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Bioprospection Beyond Intellectual Property Rights:
The Kani Model of Access and Benefit Sharing

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Contributed paper prepared for presentation at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12-18, 2006

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ABSTRACT

This paper addresses the value of bioprospection for genetic resources (GR) and traditional knowledge (TK) from the South for industrial/research input. The focus is on a dynamic approach to contracting and property rights building upon insights from evolutionary institutional economics. Drawing on a unique 'access and benefit sharing' (ABS) bioprospecting contract from the Western Ghats, India, we show how the monetary value of plant genetic information from the traditional knowledge holders' perspective can be assessed using a contingent valuation modelling approach. While the study allows the identification of such values from one of the main stakeholder's (i.e, the Kani community) perspective, it also allows to point out some of the key gaps in the valuation of GR/TK associated to ABS cases from an evolutionary institutional perspective. Two important conclusions come out of this analysis. First, it highlights the necessity to go beyond standard market approaches to economic valuation of GR/TK in order to address the issues of future possibilities of use and innovation and the integration of the different stages in the process of value creation from GR/TK. Second, it shows the necessity of developing alternatives to the current intellectual property rights regime, including systems for appropriate protection of TK of local communities.

Keywords: Bioprospection, genetic resources, traditional knowledge, Kani model, Western Ghats,

1. Introduction

There is a significant strategic interest by 'Northern' industries of accessing and using genetic resources (GR) and associated traditional knowledge (TK) from the South. Such repository of bioresources in the South co-evolves through the development of TK and the continuous GR refinement adaptations in natural and managed ecosystems. The North/South debates over ownership, intellectual property rights (IPR), and of and access to the GR-TK stock were crystallized in the negotiations of the United Nations' Convention on Biological Diversity (CBD) which entered into force in 1993, and now establishes the legal framework for the reciprocal transfer of bioresources between countries (Bhat, 1999).

However, in many instances the rights of GR-TK holders, including the source country governments and indigenous/local communities are being erased and replaced by those who have exploited their biogenetic and TK through prospecting endeavours. Such cases of *biopiracy* are being reported more frequently (Sheldon and Balick, 1995; Shiva *et al*, 1997; Drahos, 2000; Dutfield, 2002; Verma, 2002).[1] The CBD acknowledges

[1] The word 'biopiracy' was first introduced by Pat Mooney of the Rural Advancement Foundation International (now known as ETC, Action Group on Erosion, Technology and Concentration). RAFI defined biopiracy as "the use of intellectual property laws (patents, plant breeders' rights) to gain exclusive monopoly control over genetic resources that are based on the knowledge and innovation of farmers and indigenous peoples" (RAFI 1996:1).

that when effective ABS systems are removed, it creates disincentives for *in-situ* conservation of the GR-TK stock. Against this backdrop, the debate on the conflicting approaches to IPR with regard to domesticated and wild bioresources and associated TK is re-emerging in order to devise ways of defensive protection against the misappropriation by bioprospectors and to design innovative means for positive protection (Dutfield, 2002).

In order to evaluate the potential contribution of benefit sharing systems to local communities and others, a number of studies have focused on estimating the value of bioprospecting using a wide array of approaches (Principe, 1989; Pearce and Purushothaman, 1992; Simpson *et al*, 1996; Rausser and Small, 2000; Craft and Simpson, 2001). Broadly speaking, these studies assess the value of bioprospecting using standard cost-benefit analysis, in which the opportunity cost of land conservation, among others, is weighted to assess the expected benefits related to the discovery of a new useful property of a bioresource (net of the associated R&D costs such as biological material screenings).

In the light of the debate of how to address the IPR problem this paper addresses the question whether a static analysis is appropriate to approximate the social welfare loss from depreciating the GR-TK stock through non adequate or absent North-South bioprospection contracts and ABS agreements. We draw insights from contemporary economic analyses of contracts and property rights based on (evolutionary) institutional economics. We use the case of a unique ABS biodiversity contract in India as an example of how the monetary valuation of TK/GR may be assessed from the direct TK holders' perspective following a neoclassical economics (static) perspective. While the study allows the identification of such values from one of the main stakeholder's (i..e, the community) perspective, it also allows to point out some of the key gaps in such ABS cases from an evolutionary institutional perspective. This case study is based on a widely acclaimed model of ABS that involves the Kani tribe of the Western Ghats (WG), a global biodiversity hotspot, in India (Anuradha, 1998; Moran, 2000). The WG is a 160,000 km2 eco-region shared by six southern Indian states: Gujarat, Maharashtra, Goa, Karnataka, Tamilnadu and Kerala. It is one of the 25 biodiversity hotspots that have been identified globally (WGF, 2003). According to Ranjit Daniels, an estimated 10,000-15,000 species of organisms are likely to be found in the Western Ghats, of which about 40% are endemic.

