour (1987) points out that SK not only produces the artifacts of science but also their utility, meaning that scientific innovations have been shaped to serve specific industrial or commercial purposes for humanity. In the case of new varieties of plants, scientific innovations work under certain specific conditions: for instance, the use of a laboratory or the application of molecular markers to identify a particular sequence of DNA. Science has its own conception of when an innovation is produced, which actually fits perfectly with the concept used by the IPRs regime. This is what Van Dooren (2008, p. 682) calls "the rhetoric of invention" which is built upon the concept that a person works on nature, and not within nature. Due to the fact that, from a Western perspective, objective nature is divided off from subjective culture, it has been considered that it requires an expert or a scientist to translate or intercede between 'reality' and 'humanity' to have an innovation (Latour, 1993; Van Dooren, 2008).

Yet, what happens to all the genetic information that has been preserved by farmers and indigenous communities around the world for thousands of years? On this topic, Kloppenburg (1991) argues that even if farmers and indigenous communities have produced genetic and cultural information over millennia, these innovations and TK has not been valued as eligible for IPRs protection despite the recent explicit recognition of their utility. Thus, not only these people have not been considered genuine inventors but, on the contrary, their work has been classified as a "natural" part of evolution (Van Dooren, 2008). The logic behind the IPRs regime is that neither the TK that peasant peoples and indigenous communities keep, nor the traditional varieties of plants that they breed, are patentable because they generally do not fulfill with the legal requirements of being novel, distinct, uniform and stable (Salazar *et al.*, 2007). The irony is that, when this knowledge and information are processed and transformed in developed nations it is then considered an innovation in terms of IPRs and can be legally protected and even enforced with the mechanisms provided by these laws. As Latour (1987) points out, all knowledge systems, including SK, is constructed upon previous knowledge systems and practices, therefore, all these innovations should be equally protected and analyzed and potentially protectable.

In recent works more authors have been talking about a new model for innovation, which has been identified with concepts like 'open innovations,' 'social innovations,' 'distributed innovations,' or, in our case 'biocultural innovations.' The term of 'open innovation' was first used by Chesbrough, (2003) to identify different sources of ideas, that could come either from inside or outside the firm, and could be taken to the market through different paths. Moreover, Gabison *et. al.* (2014, p. 19) use the term of 'social innovation' to refer to "new ideas, institutions, and innovation processes that meet societal needs through new forms of civic participation and collaboration." Within this category the authors also identify 'distributed innovation' as the model of innovation consisting of "transparent communications, collective decision-making processes, distributed actions and voluntary involvement." All of these elements are important for an open source approach to innovations, where the objective is to offer solutions with social impact that will help empower people who will, at the same time, benefit from the innovations. As a consequence, these people, as users, become active co-creators and beneficiaries of innovative and ad-hoc solutions that will be developed with greater possibility of success (Gabison *et. al.* 2014).

In consonance with the concepts described before, the organization ANDES introduced the concept of 'biocultural innovations,' specifically to identify "the interaction among the components of biocultural heritage (traditional knowledge, biodiversity, landscapes, cultural and spiritual values and customary laws), or the interaction between traditional knowledge and science." (ANDES, 2016, p. 7). Although this concept is part of the open and social approach to innovation, it encompasses additional elements that fit better in the field of agrobiodiversity and seed systems than the concepts of open innovation used by the authors referred above. To exemplify this concept ANDES presented a study (ANDES, 2016, p. 8) were they identify 31 biocultural innovations in the Park:

- *18 technological innovations (e.g. shifting the range of potato cultivation, community seed bank, seed and knowledge exchange).*
- *4 market innovations (e.g. the development of Potato Park micro-enterprises for biocultural products and tourism).*
- *9 institutional innovations (e.g. the Potato Park Association for collective governance of the park, an inter-community benefit-sharing agreement and inter-community groups of potato experts and community researchers). The repatriation agreement with CIP has significantly increased the gene pool for climate adaptation.*

For this reason, this concept will be used in the analysis section of this study. Finally, it will be important to define the concept of community that will be used to determine the existence of these 'biocultural innovations.' For that, it will be taken the position of West *et. al.* (2008), who contend that even if most of the literature on open innovation refers to a network of firms that share technology, there can be non-firm actors that participate in the innovation process from a community-based model. They define community as a "voluntary association of actors, typically lacking in a priori common organizational affiliation (i.e. not working for the same firm) but united by a shared instrumental goal -in this case, creating, adapting, adopting or disseminating innovations" (West *et. al.* 2008, p. 224). Accordingly, it will be considered that in order to have a community-based innovation it is important to determine if there has been knowledge transfer and sharing between the members.

3.4. Alternative property rights regimes

This final subsection will show the interaction between the concepts that I explained before and the alternative property regimes proposed by several authors. So far, I have portrayed two main branches of thought: The Western-rationale vision of knowledge and innovation, which is compatible with the dominant global IPRs regime; and an alternative vision with different understandings of knowledge and innovation. Figure 1 illustrates the interrelation of the aforementioned:

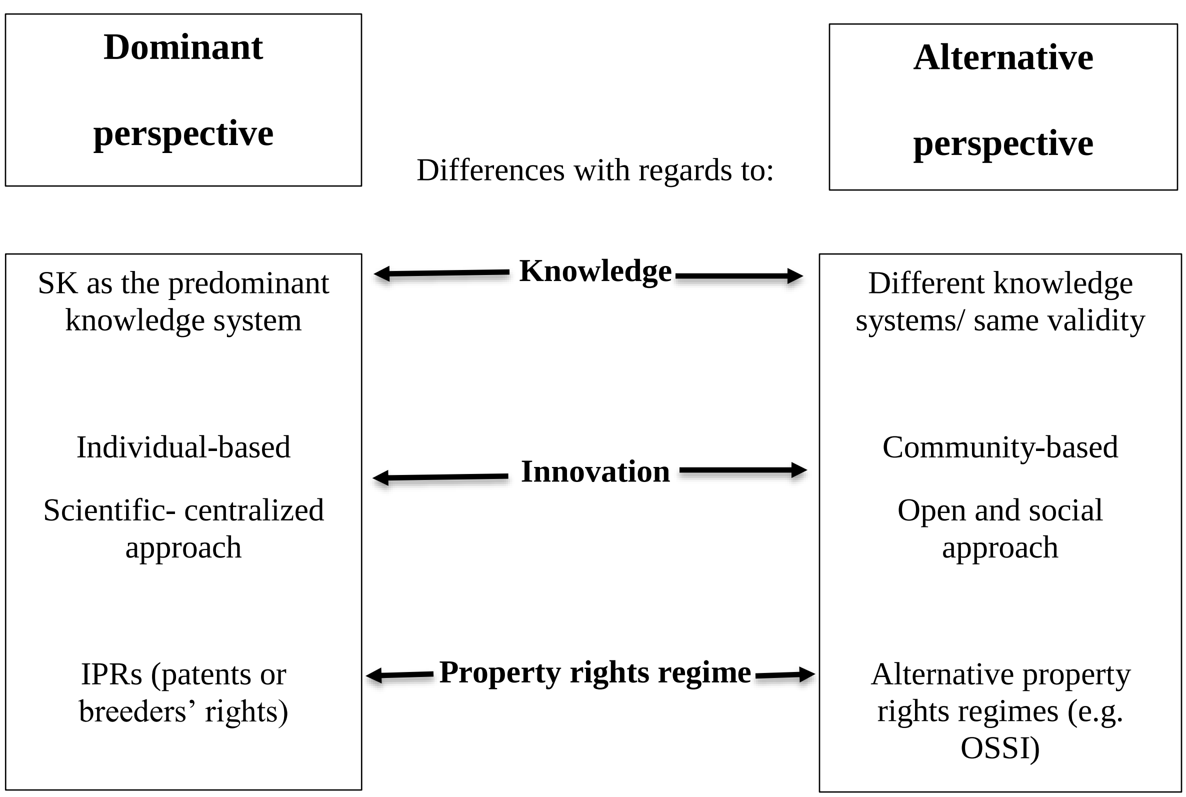

Figure 1. Interaction between concepts

Nevertheless, what is intended in this research according to the objectives and theoretical framework, is to show how intellectual property regimes might affect relationships of knowledge systems and innovation surrounding seeds and communities, and how might alternative IPRs shift those relationships. Taking into account that the dominant centralized IPRs regime only recognizes specific types of innovations as being genuinely creative or inventive, and this is directly related to the production of scientific knowledge, Hayden (2003, p. 24) contends that there are some limitations of the logics of IPRs as a mode of protection for indigenous communities, which may have a different view on what is knowledge and innovation. She argues that patents exclude any other type of innovation because they grant property rights to individual inventors that develop something from the "natural state." She continues saying that the idea of putting boundaries between "the already existing and the privatizable realm of novelty and innovation" has been very politicized by corporate entities. Furthermore, Halpert *et al.* (2017, p. 4) pertinently question whether IPRs really incentivize innovation or rather enclose the pool of knowledge more than they are giving back to humanity. Furthermore, the authors argue that global IPRs system tends to decrease diversity and "…thus, limit usefulness and adaptability of our future seed supply…"

Due to these limitations several authors have explored the idea of an alternative property rights regimes in the field of wild varieties and plant genetic resources that have been preserved by indigenous communities and peasants' farmers with the use of TK. This has opened up the idea of an indigenous property rights regime where these people become participants of this new global knowledge economy (Hayden, 2003). Some of the authors have thought about extending the IPRs regime to wild varieties, however Van Dooren (2008) argues that the extension of IPRs to protect farmers is problematic in practical terms due to the complexity of allocating rights and determining how these communities will enforce these IPRs regulations in a global market. Therefore, he proposes a middle ground solution that would let farmers save and exchange the seed only when there is no commercial purpose; thus, using the existent IPRs regime but making it less restrictive. Although he recognizes that even if in this case farmers' rights would not be recognized as property rights holders, at least there would be a legal solution that would allow them to keep their traditional practices.

On the other hand, Elkin-Koren (2005) refers to the "private ordering and self-regulation" voluntarily taken by parties to allow individuals to find a way to avoid or protect themselves from the protectionist and restrictive IPRs regime. Even if the author recognizes the need to have some sort of license agreements under this system it is stated that these agreements would have to contain more generous terms that would enable access and sharing of information. This would be the case for an open source seed approach as an alternative property rights system that would be a solution to protect non-scientific innovations. In their study, the authors Halpert *et al.* (2017), contrast the centralized contemporary IPRs regime for plant breeding to the decentralized *in situ* breeding systems, stating that even if centralization often offers good results in terms of new, resistant varieties of plants, it does by encouraging homogenization and therefore eliminating biodiversity. On the contrary, decentralized breeding systems (e.g. Participatory Plant Breeding) that allow access and freedom to use genetic resources could provide a better solution to the problem of genetic erosion and may be deal better with the complex relationship between nature, culture, traditional knowledge and alternative property rights regime (Desclaux *et al.*, 2012; Halpert *et al.* 2017). This would depend on how these alternative property rights are instituted in practice; different factors would have to be also taken into account.

To conclude, in this research I will use the theoretical assumption that the concepts of innovation and knowledge can be interpreted in a different way than the one used by the dominant IPRs regime. From my point of view, there are diverse knowledge systems and traditions that might not be able to be quantified or codified, but are equally valuable as the scientific knowledge. Likewise, innovation can be the result of a larger, interconnected system that includes a social and political context, traditions and conservation practices, and also a biocultural community-based approach. For that reason, the concept of 'biocultural innovations,' as shown in Figure 2, will be the most compatible to the various solutions presented by alternative property rights systems like the open source seed initiative referred in Chapter 1.