The paper is structured as follows: First some key questions that point towards the reasons for the inadequacy of the current incentive mechanism that leads to socially sub-optimal levels of investment in biogenetic resources as a source of innovation under actual ABS regimes are addressed. The conceptual discussion is then applied to quality the degree of 'success' of a unique bioprospection case based on the Kani model of benefit sharing (KMBS). After briefly describing this bioprospection case, the KMBS is analysed from a wider institutional angle. This allows us to shed more light into one specific question in the context actual ABS under the CBD based on the acclaimed KMBS case: How does the realized KMBS agreement match with the implicit value of the compensation for sharing TK from the local TK holders' perspective? We finally draw some conclusions from the analysis.

2. From a static to a dynamic IPR framework in bioprospection contracts

The existing mechanisms for the regulation of bioprospecting contracts proceed on the two poles of the contractual relationship, generally characterised by the industrial sector in the North (mainly the biotechnology and pharmaceutical sectors) and the providers of the biogenetic resources in the South (mainly local communities, botanical gardens and government administrations). Two basic features are inherent in the contracts. Firstly, the contracts aim at providing an incentive for innovation through the IPR on the finished product at the end of the production line. Secondly, they aim at protecting the providers' rights through the insertion of clauses in the contract with regard to the *free prior informed consent* to be obtained from the holders of GR-TK and the equitable sharing of the benefits from the development of commercial applications, i.e., *access and benefit sharing* clause. Since the CBD entered into force, numerous ABS agreements have already been signed and analysed (see: Mulligan, 1999; Svarstad and Dhillion, 2000; Peña-Neira *et al*., 2002).

CBD and Access and Benefit Sharing (ABS) agreements are dependent on a static notion of efficiency that has characterized the classical economic analysis of law (Dedeurwaerdere, 2005: 473-475). This notion is linked to the idea of optimal allocation of existing resources under ideal conditions of perfect rationality. Moreover, it has characterized environmental policy during the last two decades resulting in an intensive application of benefit-cost analysis in the determination of the objectives of environmental regulation and the recourse to economic incentives as the means to achieve these objectives, increasingly through the creation of markets for environmental goods or environmental titles (Driesden, 2003). By contrast, a dynamic conception of efficiency, focuses on the acquisition of new knowledge and new competences allowing to maximize the range of future choices of development processes.

In the context of regulations for the conservation of GR-TK, the actual approach by the CBD is largely based on the static approach ultimately seeking to provide the 'right' incentives to effective GR-TK conservation through market creation (bioprospection). The problem is that the actual IPR mechanisms rely in valorising (i.e., adding value) to GR-TK at the final stage of the innovation process. By contrast, the dynamic approach seeks to address each step of the innovation process from the ecosystem as the repository of co-evolutionary GRs to the industrial applications, and through the added value of local communities' TK and research laboratories. This implies that there is a need to create incentives for innovation along the entire chain of the innovation process in order to realize the objective of maximizing the future options of development, In the broader field of biodiversity governance, there is already an increasing recourse to tools aiming to implement such dynamic approach.

In the context of ABS under the CBD, the dynamic approach to economic efficiency helps to point out a double limitation as regards effective incentives for biodiversity conservation, that is inherent to the static approach in the actual IPR mechanisms that affect ABS agreements. The first limitation of the static approach is organisational. It shows the incapacity to deal with the integration of the distributed knowledge generated along the entire innovation chain, on which economic innovation in a world of specialization depends. The second limitation is institutional. It shows how the static approach leads to the blocking of the innovation process in a suboptimal development path, by providing only institutional incentives related to the current market opportunities and not addressing the future options of development.

The first limitation in the actual IPR model that constrains CBD as regards bioprospecting activities arises due to the overwhelming attention to those products that are '*currently*' interesting to the industry, making the bilateral contract mechanisms considered in the ABS regime inadequate from a social perspective. Solving the problem of the uncertainty on the potential value of these contributions to knowledge generation through only compensating the few lucky cases of bioresources that make it to the marketplace is a poor strategy from an economic (efficiency) perspective.. At each step of value creation (fro the ecosystem to the biotech firms), the outcome of the investment is uncertain and, moreover, the investment at each stage is motivated by a broader set of social values than only utilitarian values related to potential monetary benefits.