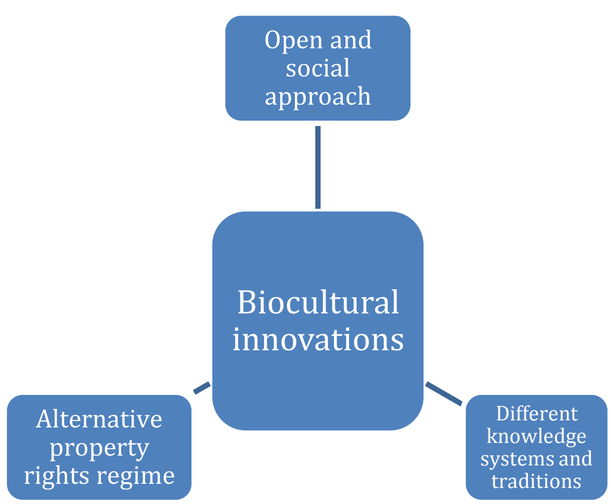

Figure 2. Biocultural innovations

4. Methodology

This thesis is based on qualitative research methods, as it was considered the most appropriate and advantageous in regards to my research questions, my aim and objectives. Through qualitative methods the researcher intends to understand and identify phenomena and perspectives with the aim to explore and explain further ideas and theories from the data gathered (Styśko-Kunkowska, 2014). As Mishler (1986, p. 112) advocates, the purpose of this type of research is not to determine a "singular and absolute truth" but to assess "the relative plausibility of an interpretation when compared with other specific and potentially plausible alternative interpretations." Accordingly, the aim of this study was to get answers to questions by understanding the experience and perspectives of other people, and the meaning they make of these experiences (Seidman, 1998).

Hence, the data analyzed was the result of interviews, conversations and participant observation carried out during 4 weeks in Cusco and 5 days in Lima, Peru. There are important reasons why I chose Peru, and specifically the Park, as the site to conduct my research. First, Peru is a gene rich country, being one of the world's major centers of origin of plant genetic resources, specifically center of origin of one of the most important crops in the world: the potato. Second, Peru is member of the most important international treaties in the field of plant genetic resources; for instance, the FAO Plant Treaty, CBD, and Nagoya Protocol. Finally, the reason why I specifically chose to conduct my research in the Park, which is located in the southern Peruvian Andes, is because I wanted to work and learn from indigenous Quechuas' communities. Apart from being rich in agro-biodiversity, Peru is a multiethnic and multicultural country where the indigenous communities still conserve ancient farming practices and TK coming from the Incas ancient civilization. For these reasons, I contacted Alejandro Argumedo, the director of the NGO called ANDES, organization that has been working with indigenous communities in projects related to *in situ* conservation of traditional Peruvian crops since 1995. When I explained my research proposal and my interest in conducting my study in the Park, he agreed to help me with my project by providing a place to work in the NGO offices, which were located in Cusco. He also helped me devise my research questions so the study could be useful for my thesis and at the same time for the NGO and the Park. In addition, the NGO helped me with the logistics regarding the visits to the Park (located 40 km from Cusco) and Alejandro also put me in contact with different experts in my topic, including academics and policy-makers in Lima, so I could plan interviews with them for my days in Lima.

4.1. In the field (data collection)

In order to answer my research questions and achieve my aim and objectives, I first considered the theories developed around the concepts of knowledge and innovation as central part of this study. However, I used the grounded theory methodology as the strategy and design of this study. According to this methodology as a researcher you intend to develop theories grounded from the data gathered and analyzed in the social research (Glaser *et. al.* 2009), thus, I followed what came out of my data to choose theories that would be most applicable to what I found on the ground. Because the purpose of this research is to answer questions regarding both indigenous people and policy-makers' perceptions of the concepts referred in my theoretical framework, I considered that qualitative research was the most adequate and efficient way to get the required information while contending with human complexities and difficulties of empirical situations in the field (Glaser and Strauss 2009). I chose the semi-structured interviews with open – ended questions because I was interested in knowing people's point of view and not specific concepts and particular resources or questions that would induce them to talk only of certain aspects (always taking into account my own bias and Western perspective of the same concepts that I am analyzing). Thus, my priority was to let my interviewees talk broadly about all the matters they felt appropriate or adequate with my questions, and what they felt was the most relevant to express.

My primary data was gathered through semi-structured interviews, in-depth conversations and participant observation during 35 days of fieldwork. Secondary data was gathered from document analysis provided by the NGO and a meeting with the Peruvian Ministry of Agriculture, in Lima. During my 4 weeks' stage in Cusco I worked at the NGO office where I constantly had informal conversations about my topic with three members of the staff of the organization. ANDES has one main office in Cusco and is currently working in two main projects: Potato Park and Lares. Three members of the staff work directly in the Park and they visit it approximately twice per week. I was able to conduct two formal interviews with two of them in one of our visits to the Park. I also visited Lares once, where I had informal conversations about the aims of the NGO with three other members of the staff. I planned the semi-structured interviews to conduct in the Park, and with the help of the staff of the NGO I was able to conduct 6 interviews with the different technicians representing the different communities in the Park (6 technicians out of 8). I went to the Park 6 times and on my sixth visit I stayed in the community of *Amaru* with the family of one of the technicians in order to gain additional on-the-ground knowledge and to experience their way of living, not only from the perspective of the technicians but also from the rest of the community. During my visits I worked in the harvesting activities before and after the interviews and therefore I was able to achieve meaningful participant observation. Field notes were taken at the end of each working day and also while recording the interviews and other informal conversations.

Additionally, I carried out documentary research in order to understand and analyze Peruvian national legislation on seeds, traditional knowledge and breeders' rights. As a primary document from the NGO I analyzed the Community Agreement (*Acuerdo interinstitucional)* of the Park, where communities consent on several issues related to benefit – sharing from the lucrative activities carried out by the Park. I also analyzed several legal documents from Peruvian State, including the Peruvian applicable legislation on breeders' rights, farmers' rights, and protection of indigenous communities and traditional knowledge, which will be described in the next Chapter of this study. Finally, ethical guidelines were strictly followed during my research, ensuring that I had explicit consent from my interviewees to participate and be recorded in the interviews. In order to ensure confidentiality and anonymity I will be using pseudonyms throughout this research with the exemption of Alejandro Argumedo, the Director of ANDES Foundation.

Sampling method

Taking into account that my intention was to learn and develop knowledge from selected cases and relevant behavior, I chose the group of 'technicians' who work as intermediaries between the NGO and the indigenous communities to discuss their perspective on knowledge systems and innovation. The reasons behind this sampling method were a) the technicians were the people from the community that spoke better Spanish and b) they were the people involved with the NGO and CIP gene bank for the projects regarding *in situ* conservation and biocultural innovations. For my interviews with experts and policy-makers in Lima, I used the snowball method. With the help of the director of the NGO and the same people that I was interviewing I was able to identify further interviewees and even new questions to be asked (Goodman, 1961). This means that I was already analyzing my data while collecting it. In total I had 3 formal interviews: one expert from the SPDA and two people from the Ministry of Environment. Additionally, I participated in one workshop and one meeting in the offices of the Ministry of Agriculture were I had an informal conversation with a member of CIP gene bank and participant observation from the meeting and the Conference.

My formal interviews lasted between 40 and 90 minutes and all of them were face-to-face. Unstructured interviews and conversations with the staff of the NGO were also conducted, which provided me with in depth conversations in specific content that helped me to understand the context and background of the Park and Peruvian policies and legislation. I was also invited to participate in a workshop and Conference in Lima regarding the implementation of the FAO Plant Treaty and the provision of the National Seeds Regulation at the National Institute of Agriculture and Innovation (INIA) where representatives from academia, CIP gene Bank and other NGOs were invited to discuss Peruvian seeds regulations. This allowed me to perceive how relevant policy makers perceive different topics on this field and how they interact between each other and the government priorities. Table 1 provides information of my interviews, conversations and workshops.

Table 1. Interviews, conversations and workshops

Stakeholder group	No.	Description	Methods and documentation
Quechuas technicians	6	Paco - *ParuParu* Antonio - *Pampallaqta* Manuel – *Pampallaqta* Juan – *Amaru* Jaime – *Amaru* Julio – *Chawaytire*	Semi-structured interviews (recorded) Participant observation Field notes Documentation Community Agreement (*Acuerdo interinstitucional)* of the Park
Local people from communities in the Park	3	Lorena – *Paru Paru* Neighbors from *Amaru*	Informal conversations (notes)
Local people from Cusco	2	My host family in Cusco	Unstructured interviews (recordings) Observation Field notes
ANDES Organization	6	Alejandro Argumedo Director of ANDES Camila and Pedro Staff with whom I was going to the Park.	Semi-structured interviews with two of the staff that work directly with the Park (recordings) Unstructured interview with the director of NGO (recordings), several e-mails exchange and informal face-to-face and Skype conversations. Informal conversations with people that were working there (Notes) Participation in one of the workshops in Lares, where other Quechuas communities work with the NGO in a different project.
Academia and experts from SPDA	2	Environmental lawyers and experts in IPRs and agrobiodiversity conservation	One semi-structured interview (recordings) with one of the experts and e-mails exchange with another.
CIP gene bank	1	Environmental lawyer	Informal conversations during coffee break in INIA workshop and field notes
Ministry of Environment (MINAM)	2	Department of Biodiversity and Access to Genetic Resources	Semi-structured interviews (recording)
Ministry of Agriculture, Institute of Agriculture and Innovation (INIA)	3	Specialist in implementation of Plant Treaty and Seeds regulations	Participant observation from workshops and Conference at INIA in Lima Field notes

4.2. Coding (data analysis)

The data gathered, interviews, conversations and field notes were transcribed and then analyzed using techniques and procedures from Strauss and Corbin (1998) open coding method. The first step, according to this method is to come up with concepts, labels or abstract representations of the data that I found relevant. I then wrote the concepts that I found, in the format of code notes in the margins of the interviews' transcriptions. This allowed me to find commonalities, differences and interconnections on the perspectives of different stakeholders' groups and to compare them. After that I grouped them in categories and patterns in order to make conclusions.

4.3. Limitations

Some of the limitations of this research were related to the lack of time and logistics-related issues. First, the fact that I do not speak Quechua and I did not have translator from Quechua to Spanish made it difficult to interview more members of the different communities that integrate the Park but do not work directly with the NGO. Even if the Park was only 40 km away from Cusco city, access with public transportation was not easy so I could only visit the communities when the staff from the NGO planned to go, and it was always during the technicians' working hours. This meant that the technicians were very busy working when I arrived and I had to take time from their working schedule to conduct the interviews, which in some cases might affect the quality of the data. Although I went to their work place to disturb them the least possible, it was still difficult to make them comfortable enough to stay with me for more than an hour in the interview. That's why I decided to stay in the village and interview some of them, one in the evening after dinner and Jaime during breakfast and tea, before work. It was good that they were in familiar surroundings.

My relation with the NGO can be seen as a strength or weakness depending the point of view. Thanks to the help of this organization I had access to most of my data and my interviewees had great disposition to collaborate with me. However, the validity of my data could be biased for the same reason that my interviewees are also very close to the NGO

Due to the fact that I only spent 4 working days in Lima made it difficult to interview many policy-makers, who did not have flexible schedule and some of them even cancelled. It is important to acknowledge the complexities of human interactions. I could not record all the interviews and conversations because some of them took place during the coffee break of the workshop without any planning and some of the people did not want to be recorded. Finally, it is important to establish that the data, results, conclusions and recommendations illustrated in this study do not represent the perspective or vision of all the Quechuas that live in these four communities or any broader population. The fact that I only interviewed the technicians who have been working very close to the NGO and CIP bank for years, acting as intermediates or mediators between these organizations and the rest of their respective communities may affect the objectivity of my data collected from them, which should also be considered when making conclusions and recommendations.

5. Agrobiodiversity in the Peruvian Andes

In this Chapter I will address the characteristics of Peru in terms of agro-biodiversity, cultural heritage and traditional farming systems, in order to understand the background of the case study used for the purpose of this research. I will also explain briefly the applicable legal framework in the Peru, in the field of IPRs on plant breeding, biodiversity conservation and farmers' rights.

5.1. Agro-biodiversity

Peru is a gene rich country and is one of the world's major centers of origin of plant genetic resources. It is one of the 10 megadiverse countries in the world (CONAM, 2008) hosting a great diversity of ecosystems, species and genetic resources. Because of its geographic location and natural features, Peru has many ecological and climatic zones (Scurrah, 2008), as shown in Figure 3. The country also has a wide variety of flora and fauna: 10% of the total species of identified flora in the world are located in the Peruvian territory (Pastor Soplín, 2004). According to the Peruvian Ministry of Environment (MINAM, 2010) 20,375 species of vascular plants, accounting for 7.5% of the total registered plants in the world, are located in Peruvian territory, which represents less than 1% of the global surface. From these species, at least 5,509 are endemic (Silvestri, 2016; Leon *et. al.* 2006). All of this biodiversity makes Peru an important supplier country of valuable genetic resources for the agricultural and pharmaceutical sectors.

Figure 3. Peru, Ecological Zones

Source: Accessed July 4, 2017 URL: http://www.productosparaperu.com/peru-travel-info.com/peru-climate.html

Peru is center of origin and diversity for several important crops, including potato, maize, mashua, oca, olluco, sweet potato, cassava and tomato. Many of the plants that are located in this country have been domesticated for more than 10,000 years, through the use of innovative techniques and experimentation. (CONAM, 2008). Peru is also characterized for its number of useful native plants. According to Scurrah (2008) the country has roughly 4,400 native plants from which only 220 are domesticated.

Specifically, in the Andean Mountains, where this research was conducted, agrobiodiversity has persisted thanks to the indigenous communities that have maintained strong agrarian identities, as I will explain in the next section (Graddy, 2013). The high Andes of Peru, including Bolivia and the Northwest of Argentina is recognized as one of the centers of diversity of genetic resources of wild potatoes (the other center is located in central Mexico) (Huaman *et al.* 1999). Potatoes are a very important crop for the whole world, accounting for almost half of the world's annual outputs of all roots and tubers. This crop has more wild relatives than any other crop and many species are only found in ecological zones located at high altitudes, up to the 4,500 m (Huaman *et al.* 1999). Only in the region of Cusco, where the Park is located, are located 8 of the known cultivated and native potato varieties and over 2300 of the 4000 varieties in existence (Graddy, 2013; Argumedo *et al.* 2011).

5.2. Traditional farming systems

Peru is a multiethnic and multicultural country, hosting 72 ethnic groups and 14 different linguistic families (WIPO, 2007; MINAGRI, 1994). The indigenous population in the country represents 14% of which 83.11% belong to the Quechuas' communities (IWGIA, 2016). The Quechuas are descendants of the ancient civilization of the Incas and live in rural areas mainly located in the Andean mountains, as showed in Figure 4. According to WIPO, indigenous people in Peru "are the heirs to the former Peruvians who, more than 10,000 years ago, domesticated and diversified plant and animal species for different uses, and are at present the depositary of a rich heritage of traditional knowledge concerning the use of those species" (WIPO, 2007 p. 1).

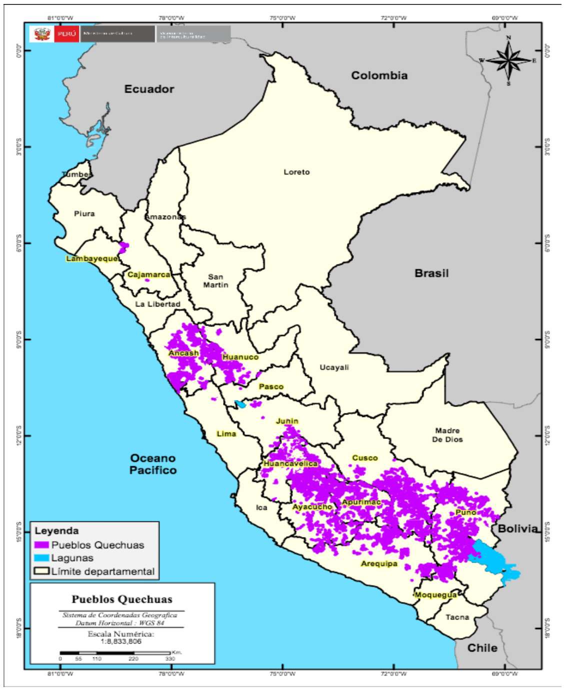

Figure 4. Quechuas population and territories

Source: Ministry of Culture in Peru, Database of indigenous population Accessed July 15, 2017 URL: http://bdpi.cultura.gob.pe/pueblo/quechuas

Quechuas' people have complex farming systems, which are based on millennial traditions and the heritage of the Incas. The system combines the use and construction of terraces (*andenes*) at different levels of the hill with effective irrigation systems containing cisterns and canals. They also use sectorial rotation of crops according to the land requirements, and in order to leave the land rest after certain time of use (Ministerio de Cultura, 2016). The communities also have their traditional tools for farming and traditional methods for planting crops. They mainly produce tubers and flowering plants like quinoa, kiwicha and cañihua (Gonterre, 2009).

Specifically, in the Peruvian Andes, farming is the central and most important activity for Quechuas' indigenous people. Not only they use traditional farming systems but they also undertake the task of biodiversity conservation and preservation of their cultural heritage. "These communities grow a variety of crops adapted to the local environment, and there are strong linkages between territory, culture, food security, and local knowledge" (Scurrah, 2008, p.7). Quechuas grow their crops in very farms, called *chakras*. However, their agricultural activities in these areas have not been profitable. According to Scurrah (2008) land fragmentation and the lack of interaction with the market have been the main barriers to agricultural profitability, and this is mainly due to the topographic characteristics of the area (Scurrah, 2008). However, most of the Quechua people depend largely on farming and agriculture to satisfy their basic needs (Ruiz Muller, 2009; Scurrah, 2008). These communities have been maintaining large genetic diversity in their territories and that is why the Peruvian Andes are such a relevant place from a cultural, social, ecological, economic and scientific point of view (Ruiz Muller, 2009).

5.3. Applicable legal framework in Peru

Peru has a very complex legal framework in the field of breeders' rights, farmers' rights and biodiversity conservation. It has national, regional (Andean Community) and international regulations that sometimes could contradict each other. The objective of this section is to briefly address the applicable legislation in Peru on the topics outlined in the literature review.

5.2.1. On breeders' rights

Peru ratified the 1991 UPOV Convention in 2011, as a result of the Trade Promotion Agreement with the US, which entered into force in February 2009. One of the conditions that the US established with this agreement was that Peru had to be more restrictive with its intellectual property rights legislations. However, Peru already had a *sui generis* system similar to UPOV since 1993 with the Decision 345 of the Andean Community of Nations, which established a common regime on the protection of breeders' rights (Lapeña, 2012). This regulation already had a farmers' clause in article 26 as it follows:

> *26. Anyone who stores and sows for his own use, or sells as a raw material or food, the product of his cultivation of the protected variety shall not be thereby infringing the breeder's right. This Article shall not apply to the commercial use of multiplication, reproductive or propagating material, including whole plants and parts of plants of fruit, ornamental and forest species.*

With the accession to UPOV, however, Peru had to create regulatory framework that lay down rules for implementing both, the 1991 Convention and the Andean Decision 345. So, in 2011, with the Supreme Decree Nº 035-2011-PCM, the Regulations for the Protection of the rights of breeders of new plant varieties were approved. Again, they included an explanation of the farmers' clause as follows:

> *Article 16 The Storing and Sowing of Seeds for Own Use*
>
> *"Anyone who stores and sows for his or her own use" as per article 26 of Decision 345, shall mean anyone who stores and sows on his own holdings, within reasonable limits and subject to the safeguarding of legitimate interests of the breeder, the product of the harvest which he has obtained by planting, on his own holdings, the protected variety or a variety covered by Article 24 of Decision 345.*

With the Legislative Decree Nº 1080 from June 28, 2008, the Seed Legislation was issued as one of the first national legislations that were modified after the signature of the US Trade Agreement. Moreover, in 2012 the instrument that regulates this legislation was approved with the Supreme Decree Nº 006-2012-AG (Lapeña, 2012). This legal instrument is important because it specifies in articles 105 and 106 that native varieties could be subject to registration without the requirements of adaptation and efficiency, and even taxes (required by commercial varieties) when they could be economically exploited, in order to promote native cultivars. Article 106 talks about the maintenance of native varieties that are registered. Finally, in 2003 Peru ratified the Plant Treaty by the Supreme Decree N° 012-2003-RE and issued the Law 28126, which sanctions infringements against breeders' rights.

5.2.2. On farmers' rights and traditional knowledge

In the literature review there were explained the international treaties that talk about farmers' rights; among them, the CBD, the Plant Treaty and Nagoya Protocol. Peru ratified both the CBD and Plant Treaty in 1993, and Nagoya Protocol in July of 2014, and has been a pioneer in development of legal framework in terms of ABS regulations. Apart from these international treaties, Peru is also member of the International Labor Organization Convention 169 on Indigenous and Tribal Peoples, since 1994.

According to Clark *et. al.* (2004) there were a series of circumstances that influenced the country to implement a national legislation to protect traditional knowledge. Due to the fact that in the Andean community there were already regulations to protect breeders' rights

(Andean Decision 345), which, according to some organizations and institutions, was made only to protect plant varieties that would fulfill with the technical requirements led by UPOV (stable, homogeneous and distinctive), many other native varieties would be left out of this protective sphere, and traditional knowledge would eventually be lost. Therefore, legislation was needed not only to protect native crop varieties, but also traditional knowledge used to breed these varieties.

At the regional level, the applicable framework in terms of access to genetic resources is the Andean Decision 391 on a Common Regime on Access to Genetic Resources (1996), which regulates access to genetic resources and benefit-sharing in the Andean community, which is formed by Bolivia, Colombia, Ecuador, Peru, and (at the time of the signature of the treaty) Venezuela. This legislation is important for farmers and indigenous communities because it talks about the protection of traditional knowledge providing communities with the right to permit access to and use of traditional knowledge related to genetic resources and their derivatives. The aforementioned must be negotiated through an 'access agreement' between an applicant and the State authority" (Clark *et. al.* 2004).

In 2000, another important Andean Decision entered into force; this is the Decision 486 on Common Industrial Regime for the Community and creates measures to protect traditional knowledge from IPRs applications. Article 3 of this Decision establishes that "…*the grant of patents relating to inventions developed on the basis of material derived from that heritage or knowledge shall be subject to that material having been acquired in accordance with international, community and national legal provisions…"* This means that the Peruvian authority on IPRs (INDECOPI) may not grant a patent or any other form of IPRs to the applicant, unless he shows that the genetic resources were accessed through an access agreement according to the applicable international and national legislation. The aforementioned in order to respect and safeguard the biological patrimony and traditional knowledge in the Andean countries (Clark *et. al.* 2004). Additionally, at the national level, and based on these Andean decisions, Peru issued the Law 26839, entitled Law for the Conservation and Sustainable Use of Biodiversity in 1997. This law was issued specifically to protect knowledge, innovations, and practices of indigenous communities, determining that these are part of cultural patrimony and therefore mechanisms should be developed to regulate their use and dissemination (Clark et. al. 2004).

Throughout this Chapter I outlined important elements of Peru in terms of agro-biodiversity, cultural heritage, traditional farming systems and the current legal framework applicable in the field of breeders' rights and farmers' rights. Both the legal framework and the background of the country will be important for the next three Chapters in which the findings of the research fieldwork conducted will be analyzed through the lenses of the theoretical framework that was already outlined.

6. The integration of different knowledge systems

This Chapter will be divided in three sections that will show the results and findings of my interviews with the technicians and ANDES in regard to their perspectives on knowledge systems and in order to answer Research Question 1: *How do the Quechua communities involved in the Potato Park value their seed-saving traditions and knowledge systems, and how has the situation changed after the designation of the Potato Park and cooperation with the NGO Andes?*

As I noted in the theoretical framework outlined in Chapter 3, there are different knowledge systems or ways of understanding the world, that may not always be compatible. As it will be addressed throughout this Chapter, the Park is a notable case of introduction of SK in indigenous communities that have been working according to their traditions for years, and whose knowledge system comprehend an interesting interrelation between humans /culture and nature. Through the first section I explore Quechuas ancestral practices, farming systems and TK, and I acknowledge that several factors (from environmental conditions such as climate change to social and political factors as the designation of the Park and the agreement with CIP) have been affecting Quechuas' knowledge systems and practices; however, I will also argue that TK has not been lost, but rather Quechuas have been adapting and changing their practices to new conditions.