The second reason for the sub-optimal character of investment in biogenetic resources in the ABS regime is related to the inadequacy of the IPR mechanism regarding a resource that is itself evolutive by definition (Swanson and Goesch, 1999). An illustrative example is that of the agricultural sector in which a highly productive, competitive seed that is resistant to pathogens is introduced. This introduction induces an adaptation in the population of pathogens in a way to make them more 'aggressive', therefore enhancing the relative fitness of successful mutants adapted to intensively cultivated crops (Swanson and Goeschl, 1998) or by increasing resistance of the pathogens to pest control technologies (Goeschl and Swanson, 2002). As a result, the resistance of these newly introduced productive seeds decreases with time and its latent competitive disadvantage needs to be taken care off permanently by adapting the seeds and/or the means of production in reaction to the adaptation of the population of pathogens in the environment.

This double inadequacy of the current incentive mechanism leads effectively to sub-optimal investment in biodiversity as a source of innovation. Following Goeschl and Swanson (2002), three kinds of insufficiencies that result from ABS regimes can be underlined, all based on incentives relying on the existing IPR mechanisms: First, the IPR mechanism is insufficient for investment in products with a short life span. It creates an underinvestment in GRs with high adaptability. Second, the IPR mechanism creates a trend of monopolisation and is therefore not compatible with the requirements of an innovation process based on diversity. Third, the IPR mechanism acts at the level of individual companies and does not create an incentive to invest in the other stages of value creation whose benefits are diffuse. In particular, it produces an underinvestment at the level of the ecosystem and its local or indigenous users.

What are the consequences of such a dynamic framework for the economic analysis of bioprospecting contracts?[2] As has been shown by North (2005), dynamic efficiency ultimately depends on the cognitive belief structure of the broader community involved, such as the beliefs underlying science and democracy, which have played an important historical role in organising processes of permanent inquiry and social learning. Because of the effect of these background beliefs on dynamic efficiency, no full dynamic theory that is useful is likely to evolve (North, 2005: 125). Nevertheless, North indicates some more modest and pragmatic goals that should be the object of an economic analysis of dynamic efficiency (Ibid.: 163-164): (1) analyze why dynamic efficiency has been blocked in suboptimal development paths (2) understand the cultural heritage of

[2] Several general methodological consequences have been drawn from these insights on dynamic efficiency, most importantly in Aoki, 2001: 387 ; Eggertsson, 2005: 184 and North, 2005: 155-165. Here we follow in particular the cognitive framework put for by North (2005).

a society and the margins at which the belief system may be amenable to changes (3) develop the institutional / organizational framework for capturing the productivity potential inherent in integrating the dispersed knowledge essential to efficient production in a world of specialisation (4) analyze the conditions for more effective monitoring of the political system. The second and forth goal are clearly beyond the scope of this paper. The first and the third have been the focus of our analysis thus far and it is to these two objectives that we turn in the next sections[3].

Next, in section 3, we provide a qualitative assessment of the reasons why bioprospection contracts are not able to realize the full potential for biodiversity conservation and improvement of economic welfare. In order to do so we introduce a unique bioprospection case from the Western Ghats of India which has been widely praised as a 'successful' contract design involving the holders of TK[4]. Then section 4 carries out a comparative institutional assessment of the IPR mechanisms that are perceived as being a source of economic progress by the different contractual agents (i.e., the TK holders, private commercial company and the State). The two situations that are addressed are: (a) the full transfer of IPRs to the private company, as it is in the actual contract as described in section 3, and (b) the alternative situation in which the TK holders retain full ownership of their TK[5]. We argue that the latter case would provide a more sustainable contractual design because it takes into account the perception of a key agent in the innovation chain, i.e. the local community, which is not taken into account in the actual contract design.

3. The Kani model of benefit sharing (KMBS): An institutional fitness analyis.

This section introduces and then analyses the widely acclaimed bioprospection based Kani model of benefit sharing (KMBS) in the Western Ghats of India from an institutional economics perspective. Before the institutional 'misfits' of the KMBS that limit the scope of a more complete ABS system from a dynamic perspective are addressed, let us first describe in a nutshell this ABS case that prises itself of being a unique case in which actual payments have been made to the TK holders for a successfully developed commercial therapeutic product (Anuradha, 1998). Following an 'incidental discovery' of an small perennial herb known as *Trichopus zeylanicus* by a group of scientists of the therapeutic properties of the herb, a local Botanical Garden from Kerala formulated the herbal tonic *Jeevani* (also known as 'the ginseng of the Kani people'), that can bolster the human immune system. The production technology was then transferred to an Indian pharmaceutical company, AVP, for its commercialisation and the company agreed to compensate the Kani community through the intermediation of a locally established Trust.