In the second section I discuss the integration of knowledge to science arguing that even if Quechua people have been recognized as knowledge producers by the Potato Park, still this recognition has been made from a scientific approach in which TK is considered valuable for the fact that it has been integrated into science by being codified and formally recognized. Through the last section I investigate how the introduction of the monetary system and the designation of the Park has shifted community relations and has caused important changes in Quechuas' knowledge production process. This part will also be related to community-based breeding, which will be addressed in the next Chapter.

6.1. Quechuas' ancestral traditions, farming systems and agro-biodiversity

For Quechuas, potatoes are a symbol that represents life. The potato is the most important crop because it can grow in high altitudes resisting the cold temperatures of the Andes.[1] Manuel explained that potatoes are living beings: "*they have spirit and that's why we have to make Papa Watay [ritual described below]. They are living beings that only grow in the highest parts of the Andes [el altoandino]. Without potato we would not survive because we live high above the 4000 and nothing else grows here, only potato.*" In addition, Pedro explained to me that traditionally Quechuas breed different varieties of potatoes in the same *chakra* (contrary to what is thought that is better from a scientific point of view). He mentioned that for Quechua people, potatoes are social living beings "just like us;" therefore, they need each other to grow better and protect themselves: *"In the greenhouses we work in an organized way, but the Quechuas have the belief that varieties will grow better if you grow different varieties together. Because varieties of potatoes, like us, need the help of others to relate and grow in harmony… some varieties, for example, will protect others from insects, like a symbiosis."* When I asked if this actually worked he replied that,

[1] Taking into account that the Park is approximately 3,900 meters above sea level and according to my interviewees one of the major risks to biodiversity conservation has been climate change.

indeed, it did work well for them. *"Quechuas know which varieties will be stronger and more productive. But then we [ANDES] tell them how to do the crossing pollination, and that's the scientific knowledge. That's why this is called participative breeding."*

During my interviews and conversations with the staff from ANDES they explained to me that there is a condition in the agreement between CIP and the Park, that states that CIP would always respect and protect Quechuas' TK during the repatriation project. However, what exactly is this TK that Quechua communities at the Park retain? What really constitutes the Quechuas' knowledge system?

In order to understand Quechuas' seed-saving practices and knowledge systems I asked the technicians about their traditions regarding the cultivation and harvesting of potatoes, and also their perspectives on these traditions. Thus, I was able to learn some of these important traditions that are embedded in the communities, specifically in the area of their farming systems, which were greatly related to Quechuas' role of conserving native potato varieties. During my fieldwork I learned that Quechuas' TK is mainly symbolized by the profound respect that they have for Mother Earth (*Pacha Mama)*, their connection to their land and crops and the way they revere their 'sacred' mountains (*Apus)*. An example of this respect is represented by what they call *layme* which refers to the sectorial rotation and rest of the land: "*we rotate the land every 7 or 8 years. The land needs to rest so it can be productive again" (Jaime, 2017).* This example shows a traditional agriculture system that was performed since the ancient Inca civilization; however, it is also related to the value Quechuas give to the Earth and nature while producing food.

Apart from *layme* Quechuas have also specific rituals for the harvesting of potatoes. They described to me the whole ritual of *Papa Watay,* which is a ceremony to "hold" or "capture" the spirit of the potato. This happens once a year, in "The National Potato Day," in one of the communities, and is done in order to bring the spirit of potato back to the earth and have a good harvest for the next year. Quechuas believe that if they don't "hold the spirit" they could lose varieties. They start the ceremony with local music and they put all the potatoes together with rose petal confetti; in that way 'holding the spirit of potatoes.' This ceremony is an example of *ayllu*, another Quechua principle that was explained by Alejandro (ANDES) as a holistic system where humans, nature and 'the sacred' interact in a perfect equilibrium.

Furthermore, Alejandro explained to me the Quechuas' agricultural system, which is based on what is called 'mirror symmetry' were Quechuas grow their crops in 'three ecological stages,' dividing the mountain in three parts and growing different crops according to the climatic conditions of each part. Additionally, they believe that it is the seed that 'chooses' the land and not the human who decides where to put the seed. One of them explains to me that "*because they know their chakras they know which variety to grow and where.*" However, technicians told me that due to challenges of climate change, things have been changing and they have been forced to grow potatoes in higher and higher areas. This statement indeed contradicts the dominant Western belief that aboriginal culture is static and frozen. Quechuas clearly have been adapting their agricultural practices according to the new environmental conditions and climatic challenges that they face year to year.

All of the traditions that were explained above are important to understand how indigenous TK, as opposed to SK, has characteristics and elements that cannot be easily quantified and categorized from a scientific approach, and that are also changing and adapting along with climate change and other social, political and economic factors. However, specifically in the Park, there has been an attempt to combine this TK with SK, thus "integrating knowledge to science" as Nadasdy (1999) would say.

6.2. The designation of the Park

> *"If you want to interview the technicians you should first go to the Park, introduce yourself, explain you project, work with them; then, on the next visit you will be able to set up some interviews."* (Staff from ANDES)

Following the above stated advice, on my first day of fieldwork I went to the community of *Paru Paru* where the staff from ANDES introduced me to the 'technicians' *(técnicos locales)* who were harvesting potatoes in the greenhouse that was built few years ago with the help of ANDES. The word 'technician' is used in the Park to refer to the breeders that work directly with (and not for) ANDES. Therefore, this term or occupation has been used among the communities since the designation of the Park. According to the Park Agreement (*Acuerdo Interinstitucional del Parque de la Papa)* the technicians must be elected in each community through an Assembly and for the term of two years. However, most of the technicians interviewed have been holding the same position for more than two years. When interviewed, some of them said that their communities have been ratifying them every two years, and some of them said that they just keep their position and no one else from their communities has requested elections again; "*no one else is interested*," as one of them commented. For instance, Jaime from *Amaru,* who has been a technician for 7 years already, explains to me that there is no point in rotating every two years: "*we would have to train different people every two years and ANDES says there is not enough budget to do everything again.*" Antonio from *Pampallajta* has been a technician for 15 or 16 years. He has been ratified by his community every two years: "*people already know me, they know I do a good job and that I am responsible*." Manuel, the other technician from *Pampallajta,* who was elected in 2008, told me that the reason why he has this position is because he has been conserving plant varieties since he was a kid: "…*My community is far away from the closest city and we have no money to access education…therefore, I worked with my parents in the 'chakra' (the farm) since I was a kid…"* He told me that ANDES contacted him because they knew that he always won awards in the exhibitions of native potato varieties (*ferias de papa nativa),* thus, he was persuaded to become a technician when he realized that he would get extra money, or as they call it "tips" (*propinita)* for this work.

From the information above stated it is important to note two things: a) the power dynamics between ANDES and the technicians, in which ANDES has the financial resources to train and teach the technicians what they need to know to hold this position, (thus, in the end is ANDES who decides if they can train more people from the community), and b) the separation between technicians and the rest of the community, since they get this extra money for their job, even if they are not directly "hired" by ANDES.

During my interviews, the technicians mentioned that they been receiving numerous trainings and have been participating in different workshops with ANDES and CIP, where they have learned scientific techniques of breeding among other things. This is how SK has been introduced in the communities. For most of the technicians interviewed, the most important project since the designation of the Park has been the repatriation of native varieties of potatoes (project referred in the first Chapter) with CIP.

> "*During the seventies CIP took without permission our native potato seeds. But I think that since they noticed that now we are organized and associated as a Park, they decided to start the repatriation project. They cleaned the potato seeds in the laboratory and now they have disease-free seeds and they have given them back to our land. We grow them in the greenhouses… and then we take them to the field" (Julio, 2017).*

This quote gives us an insight of the so-called 'knowledge economy' referred by Hayden (2003), in which the Quechua people need to be well 'organized' and 'associated' in order to be formally recognized (from a scientific approach) as knowledge-producers and therefore, be eligible to participate in the repatriation project with the experts or scientists' community (in this case CIP).

Furthermore, from my interviews with the technicians I observed that, from their perspectives, there has been a change in the way they understand knowledge since they started working with ANDES and CIP. "*Since I am a technician I've learned so many new things. I mean, yes, traditional knowledge I had it before ANDES, but not the <u>scientific knowledge that I have learned as innovations</u>" (Julio, 2017).* Most of the technicians that I interviewed told me that thanks to ANDES and the designation of the Park, they now "value" their TK more than before. From Julio's perspective, the fact that their TK has now been codified with the help of ANDES, made a positive impact in their communities: *"Everything was already in our minds (referring to knowledge), but it was not in a written form."* It is true that this codification of TK can bring potential benefits to the communities in the Park, either as a means to safeguard it or to demonstrate [translate] it's utility to a wider audience, e.g. CIP bank or lawmakers in Peru. However, it is important to acknowledge the potential risks of this codification; for instance, the process of identifying and separating 'useful' knowledge, as Agrawal (2002) calls "particularization," and the further validation and abstraction of this 'codified database' to decide if it is actually knowledge and if it is useful for development, according to the scientific parameter.

Juan from *Amaru*, the newest member in the technicians group, told me that thanks to the designation of the Park, they are now recovering the potato varieties that were already lost in their territories. He added: *"thanks to technicians, potato varieties are being conserved and increased."* This shows how proud the technicians are of their work, now that it has been formally recognized and codified with the help of ANDES. When I asked if things were better after the communities started working with ANDES, and thus, they decided to designate the Park, most of them were positive. Juan even told me that, before the Park, people would not agree on anything and they would argue all the time, but that now communities are happier.

This analysis led me to understand that there has been a shift on Quechuas' perception of knowledge since the designation of the Park. The aforementioned was mainly showed by the fact that the technicians value their TK more than before, now that it has been explicitly recognized and integrated into science, according to the Western standards of knowledge. The technicians' perspectives not only showed the dividing line between TK and SK as different knowledge systems, but also the "integration of knowledge to science" that Nadasdy (1999) referred. The fact that they felt they needed confirmation and validation from an outsider (in this case both ANDES and CIP) to give value to this TK reveals the need for scientificity and rationality as the bench mark criteria to define what TK actually is and who the knowledge producers are.

6.3. The monetary system and the shift of community relations

The questions for this last subchapter are: is this TK being still practiced by all the members of the community or only by the technicians? What are the benefits and risks of using the language of TK?

In order to clear my doubts and solve this question I started asking the technicians how they have managed to conserve all these different native varieties for so long and the reason why the varieties that were repatriated by CIP were lost in the first place. Jaime told me that, after the repatriation project with CIP: "*people were excited because they saw varieties that were lost; varieties that they saw for the last time when they were kids.*" I asked about the reasons of this loss and they all referred to a certain NGO [they did not mention the name] that came and introduced hybrid varieties of potatoes. They told me that, at the beginning, people preferred these varieties because they were more productive, thus they stopped growing some of their native varieties. However, after some time, they realized that hybrids were dependent on other inputs [pesticides and chemical fertilizers] and they did not have the money to pay for them so they stopped using these varieties. Manuel mentioned that after this experience people realized that their local varieties were actually more resistant to pests and diseases because they did not need chemicals and they could survive for more years than the hybrids.

When I asked about agro-biodiversity conservation practices technicians acknowledged that plant genetic resources are part of their heritage: *"it belongs to us because we have been protecting it for millennia,"* explains Antonio. According to Graddy (2013, p. 597) who did her research on *in situ* conservation in the Park, the varieties that have been reintroduced are important for the communities that work at the Park not only in terms of agricultural or biological value but also cultural and political: "the genetic traits of value within these native varieties cannot be defined as merely natural resources to be extracted, modified, and manipulated, as if they were neutral, inert commodities there for the taking." The author points out that agro-biodiversity cannot be reduced to genetic resources which "as natural resources, can be preserved most effectively through ex situ and in vitro methods." In the same line Rist (2000, p. 312) refers to indigenous agricultural systems, which often involves "concepts that go beyond mere economic and materialistic considerations: production is the result of interplay between human beings, their communities, and the spiritual entities that animate what the Western world calls 'natural resources.'" Yet, when I asked Lorena (the Quechua woman who was cooking for the technicians in the kitchen in one of my work days) about her opinion on the repatriation project, she seemed not to know about CIP or the new introduced varieties. She was boiling potatoes in a big pot (as illustrated in Figure 5) where I could observe many different potato varieties with different colors and shapes; however, she could not tell me significant differences between them or at least the name of some varieties. This is an important, if anecdotal, data point that raises questions about how widespread the knowledge system is in the broader communities, beyond the technicians, which should be investigated in future research.

Figure 5. Potatoes pot

Source: author

Yet others mentioned reasons beyond agrobiodiversity conservation for their work. When I asked Antonio about his opinion on biodiversity conservation he said:

> *"Well, it is important in order to resist and fight climate change or any other unexpected environmental condition. We need strong potato varieties. Also, due to food sovereignty. We cannot be forced to eat certain food; we have the right to decide what we want to eat and what we want to do with our crops, either to sell, exchange or consume. Having food to survive (food security) is not enough. We need diversity."*

Through my interviews I was impressed that the technicians used terms like food sovereignty and discussed the difference between food sovereignty and food security, which made me think about the strong relationship between ANDES and the technicians, and the way the concept of TK for agro-biodiversity conservation has been used outside the Park, in all of the conferences and workshops where the technicians have participated.

While harvesting potatoes with the technicians I also asked questions related to the source of their knowledge. They all mentioned that knowledge and traditions pass from generation to generation; that they had learned everything from their parents and grandparents and that they are trying to teach everything they know to their children. However, they also mentioned the fact that now young people are losing interest in agriculture, conservation and traditional practices. According to Juan "*young people has different mentality now.*" He says that young people prefer money over the traditional 'barter system,' (*trueque)* which is part of the Quechua *ayni* principle, meaning 'reciprocity.' Antonio told me that before they had more *ayni* because they did not have a monetary system, but now that they have more education and money, they do not need *ayni* so much (referring to the help of each other and the barter).

The introduction of the monetary system in these communities has been influenced by several factors, for instance, the designation of the Park as a biocultural heritage area (BHA) with touristic services and, in general, the fact that the Peruvian Andes is becoming a very popular touristic destination in the last decade. These circumstances have changed the Quechua peoples' lifestyle to a certain extent. Technicians mentioned that many people, especially young people, would rather go, work and earn money in *'Camino Inca'*[2] than stay in the community and work in their *chakras*. Also, as Juan reflects, the fact that the Park, designated as a BHA, is economically more prosperous for all the communities now

[2] Camino Inca is the hiking trail in Peru that terminates in Machu Pichu.

that they are associated, contributes to people's happiness and comfort: *"people are happier because each community receives extra money."* However, Manuel recognized that these changes have not been easy for everyone. He told me that there are several groups that are not happy with the way things are and still do not support the decision of unifying communities to constitute the Park as a BHA; on the contrary, that they see the Park as competition for themselves.[3] This shows that the monetary profits arising from the new economic activities performed by the Park have made both positive and negative impacts in the community organization. According to the technicians' perspective, communities would have a better chance to agree on something if they were all receiving extra money. However, we also have to take into account the fact that young people are less interested in learning traditions and practices now that they have the option to work for money. It is also important to consider the fact that not everyone is happy with the decision of constituting an association of communities, even if they could get more money out of it.

Finally, from the facts and perspectives exposed throughout this Chapter, it is possible to perceive the change in the knowledge-production process within the communities since the designation of the Park. First, TK has been integrated into science by being codified, categorized and formally recognized by both ANDES and CIP, which, from the technicians' perspectives has been beneficial for the communities integrating the Park. Thus, even if the relationship with ANDES and CIP, and the designation of the Park, has been causing changes in the knowledge-production system, there are other factors to

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[3] It is important to say that in the beginning of the designation of the Park there were 6 communities involved. However, two of these communities are currently out of the agreement of the Park. Although I could not get the exact information about the reason of the aforementioned, this shows that not everyone is completely happy about the designation of the Park.

consider that have been affecting traditional practices and community relationships, as the introduction of the monetary system and climate change. This is an example of TK considered in the context of a broader sociopolitical process in which knowledge is embedded. Furthermore, the fact that knowledge systems are changing does not necessarily mean that TK will be lost, but rather that communities are able to adapt to new conditions, as they have already been adapting to environmental or sociopolitical circumstances. In the end, and as Goldman *et. al.* (2011) pointed out, we cannot ignore the social, economic and political agendas in which knowledge-production process has been shaped or adapted. This adaptation process and the community relations will be further explored throughout the next Chapter.

7. An open approach to biocultural innovations

This Chapter will portray the results and findings of the interviews, informal conversations, workshops and meetings carried out throughout my fieldwork, in order to answer Research Question 2: *How do farmers, policy-makers, and the NGO understand innovation in breeding, and how does this intersect with current legislation applicable in Peru?*

In order to do so, I will first show the different perspectives and understandings of the term 'innovation' dividing the stakeholders in three groups: a) policy-makers and experts, whose views match the current dominant IPRs approach in terms of innovation and science, b) the technicians with an open and social approach in which community-based innovations could fit and, c) ANDES with a hybrid approach, working more as the mediator between the two previous approaches. The purpose of this division is to analyze the different approaches to innovation referred in the theoretical framework (section 4.3) of this study. For that I will contrast the dominant approach with the alternative, open approach. I will argue that while experts and policy-makers seem to consider native varieties primarily as the raw material necessary to conserve and protect for further research and innovation, technicians have a more complex and holistic understanding of innovation as being a restoring of TK and seeds, and using SK to help solve some of the problems (e.g. diseases or nutrition related problems), but seeing themselves as still innovators. Finally, I will show the hybrid vision of ANDES in which native varieties are indeed biocultural innovations, and with the help of SK they are making TK also economically profitable, but in a way that can still socially benefit the communities.

I also argue that the 'biocultural innovations' that have been carried out in the Park could fit in the term 'open innovation' used by Chesbrough (2003), in which different sources of ideas could come both from the inside (Quechuas' TK) and the outside (technical assistance and SK with the help of ANDES and CIP). I will consider Gabison *et. al.* (2014) concept of 'social innovation' to argue that biocultural innovations in the Park are being developed with the purpose of meeting societal needs and solving specific problems related to agrobiodiversity and plant breeding. In summary, and according to the authors referred to above, these are the main elements to consider biocultural innovations from an open approach:

1) They are collaborative
2) They are aimed at meeting social needs
3) The involvement is voluntary

Further on, I also reflect on the fact that there appears to be a clear difference between the involvement of the technicians and the rest of community, and thus not every community member is an active co-creator (though more research would need to be done on the perspective of members of these communities who are not working directly with ANDES). When the Park was designated there was an agreement that technicians should transfer and share all their knowledge to the rest of community, yet, to date it could not be ensured that this is actually done, which would be important to implement in order to avoid new divisions in the communities, particularly in the event of registration or commercialization of new varieties (as it will be referred in the next and last Chapter).

7.1. Policy-makers and experts

After interviewing the first stakeholders' group, comprised by policy-makers and experts, I found divergent opinions in relation to both innovation and also the value of native varieties of potatoes. When I spoke to people from the Ministry of Environment (MINAM) I noted a resemblance with the dominant IPRs approach to innovation, as they seemed to relate native varieties and plant genetic resources originated in Peru with the 'raw material' that could be accessed, both for research and commercial purposes, rather than valuing them as the product of innovations in the past or as potential partnerships for the future. One of the policy-makers from this Ministry stated that indeed, *"this access always involves knowledge,*" and that this was recognized by the Peruvian laws: "*this is the reason why researchers or foreign companies that want to access need to share benefits with the communities that conserve this knowledge and natural resources."* However, it was also explained that in 2010 there was some political pressure from the part of public research institutes, who wanted to modify national regulations on access to genetic resources because they considered that these were not incentivizing innovation (due to the high percentage of the monetary benefits that had to be shared) My interviewee expressed her position on this situation:

> *"In order to modify the regulations we should talk to communities and make them understand that having such a high percentage, in reality, will not be beneficial for them. The companies will not be keen on paying… We have the case of Brazil, as an example, where the percentage is only 1% and therefore, they provide a big market for innovations with foreign companies."*

The Regulation has not been yet modified; however, her vision showed me that the priority was to incentivize and support foreign companies and researchers to access genetic resources and develop 'scientific innovations' in a legal way; that is to say, through an access and benefit sharing agreement, in accordance with the Nagoya Protocol. This perspective goes in line with what Van Dooren (2008) said about the classification of native varieties as the "natural" part of the evolution. Instead of recognizing the indigenous people as the source of innovation or even as the genuine inventors, in this case it seems the genetic resources and TK in Peru are both seen as raw materials which could be used by scientific experts (foreign companies or public researchers) to innovate. According to this perspective the priority regarding native varieties is only in terms of conservation, as they might be useful for experts for further research and innovation.

The same point of view was expressed by the expert from the SPDA. She told me about Peru and the complex process of implementing international treaties, like the Nagoya Protocol and the FAO Plant Treaty: "*Peru has few important endemic resources. Foreign companies will not be incentivized to access our resources and innovate if the legal process is too complicated.*" She explained that, since the adoption of these two international treaties, the Peruvian authority on IPRs (INDECOPI), has been asking for 'access agreements' before granting a patent on plant genetic resources: "*INDECOPI does not want to put obstacles to innovation but at the same time has to comply with the Nagoya Protocol so they have to ask for the access agreement.*" She added that the objective of the Nagoya Protocol was to promote equitable benefit sharing, but not by restricting innovation. Thereupon, I understood that, similar to the people from MINAM, her conception of the word 'innovation' was directly linked to scientific knowledge and the dominant IPRs approach referred above.

After talking to the same expert about the implementation of international treaties in Peru, in the field of access to genetic resources, we changed the subject to the potential restrictions that UPOV 1991 could cause to farmers in the Potato Park. This topic was important for this research taking into account that this international treaty could potentially restrict farmers' traditional practices regarding the use of the seed, both in terms of mere exchange or formal commercialization, due to the fact that, from an IPRs approach, the indigenous communities are not registered as the genuine breeders of these varieties. Indeed, she mentioned that, for this topic, it was important to differentiate Western breeding systems from traditional or informal systems, meaning that, from a legal perspective, UPOV regulations would in fact prevent the farmers from using the seeds for a commercial purpose if they are protected by breeders' rights. However, she explained that the implementation of the national legislation on protection of breeders' rights (based on UPOV 1991) was still very weak and therefore, the enforcement of these laws was quite difficult in practice. She added that small-scale agriculture was not a priority for the Peruvian Government to the point of verifying if the farmer is illegally using a protected variety.

On the same topic, one of the lawyers from CIP told me that it would be difficult for UPOV 1991 regulations to restrict farmers' traditional practices for two reasons: a) the trade market in potatoes is mostly informal and, b) the indigenous communities in Peru do not use varieties in a commercial way. Here it is important to acknowledge that even if these statements are true, this does not mean that UPOV would not be a potential threat for farmers that, in a given case, decide to start commercializing their varieties or to cross varieties with protected ones. Additionally, the lawyer from CIP mentioned that they are currently using UPOV regulations to protect their varieties because they needed this "incentive to keep innovating," which again seems to mean that the use of traditional varieties is only as the raw materials for innovation, rather than seeing potential for cooperative innovation with the communities. Finally, he made clear that in the case of indigenous communities they CIP would keep providing material without a transfer agreement or fees, considering that the original resources are native from Peru.

Now, the fact that Peruvian authorities do not have enough resources to implement UPOV regulations does not mean that these will never affect traditional practices of indigenous communities, therefore, it will be important to consider the potential harm that these regulations could cause to biocultural innovations developed in the Park, in the field of plant breeding, particularly if there is international pressure to implement and enforce these regulations at a later date.