The Kani community comprises around 18,000 people spread across 30 settlements and villages in the forests of the Agasthiyar Hills of the Western Ghats in Kerala. This area is designated as a reserved forest, rich in biodiversity and strictly regulated by the Forest Department of the State Government. Traditionally, the

[3] In particular, we focused on the importance of the preservation of future possibilities of innovation beyond the blocking of dynamic efficiency by only dealing with the current market opportunities (first goal) and knowledge acquisition throughout the entire process of value creation (third goal).
[4] See footnote 5.
[5] Which we have studied through a contingent valuation survey (cf. section 5).

Kanis have consumed dry fruit of *T. zeylanicus* to reduce fatigue (Pushpangadan *et al*, 1988).[6] The 'discovery' of the therapeutic properties of the herb, *Trichopus zeylanicus* ssp. Travencoricus (locally known as *Sathan Kalanja* or *Arogyappacha*), by a team of Indian scientists visiting the reserve in 1987, effectively laid the foundation for the KMBS. On the basis of this discovery, the Tropical Botanical Garden and Research Institute (TBGRI) from Kerala standardized a herbal as tonic to bolster the immune system and provide energy known as *Jeevani* ('*provider of life*') and formulated with *T. zeylanicus* in combination with three other medicinal plants. Then in 1996 the production technology was transferred to an Indian pharmaceutical company, Arya Vaidya Pharmacy Coimbatore Ltd (AVP). The TBGRI licensed *Jeevani* to AVP, and it agreed to share the licence fee of Rs 1 million (about US$ 23,000) and a royalty of 2% on ex-factory sale of the product with the Kani community on a 1:1 basis.

This was then followed by the creation of a local Trust Fund for the Kanis known as the 'Kerala Kani Community Welfare Trust', first registered with members from the Kani tribe. In 1997 the amount due to the Kanis was transferred to the Trust with the understanding that the share of the licence fee and the accrued interest and royalty would be in the form of a fixed asset of the Trust used for welfare enhancing activities of the Kanis (Sahai, 2000). More specifically, under the establishment of the Kani Welfare Trust in 1997, the KMBS was based on the transfer by AVP of Rs 519,000 to the account of the Trust (Rs 500,000 as the 50% of the licence fee and the rest was the first instalment of royalty from the sale of the drug, which up to 2003 generated Rs 100,000).[7] The mode of expenditure of the Trust was decided by majority voting in the Trust, employing the service of two lawyers to help in legal matters.

Once Jeevani started to be marketed, the fast proliferation of domestic and international markets for the herbal tonic necessitated regular supply of fresh leaves of *T. zeylanicus*. Since the wild collection was both inadequate to meet the market requirements and could create ecological overexploitation due to being habitat-specific (the therapeutically active compounds are produced only when the herb is cultivated in and around its natural habitat), AVP proposed a plan for the cultivation of *T. zeylanicus* to the Kerala Forest Department, part of the State Government, and the Tribal Welfare Department. According to this plan, the AVP would enter into a buy-back arrangement with the local community to buy the leaves harvested from the cultivated plants. The firm was prepared to buy five tonnes of leaves per month and the TBGRI trained 50 Kani households for a pilot level cultivation season in 1996 by availing a subsidy of Rs 1,000 (about $US 22.25) for each cultivating household. However, due to the lucrative nature of the leaf sale of *T. zeylanicus*, the local community began to collect the whole plant from its natural forest habitat. This made the Forest Department to proscribe its cultivation fearing the ultimate extinction of the species.[8] It was not until several years of negotiation concluded in 2003 that the Forest Department re-issued consent to cultivate the herb and the Kanis were in a position to bargain for a better price for their produce. However, the contract with the AVP lasting

[6] The phytochemical and pharmacological studies of *T. zeylanicus* have revealed the presence of certain rare glycolipids and non-steroidal polysaccharides with profound adaptogenic, immuno-enhancing, antifatigue properties.
[7] The inadequate supply of the leaves of the herb was the main reason for the relatively low amount of royalty accrued during this period. Subsequently, the pharmaceutical firm, AVP, began to use a limited quantity of raw drug collected from another Western Ghat region of the nearby State of Tamil Nadu.
[8] TBGRI tried with only limited success to develop a propagation technique through tissue culture seedlings.

only for another six months, made the pharmaceutical firm unwilling to negotiate a new price contract for the produce.