Later on, in one of the meetings that I attended at INIA (seeds authority), policy-makers were discussing about the need to implement a new legislation on seeds, which would benefit farmers that are conserving native varieties. They talked about the commercial value that has been given recently to native varieties in the market (particularly potatoes) and the fact that the Park is already producing basic seeds of potatoes, which is a precursor of becoming a formal seed producer. However, they emphasized that the case of the Park is very particular and thus, cannot be used to generalize or exemplify the case of other indigenous communities or small-scale farmers in the country, who might not be producing clean seeds yet. This shows that the value of native varieties was given in regards of their commercial potential, e.g. if the seed are clean of diseases. Again this shows a perspective in which native seeds need SK in order to be valuable in terms of innovation. However, more research would be needed with experts specifically on potential forms of innovation in order to further clarify these initial insights.

In the same meeting, some of the policy-makers were questioning the need to protect native varieties at all. "*The main problem of native seeds is that they have a lot of diseases and also low productivity, so what is the point of producing this type of seeds? Does it have commercial purposes or is it only to improve quality?"* However, the person who was holding the meeting accurately explained that the legislation objective was to recognize the farmers as native seed producers and to help them improve their crops, by providing technical assistance and trainings so (if they want to), at some point they could choose if they want to upgrade to commercial seed suppliers: *"they will have the option, we will not force them."*

The above stated dialogue was interesting considering that in the previous workshop that I attended, where the implementation of the Plant Treaty was discussed, one of the issues that was raised was the concept of plant genetic resources for food and agriculture. One of the presenters was questioning whether it would be good for Peru to expand the multilateral system to other 'native varieties' and crops[4]. Even though potatoes are already included in the list of crops of the Plant Treaty, this shows an interesting diversity of perspectives on the value of native varieties for Peruvian government; on the one hand questioning about the adequate protection of their national heritage, but on the other hand referring to native varieties primarily as raw materials that could be accessed for further innovation, but not including the possibility of protecting them as innovations or seeing the communities' potential value as future innovators.

[4] The Plant Treaty only covers a selection of the world's food crops and exclude others in biodiversity-rich countries that have their own national laws on access and benefit sharing. But the list is not static and amendments to expand the list of crops can be proposed (Helfer, 2003)

One of the policy-makers from MINAM also referred to the particularity of the case of potato, "*a crop that is greatly protected in Peru in terms of agro-biodiversity conservation.*" He referred to the market for gourmet restaurants, who are willing to pay the additional cost that represent getting a native variety of potato. However, he said that: *"these are not very productive… for example,* Pollerias[5] *require potatoes as standardized products… they need a massive production system that the communities could never reach with native varieties."* He told me that native varieties could never be exported because they have a lot of diseases: *"Maybe here the diseases don't affect their productivity but elsewhere they would require to fulfill so many hygienic requirements."* Lastly, they referred to small-scale farming systems: *"We have projects to help farmers become more efficient and productive; we try to find markets for them in order to incentivize agro-biodiversity conservation practices. But in order to do that, we have to give them access to new technologies: to make diversity more profitable."* This vision shows the authorities' interest in the improvement of small-scale farming systems in accordance with a dominant IPRs approach to breeding practices, in which innovation has to be shaped to serve specific industrial purposes for humanity. In conclusion, even if IPRs were not deeply discussed in the aforementioned meetings and workshop, these views show a different perspective on innovation, in which native varieties are included but mostly in terms of agrobiodiversity conservation or raw materials for further innovation and not as genuine innovations or seeing the communities' potential value as future innovators.

[5] Peruvian popular restaurants that offer roasted chicken with fried potatoes

7.2. The technicians

Most of the technicians that were interviewed identified innovation with the interaction of TK and science, which is the reason why ANDES introduced the concept of ‘biocultural innovations’, referred to in the theoretical framework of this study. This was demonstrated with the answers that the technicians gave me when I asked about their understanding of the word ‘innovation.’

First, Antonio explained to me that even though their local varieties are good, they are also ‘tired’ (meaning they have diseases). *“This is why we need innovation, to get clean varieties and improve the characteristics and productivity of our local varieties with selection methods: to make them more resistant.”* Jaime immediately related innovation with greenhouses and tunnels, which are used to protect potato seed from frost, to get basic seeds, from which germplasm will be chosen for the community gene bank: *“they are very modern… now we have clean varieties and basic seed. I have never seen these techniques before.”* One of the greenhouses and the local seed bank can be seen in Figures 6 and 7. Some of them also related the concepts of innovation with the ‘quality seeds’ provided by CIP and the recently learned alternative method for potato sexual reproduction from ‘botanical seed’ or ‘true potato seeds,’ (CIP, 1983) which is the seed that is obtained from fruits of the potato plant and which is allowing them to save their seeds for longer periods, with the help of their recently built community gene bank. Figure 8 illustrates the fruit of a potato plant at the Park.

Figure 6. Greenhouse Paru Paru

Source: author

Figure 7. Local gene bank Paru Paru

Source: author

Figure 8. Botanical seed from Potato Park

Source: author

From these examples it is possible to identify the need of ‘something’ (a technique, a method, an idea, etc.) to provide solutions to some of their problems, such as the diseases attacking their native varieties or the challenges exacerbated by climate change. Even though these understandings could go in line with the scientific model referred by Latour (1987), in which innovations have to be useful or have to serve specific industrial purposes in order to be considered innovations, the technicians also referred to the use of their TK as an essential element to innovate, which indeed shows a different approach to innovation than the one referred to in the dominant IPRs regime. An example of the aforementioned is clearly demonstrated by Juan, who he told me that, for him, innovation means to “*rescue what our parents and grandparents used to know”.*

Likewise, some of them related the term innovation specifically with the improvement of their native varieties with the help of their TK. Julio specified that innovation had to do with increasing the number of varieties in his own *chakra* with the help of his indigenous TK. Paco differentiated native varieties from improved varieties stating that: *“native varieties have always been there. They are valuable because they are used in rituals, celebrations, and weddings. CIP varieties are also native varieties, but restored.”* Moreover, in one of my interviews the expert from the SPDA, I was told that at some point, the seeds authority in Peru (INIA) was giving certified and improved varieties of potatoes to farmers with the aim of helping them to have high-yielding crops, but farmers did not always like these varieties. She added: “*you can tell that, specifically in the case of potatoes, indigenous communities really value their native seeds.”* Thus suggesting that for these communities everything “new” is not necessarily synonymous with innovative.

Along the same lines, other technicians defined innovation as the transition from 'old' to 'new,' yet, without completely leaving the 'old' behind.

> "*Before we worked with TK, now with scientific knowledge (and also TK). We now have seed banks, groups for gastronomy and tourism. This is innovation…the ancient and the 'new' have to work together and then you will get something even more new [novel]. Science is that, right? To develop new things." (Manuel, 2017)*

Interestingly, this shows the immediate association of the term 'new' with the term 'science.' However, it also indicates a fundamental interaction between the old and the new (TK and SK), in which the old is always needed to actually innovate and find solutions to problems. He continued:

> "*we have numerous innovations and we are learning new things…before we only used positive selection, we only cared about physical characteristics of potatoes. Now, there is participative breeding and different ways to make pollination. We are always innovating, that's how we get the seed. The difference is that now, with CIP, each farmer gets seed from our gene banks" (Manuel, 2017).*

The technicians' perspectives contrast to what Latour (1993) identifies as the Western separation of the 'object world' and the 'human perceptions.' It shows that, for Quechuas, innovations are not entirely objectified or divided off their subjective culture. On the contrary, they understand this 'movement from old to new' in a holistic way, in which TK, culture and customary laws interact with new scientific techniques or breeding methods.

7.3. The NGO

People from ANDES shared the technicians' perspectives on innovation in terms of combining old and new; however, the staff members I interviewed showed more explicit economic goals and thus, more in line with the separation of nature and society referred to by Latour (1993).

In some of the informal conversations I had with the staff of ANDES and in order to understand the concept of 'biocultural innovations,' I asked them about their projects with Quechua indigenous communities. First they talked about participative breeding as their main project and the perfect example of the interaction between TK and SK, which is the basis to understand the concept of 'biocultural innovations': *"we call it 'participative' because it is ANDES working with the help of the communities."* From this quote it is important to note the emphasis on themselves (ANDES) as the lead partner. Another person from the staff told me about the 'biocultural products' that were being developed as market innovations (products like natural teas, shampoos and creams, or even potato-based dishes served in a traditional restaurant by the gastronomic group). They explained how ANDES have been providing trainings and technical assistance to the different 'economic groups' (*colectivos economicos),* formed by members of the communities (mostly women) in order to help them make their 'biocultural products' more profitable by, for instance, improving the design or making culinary dishes more aesthetic. One example of these market products is described in one of the studies elaborated by ANDES (2016, p. 52) as it follows:

> *8.1.2. Market innovations*
>
> *…*
>
> *C. Development of the potato culinary heritage:*
>
> *The establishment of a culinary sanctuary (restaurant) offers schools and visitors educational courses and "walking workshops" on potato biocultural systems, the politics of food and potato culinary art. It gives women a central role in showcasing their talents.*

In one of my conversations with Alejandro, he said that ANDES is interested in helping the communities in the Park start a collective microenterprise for the production and marketing of these products. He also told me that the idea is to get the Park recognized as a seed producer company that works through participative breeding and 'cooperative innovation:' he explained that for him, this *"means that at least 60% of the breeding activity has to be done through TK.*" He continued saying that, "*innovation is adaptation to changes"* referring to an evolution of the practices towards marketability. Further on, one of the staff mentioned that more dynamism in the communities' economy was needed. He highlighted the fact that *"biodiversity conservation by itself is not enough"* [referring to the monetary benefits derived from conservation practices]. For further research, it would be interesting to know if this thought is shared by the communities, that they have the need to increase their monetary benefits. Finally, the same person added that this was the reason why they were trying to get the Park formally recognized as a seed producer.

In conclusion, both the technicians and ANDES perspectives show that 'biocultural innovations' are developed in a collaborative way to solve concrete issues or to meet societal needs of the communities, which is part of the reasons why they can be considered from an open approach. Certainly, the vision of ANDES indicates a relation between the concepts of innovation and development, in terms of transforming something to make it more productive and profitable. The purpose of the technical assistance that ANDES has been providing to the communities that belong to the Park is to empower the people so they can develop these 'biocultural innovations,' as a response to specific issues or challenges presented in their society. However, whether and how these solutions will benefit all the members of the communities or only the members of the community that are directly participating in the development of these innovations (primarily the technicians) remains an open question. We can gain some insights into how to resolve this question from the concepts of 'community' and 'reciprocity' from a Quechua perspective.

7.4. *Ayni:* the sense of community and reciprocity

When I visited the Park for the first time I explained to the technicians that I wanted to learn from them, so they invited me to join the harvesting activities of the day. It was mid-afternoon, time for the customary work break to chew coca leaves, which is part of the Quechua *ayni* principle explained in the previous Chapter. The chewing of coca (or *pichar coquita*, as Quechuas call it*)* has very specific etiquette rules that symbolize the customary principles of reciprocity and sharing that govern every Quechua's lifestyle. The ritual starts by inviting the other to chew coca. They offer a small handful of leaves that the other has to accept with both hands. Then, they offer the coca to the *apus* or sacred mountains and finally they enjoy the moment together. I asked one of the technicians why this ritual was part of the *ayni* principle. He replied: *"very simple, today it's me, tomorrow it will be you."* Later, he explained that they use the coca leaves as the ritual required to ask others for a favor: *"it could be anything… because as a community, we need each other."* They chew coca together every day before working to symbolize this reciprocity principle. But why is the *ayni* principle important to understand community-based innovations?

In Quechuas' communities there is no 'private property' as understood from the Western property system. *Chakras* belong to the same family from generation to generation; however, they understand this 'belonging' as 'the right to use it' and not from a property perspective where a piece of land can be owned, sold or exchanged. A quote from Paco states: *"if my grandfather used this land how could I ever exchange it?"* Because Quechua people do not have this sense of property, they use *ayni* to help each other in the *chakras.* However, Antonio told me that things have really changed since the designation of the Park. He acknowledged other broader social and economic changes that coincided with the designation of the Park and he told me that before, many people would work together in the same *chakra* because they needed each other; now one person is enough to work in his own land and in case some help is needed, instead of *ayni*, they would pay (hire) someone else to work for them. He explained that Quechuas need each other, not only to work in the chakra but also to exchange products that they cannot grow through the barter system, which is done also through the *ayni* principle.

As said before, Quechuas live at different levels or 'ecological zones' in the Andean mountains and thus, they grow different varieties that, later on, they exchange through the barter system in the markets. This system not only allows farmers to access seeds and crops that they cannot produce in their own *chakra* but also gives them access to new pools of seeds and knowledge (Vidaurre de Mulczyk, 2016, p. 75), in this way, incentivizing community participation and collaboration in the innovation process so they can benefit from each other, as in an open source approach. However, as established in the previous Chapter, *ayni* is getting lost and the barter-trade system is getting reduced.

On this topic, staff from ANDES mentioned that, indeed there is less *ayni* and Quechuas do not use barter as before, but that in a way, they think that barter was sometimes unfair because the products that were exchanged had different value and therefore, it was difficult to be fair with trades. This perspective was confirmed by a technician:

> *"We used to exchange potato for corn (for example) in the market, but everything is based on money now. We even hire people to work in our chakra. I think that on the one hand it's good that we don't use as much barter as before because it could be unfair for people that have small chakra and don't really need ayni; they would rather get money to work for others, than get potatoes."*

Undoubtedly, traditional practices involving a*yni* (both as in barter and as reciprocal help in the *chakrai*) contribute directly to the conservation of agrobiodiversity and also to collaborative innovation in breeding: farmers exchange seeds in markets or in communal *chakras*, which is a way of transmitting knowledge and ideas to the community, and therefore, they benefit from each other's innovations. It is possible that, if farmers don't need each other as much as before, and thus, there is less barter, there would be a decrease of agrobiodiversity and community-based innovations. However, the case of the Park is particularly different. Technicians are getting paid, and being trained, and thus are being incentivized to innovate through participatory breeding. Following the same logic, they are simultaneously carrying out *in situ* agrobiodiversity conservation practices and, according to the Community Agreement of the Park, they should be sharing and transmitting their knowledge, regarding innovations on breeding, to the rest of the communities' members; in that way, keeping the sense of community according to an open approach. While several technicians mentioned the types of innovation involved in participatory breeding, the extent of sharing and dispersal of the knowledge is less clear from the research I was able to conduct.

On this topic, Pedro told me that technicians are supposed to teach everything they learn to the rest of the communities. *"In the beginning ANDES was making sure that this was happening but we stop, because we don't have enough resources to keep monitoring this and I really don't know if the technicians are actually transmitting their knowledge."* I tried to investigate this topic with the technicians; however, I was not able to get enough information to assert that knowledge is actually being transmitted in every community. It is important to consider the fact that technicians, in practice to date, almost never rotate, which means that less knowledge might be transmitted in that way than originally intended. This would be a particularly important area for ANDES to channel resources in order to make sure that the open community members' knowledge is taken into account and that more people get involved in creating new innovations, rather than creating a new class of experts, like the technicians. However, in order to be sure about this situation, more research would be needed with community members beyond the technicians.

When I asked about knowledge transmission some of them associated the question with the benefit sharing from activities regarding participative breeding. Juan told me about the communities' fund and the way they share some percentage of it with the communities through an equitable standard, according to participation. Jaime added that, from this fund, technicians get tips or *propinitas* for their work; making an interesting separation between technicians and the rest of the community, which led me to think that the innovators were actually ANDES and CIP with the help of the technicians. The potential difference between the technicians and other members of the communities also arose in one of the informal conversations I had in one of my visits to the community of *Paru Paru,* where I spoke to a man who I met in the road and I asked him about the Park. He said he actually works in *Camino Inca.* He comes every 15 days to visit and bring money to his family and he is not very informed about what is going on (he never even heard about ANDES). He also mentioned that he has better life now that he works in the touristic sector and he earns more money. This is only an anecdotal data point, but highlights that further research should be done in order to understand what the rest of the community knows or perceives from the innovations, and it is important to take into account that not all the members could directly benefit from this.

As a conclusion, things have definitely changed in the Park since the designation of the technicians and the loss of barter which has caused a loss of knowledge transmission as well (even though technicians should still transmit their knowledge). As West *et. al.* (2008) stated, in order to have a 'community-based model' of innovation there has to be a voluntary association of members united by a shared goal. However, it is important to take into account the fact that this author was referring to a community of software developers when talking about 'community-based innovations,' in which participants are clearly defined as co-creators and there might be users that have no pretention to be included in that community.

In the case of the Park, however, the delineation of community is more difficult. There is definitely a voluntary association with a shared goal of innovating with the use of TK and SK. Now, even if it is only the technicians and ANDES doing the innovative work, they are sharing the benefits of the innovations between the community members (monetary benefits from the fund according to participation). This sharing is part of the *ayni* principle and the fact that, in the case of Quechuas' communities, somehow all the members of the communities have been involved in the development of biocultural innovations for years. Thus, a broader understanding of community should be invoked than the one used by open innovations in software.

Nonetheless, we also stated that technicians are not necessarily transferring knowledge (taking into account that not all the members of the different communities participate in the process of developing biocultural products or breeding activities). Thus, it would be important that knowledge is shared in both directions (ANDES – technicians/ technicians – communities' members) in order for open biocultural innovations to take place. If the biocultural innovations are not adapted to the communities' knowledge systems there would be a risk that technicians become just a new class of experts. However, with the elements that we have, we can still consider biocultural innovations from an open approach, as they have voluntary involvement of the members, they are developed in a collaborative way and aiming at meeting social needs.

8. The Super Potato: innovation and intersection with current legislation

Through this research I have shown the complex regulatory framework applicable in Peru on IPRs and plant breeding, farmers' rights, and traditional knowledge, and also agro-biodiversity conservation. I also showed the different knowledge systems and different perspectives on innovation to understand how these intersect with the current applicable legislation. Two main findings were obtained:

1. Divergent perspectives on the term 'innovation' were found among the different stakeholders' groups. On the one hand, technicians and ANDES talked about community-based innovations from an open and social approach where ideas from TK and SK were brought up together through participative breeding, and in response to the needs of the indigenous communities. On the other hand, policy-makers, lawmakers and experts related the concept of innovation to scientific knowledge (mostly from foreign companies or research institutes) and to the dominant IPRs approach.
2. The native varieties that, until now, have been developed and conserved by the communities in the Park as biocultural innovations are not eligible to be protected through an IPRs regime because they do not fulfill the technical characteristics (distinctness, uniformity and stability) required by UPOV 1991; in other words, they are not considered innovations from the scientific-centralized IPRs approach.

The purpose of this last Chapter is to analyze the way in which an open source seed model could potentially protect these biocultural innovations under the Peruvian applicable laws, according to Research Question 3: *How could an open source seed model to protect biocultural innovations be implemented in Parque de la Papa, under the Peruvian applicable laws, and how might it affect the knowledge and innovation systems of local communities?* Through the Chapter, the term 'biocultural innovations' will be used to refer only to the participative plant breeding innovations developed by ANDES in cooperation with the technicians.

In order to answer this last research question, I will use a project idea from ANDES, which will be referred as 'the super potato,' as a hypothetical case that will serve to analyze the benefits and drawbacks of an open source seed approach as an alternative tool to protect biocultural innovations developed in the Park. The super potato project is an idea from ANDES to develop an improved potato variety in the Park derived from the crossing of a CIP variety and native variety, and also through participatory breeding. The plan is to take important genetic characteristics from these two varieties to release a frost-tolerant variety that will be able to grow above 4,000 m (characteristic of the native variety), and would also be disease-free and contain great nutritional value (characteristics of the CIP variety). This new variety would also meet societal needs of the communities that live above the 4,000 (most of the poor people in the country live in high altitudes in the Andean mountains), taking into account how hard it is for any other crop to grow at such altitudes; thus, it would contribute to food security for these communities. However, what would be the ideal legal protection for a new variety that is developed from the combination of an improved variety from CIP and a native variety that has been grown by these communities for years?

As said before, indigenous communities are not considered genuine inventors of their biocultural innovations because native varieties do not comply with legal and technical requirements to be protected through an IPRs regime. Yet, this new variety could potentially fulfill these technical requirements. However, it is pertinent to acknowledge the fact that CIP is part of the CGIAR research program on roots and tubers, and thus is subject to the Plant Treaty regulations on access to plant genetic resources within the Multilateral System. From this Treaty, it is important to point out the following provisions:

> *Article 12 - Facilitated access to plant genetic resources for food and agriculture within the Multilateral System (…)*
>
> *12.3 Such access shall be provided in accordance with the conditions below:(…)*
>
> *d) Recipients shall not claim any intellectual property or other rights that limit the facilitated access to the plant genetic resources for food and agriculture, or their genetic parts or components, in the form received from the Multilateral System;*
>
> *(…)*
>
> *13.2 The Contracting Parties agree that benefits arising from the use, including commercial, of plant genetic resources for food and agriculture under the Multilateral System shall be shared fairly and equitably through the following mechanisms: the exchange of information, access to and transfer of technology, capacity-building, and the sharing of the benefits arising from commercialization, taking into account the priority activity areas in the rolling Global Plan of Action, under the guidance of the Governing Body…*

It is apparent from the above that the Park could potentially access propagating material from CIP in order to develop the 'super potato;' however, two unresolved issues arise from the above provisions: a) whether the Park would be subject to regulations provided by Article 13.2 in respect of benefit sharing, and b) whether the Park could claim IPRs for the 'super potato,' in regards to Article 12.3.d.

In order to solve the first issue, it is important to go back to my interviews and conversations with the staff from ANDES, and the meetings attended at INIA. According to these, there are plans to start a formal micro-enterprise of seed production in the Park, which, on the surface, makes me assume that this 'super potato' would indeed be commercialized. However, it is unsure if the Park would be obliged to share benefits through the Multilateral System fund for the use of a CIP variety if this 'super potato' is indeed commercialized. This, taking into account that most of the CIP improved genetic material of potato comes from varieties that are native to Quechuas' territories. Then, according to the theory already portrayed, the original breeders of these improved varieties would actually be the indigenous communities at the Park; therefore, it would not be fair that they had to pay for these materials. In fact, this logic was used by CIP when providing genetic material to the communities for the repatriation project referred before. So in conclusion, this case would presumably be a precedent for this issue, however, further research would need to be done in order to be sure if an exemption like this could be made in regards to indigenous communities.

Regarding the IPRs issue, Article 12.3.d. is clear at establishing the legal impediment to protect CIP material 'in the form received.' According to Helfer (2003, 34-35) the scope of IPRs protection in derivative products is still questioned: "the critical issue for interpreting Article 12.3 (d) is just how far the seed's genetic blueprint must be modified before the resulting genetic material is no longer in the "form" received from the multilateral system." The Governing body of the Plant Treaty has not clarified this issue yet. Some argue that it would be sufficiently new and distinct in terms of IPRs to extract genes and incorporate it to another variety; others affirm that the IPRs ban extends even to isolated DNA. However, this legal gap opens the possibility to protect the 'super potato' through IPRs, since it would be a derivative from the CIP variety and a native variety, which, from an IPRs approach, is considered raw material for innovation.

Now, let's suppose that a seed company finds this 'super potato' variety and wants to isolate genes from it to develop some new variety and then get a patent or a breeder's certificate. Would this situation represent a risk for the farmers' communities that would be using this variety? Even if some of the policy-makers and experts that were interviewed on this topic argued that UPOV regulations would not represent a risk for the farmers, specifically in the case of potatoes, due to the fact that most of the market is informal; this argument is not strong enough to assert that a seed company would not be able to restrict farmers' traditional practices concerning the use, exchange and saving of the seed, in the case that the company had claimed IPRs on any derivative of the 'super potato.' Then why not protect the variety through breeders' rights in order to prevent that someone else from appropriating the innovative work?

From the results of this research it is possible to infer that IPRs would not be a good solution for indigenous communities due to significant practical difficulties to allocate rights and enforce them. This regime would also affect community and local seed systems, as it does not recognize community-based innovations (how to decide who is the breeder?) In addition, it does not go in line with the Quechua *ayni* principles of sharing in a reciprocal way. The aforementioned according to all the technicians that were interviewed, who showed an open attitude to sharing when they were asked about their perception of knowledge and innovation. They referred to this matter with some quotes like: *"First the Park, then the world;" "We save the seed not only for us, but for the world, for all the* *farmers in the world;" "Our farming system is horizontal. This means that we share and learn from each other;" "The seeds belong to the Park but they also belong to everyone;" "Farmers from around the world admire us because of all the diversity we conserve, so they come to learn."* Even staff from ANDES explained how Quechuas have a different way of perceiving the world: *"They don't have a concept of property on seeds, they are really open to share. They have ayni, you know? The only thing they request in exchange (when sharing) is that you will take care of their diversity.*" These quotes show how different is an indigenous worldview on property, knowledge and innovation, from the dominant IPRs approach, in which the concept of property and exclusion is taken as a necessary incentive to innovate.

Furthermore, part of the things I understood from my interviews is that, even if some of the technicians are aware of some international treaties, they are only informed as for the protection of indigenous knowledge or human rights. Some of them mentioned the International Labor Convention on indigenous and tribal people (ILO 169). Others expressed the lack of protection and information in regarding the national legislation *"Here, the farmers, we only work. No information about legislation. But at least we have recognition from other countries as protectors of diversity… even the President recognized us as the custodians"* (Julio, 2017). Few of them understood the term IPRs, by relating it to the term GMOs and by mentioning that few years ago they signed a letter asking for a ban on GMOs and they (together with other efforts) achieved a decade-long moratorium: "*In this region, transgenics are forbidden"* (Antonio, 2017). And some others related any legislation on IPRs to protected areas, proudly telling me that they also achieved the recognition of the Park as a Biocultural Heritage Area. The reason for this lack of information on IPRs might be that so far they haven't had any restrictions on their practices (derived from IPRs regulations) from seed companies. In conclusion, even if IPRs would not be a good solution to protect the 'super potato,' it is acknowledged that there would exist a potential risk that someone else could appropriate this innovation, thus it would be necessary to use an alternative property rights mechanism to protect this biocultural innovation.

Now, it is true that an open source would be a way to get around IPRs, taking into account that biocultural innovations could, in theory, be protected through this type of mechanisms Yet, in the practice, how might this affect the knowledge and innovation systems of local communities and how would it intersect with current legislation according to policy-makers' perspectives on innovation? In order to know how an open source model would intersect with current legislation, it would first be required to know if the Park would be able to commercialize its native varieties even if they are not registered and certified according to the National Seeds Legislation and applicable regulations. According to what I understood from the meetings at INIA, ANDES is currently trying to get the Park recognized as a seed producer by making suggestions to the modification project of the Seeds Regulations. If the Park's native varieties are registered, it would be easier to implement a hybrid open source seed model based on the Quechuas' perspectives on innovations because, in fact, they already have an effective system based on customary norms, in which sharing and protecting diversity are essential principles. However, it is difficult to know if this hybrid open source model could be implemented to commercialize seeds outside the Park, if they are not formally recognized as seed producers and if the seeds are not registered or certified.

Now, let us assume that the Park decides to implement an open source seed model to protect this new ‘super potato’ variety and thus, they register the seed and start commercializing the product; how would they be sure that no one would appropriate their innovative work? It was said that OSSI works with license agreements, which form part of the “private ordering and self-regulation” that was referred by Elkin-Koren (2005). In the case of OSSI the license agreement works as a pledge, which is basically a piece of paper that the breeder must insert to the seed bag, with an inscription that says that the seeds can be freely used for any purpose on the condition that all derivatives of the seeds (and the seed itself) retain the same freedoms. However, as said before this license cannot be legally enforced because it only operates in the terrain of moral norms and ethics (Kloppenburg, 2014). This would mean that, if the Park decides to implement the OSSI model, the communities, as breeders, should release this potato under a pledge and then they would be able to make arrangements with other companies or other farmers to sell the seeds. But in the given case that a company or any other contracting party breaches this pledge it might be difficult for the Park to legally enforce this license, thus the innovation behind this ‘super potato’ might be unprotected. However, it would also be possible that this case could work as a precedent, in which the written license could be brought to Court and be treated in the same way as an open source software license would be.

Certainly, an open approach would incentivize a growth of the knowledge pool because more innovations would be shared without IPRs restrictions. It would also favor genetic diversity, considering that native varieties that in principle could not be eligible to be protected through IPRs, mostly because of their genetic heterogeneity, in this case could be protected through an open source model, in this way incentivizing the use of diverse native varieties. However, it is important to recognize that the efficacy of an open source model would depend on how this is implemented and how the authorities would treat cases of breaches of obligations under the license agreement.

Final remarks

Even if it is not yet fully necessary to implement an open source seed model inside the Park in order to continue current operations, because they already have an open source approach to innovation in their minds and practices, it would have effects on future users outside the Park. An open source seed model could definitely bring benefits to the Park since it would generate an opportunity for the communities to share their innovations and finally be recognized as “real breeders” and not only TK producers and guardians of agrobiodiversity, which seems like it would be an important step symbolically. It would also potentially contribute to food security and nutrition around the world, for other poor communities living in the high mountains with limited access to food and agriculture. Additionally, it would help prevent possible appropriation through IPRs from other breeders. However, it is acknowledged in this research that this might not be enough due to the lack of legal mechanisms to enforce the license and ensure that no one would breach the agreement or pledge.

Apart from the enforcement issue, another drawback would be related to the fact that this would contribute to even more codification of knowledge and might shift community relations when implementing the benefit-sharing arising from the commercialization of the varieties released through this open model. However, during this study it has been stated that traditional knowledge systems are not static and are actually embedded in a broader sociopolitical context, in which communities can be prepared to adapt to new conditions, which in this case could mean that the communities in the Park might need to adjust their Community Agreement in order to contemplate new conditions in terms of benefit-sharing from the commercialization of varieties through the open source model. The question would be if, when releasing and sharing the new varieties as 'biocultural innovations' all the abstract, holistic and qualitative characteristics of the TK that is involved in these varieties would be actually maintained and protected after the codification. It is possible that many aspects of the TK that Quechua communities possess could be discarded when registering and commercializing the varieties through this open model, because these might not be considered in the 'usefulness' parameter of a formal micro-enterprise of seeds, or simply due to the complexity of codifying these abstract or qualitative elements of TK. However, if the communities keep developing these biocultural innovations with the use of their TK, and try to transmit the knowledge-production process to the rest of the members, as established in the Park's Community Agreement, it is also possible that these traditional practices be conserved and maintained through time. To ensure that the provisions of the Community Agreement, in terms of knowledge transmission, are actually implemented, could be a precaution that ANDES could take in implementing an open source system that involves the different communities, both in terms of sharing monetary benefits from innovations but also in terms of sharing knowledge so these innovations continue to be open.

9. Conclusion

The purpose of this thesis was to investigate the potential compatibility or conflicts of an open source seed model for biocultural innovations developed by Quechuas' communities in the Potato Park, taking into account the different stakeholders perspectives on knowledge and innovation and the applicable current legislation in Peru, in the field of IPRs and agrobiodiversity conservation.

This research has pointed out the drastic shifts in the legal treatment of plant genetic resources through time, from the strict IPRs regime to the recognition of the role of farmers in terms of conservation of traditional varieties. However, this study also reflected on the fact that the native varieties that have been conserved by indigenous communities have only been recognized and valued in terms of agrobiodiversity conservation and not as "real innovations," eligible to be registered and protected through effective legal mechanisms as the IPRs. As a response to the limitations of the IPRs regime, I have explored the idea of an alternative property rights regime, in which native varieties that have been preserved and bred by indigenous communities in the Potato Park, could fit as open innovations.

I have found that in the Park, and with the help of ANDES foundation, efforts have been carried out to integrate indigenous traditional knowledge to modern scientific techniques of plant breeding to conserve and restore native varieties of potatoes for further registration and commercialization. This has been done through a combination of TK and SK as participatory breeding, with the objective of developing biocultural innovations. However I found that this integration of TK to science has evolved in a codification of knowledge that has been considered necessary (for both technicians and ANDES) in order to be formally recognized as valuable and useful, which goes in line with a dominant IPRs approach to innovation and knowledge.

It is true that since the designation of the Park and the cooperation with ANDES and CIP, the knowledge-production processes in Quechua communities have been changing, however, I found that there are other factors, which go from environmental to sociopolitical circumstances, which have also affected traditional practices of the communities. Thus, the fact that the knowledge system changes does not necessarily mean that TK is being lost, but rather that communities have been able to adapt to new conditions. However it would be important that the NGO takes into account this adaptation process when trying to implement an open source seed model in the Park, in order to ensure that knowledge is still transmitted to the communities' members even if the process changes.

Furthermore, through this research I identified divergent perceptions on the term 'innovation' in the different stakeholders' groups that were interviewed. On the one hand policy-makers and experts related this term with the dominant IPRs approach which considers native varieties primarily as raw materials for further innovation. On the other hand, technicians described innovation as the use of TK and SK to provide ad-hoc solutions to specific problems, as the diseases of their native varieties. Finally I identified a hybrid positon from the staff of ANDES as they showed an open approach to innovations, but with a strong interest in making the Park a profitable seed producer. The intersection of these perspectives shows that even if an open source seed model could potentially be implemented in the Park there would be both benefits and drawbacks that would have to be analyzed in order to define how it would affect knowledge systems and open innovations in the communities.

It is a fact that the IPRs regime would limit access to genetic resources that might be necessary for the development of new varieties. On the contrary, an open source seed model would represent an alternative that includes the participation of all the stakeholders (members of the communities) involved in plant breeding, providing a legal framework that would ensure that the real breeders get monetary rewards for the work, while preserving the principles of sharing and seed saving. However, an open source seed model might also shift community relations as it would be difficult to allocate rights and benefits derived from the future commercialization of the varieties that would be released through this initiative. For this reason, precautions must be taken by the NGO if varieties start to be commercialized through an open source seed system. Different types of effects might be taken into account for the implementation of this model:

- **Environmental**: the fact that an open approach to innovation implies sharing instead of restricting would have a positive effect on agrobiodiversity conservation as more farmers would be incentivized to use, conserve and improve more plant varieties and plant genetic resources, thus increasing the world gene pool.

- **Social**: this model would contribute to food security and nutrition around the world since open innovations are made to provide ad-hoc solutions to meet specific societal needs (in this case to develop potato varieties that would be frost- tolerant and, at the same time, that contain nutrition value), which will help other poor communities living in the high mountains with limited access to food and agriculture. However it could have an effect on the codification of traditional knowledge and might shift community relations when implementing the benefit-sharing arising from the commercialization of the varieties released through this open model. Therefore, precautions might be taken by the NGO to ensure that the provisions of the Community Agreement, in terms of knowledge transmission, are actually implemented and thus, these innovations continue to be open.

- **Legal**: this model would generate an opportunity for the communities to share their innovations and finally be recognized as “real breeders” and not only TK producers and guardians of agrobiodiversity. Also, it would help prevent possible appropriation through IPRs from other breeders. However, it is acknowledged in this research that this might not be enough due to the lack of legal mechanisms to enforce the license and ensure that no one would breach the agreement or pledge.

Even if this research achieved its aims and objectives outlined in the introductory part of the study, it is important to add that the attempt was to provide alternative responses and insights to problems that could be broad, complex and unique in its kind. However, it is acknowledged that further research in the field of alternative property rights systems should be done in order to understand better the perceptions of the rest of the communities’ members and the potential impact of an open source system in their knowledge systems and traditions. This would provide valuable feedback in this area to more fully meet the aim and objectives of this research.

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