Despite the universal acclamation of the KMBS, it has not yet achieved its full potential due to various institutional impediments. Here we identify various intertwined aspects related to wider institutional impediments that underlie the relative 'success' of the KMBS experience. These are based on the conflict of interests and coordination problems between the the local botanical garden (TBGRI), the Forest Department, the pharmaceutical firm and the Kani local community. Whereas the TBGRI as a part of the State Government licensed AVP to manufacture the drug, the Forest Department did not facilitate the manufacturing process (Anuradha, 1998). Hence, improper coordination amidst various governmental bodies made the execution of the scheme to be partial and the Kanis unable to fully benefit out of their GR and TK wealth in the context of the bioprospecting experience.

Although the major source of income from the ABS would have come from the supply of *T. zeylanicus* leaves for drug manufacturing, the Kanis could only harvest two crops, both in 1996, before the Forest Department banned the cultivation due to fear of its over-exploitation. In fact, the 50 households who first cultivated the herb witnessed a significant increase in income given the low opportunity cost of family labour. As a result more households began to cultivate the plant in the next growing season. During this harvest, the effective bargaining by the Kanis made the price offered by AVP to increase from Rs 25/kg of fresh leaves to 75/kg Despite the small size of area for cultivation by each household (average of 0.1 ha), its cultivation allowed households to generate an average net revenue of Rs 1,123 and Rs 849, respectively during the two harvests in 1996 (the Rs 1000 subsidy given by the ITDP being primarily responsible for the higher figure for the first crop).

Therefore, had the scheme been implemented according to the proposal by AVP (in which a monthly demand of 5 tonnes of fresh leaves was anticipated), the community could have earned a minimum of Rs 4.5 million annually at a fresh leaf price of Rs 75/kg. Even without taking into account the associated increase in royalty (due to the increased raw drug supply and resulting higher level of production and sale), the income forgone by the Kanis is significantly greater than what they had achieved. But this begs the question of whether the cultivation in the forest reserve would have been ecologically sustainable. Moran (2000) has expressed concern over the present system of sourcing *T. zeylanicus*, since there is no information on sustainability studies connected to methods of managing and harvesting the herb. There are countless examples of why mere market creation for bioresources (e.g., through bioprospection) need not always facilitate conservation (see: Barrett and Lybbert, 2000). In fact, in this case unregulated biodiversity prospecting and drug development could speed up the destruction of the resource. The incident of overexploitation of wild *T. zeylanicus* can be noted as an example for this when in 1996 the raw drug price

increased threefold and the subsequent over-harvesting forced the Forest Department to ban its cultivation and harvest.[9]

Although the question of the facilitation of biodiversity conservation goes beyond a matter of methods for managing and harvesting. The question of the control and sanction mechanisms for dealing with overexploitation of the wild variety and illegal trade should also be addressed. The ABS agreement with the Kani was established on a voluntary basis and not on a broader legal framework for regulation of bioprospecting, specifying the rights and the duties of the TBGRI and private companies. In this situation, even with a clear incentive for the Kani members involved in the contract to adopt sustainable management practices, there could be no guarantee that other groups would not free ride on the contract through exploitation of the wild variety or, alternatively, that the pharmaceutical company would not look for other providers of the same plant under less restrictive conditions, as it subsequently did.

The appropriate protection of the rights of the indigenous community over its TK also depends on the existence of such guarantees. In the case of the Kanis, the disclosure of their ethnobotanical knowledge to the Indian scientists was entirely based on trust and good faith. It was based on the belief that they would honour their promise of benefit sharing in case of the development of a new product. Hence, it is not possible to replicate the contract automatically to other situations, where these relationships of trust may not be robust. Under these conditions, the incentive to disclosure TK by other communities remains limited to situations where personal relations, informal guarantees that their property rights will be protected and that the contract will lead to appropriate benefit sharing exist.[10]

Last, but not least, looking at the Kani example it can also be asked more generally whether the focus on the issues of IPR and the associated ABS system has not shifted the attention away from the question of the involvement of other actors in the negotiation of the contract. In the Kani case, the contract is clearly the outcome of an agreement negotiated between scientists from the TBGRI and the pharmaceutical, AVP, which in turn was initially based on a confidential agreement between the scientists and the Kanis. The property right holders of the physical asset, the forest administration and the members of the tribal community, seem to have been involved only marginally in the drafting of the terms of the contract and consequently the legitimacy of the agreement is not recognized with the same intensity by all the actors. In particular, as Ramani (2001) shows, different perceptions subsist between the younger and the older tribal Kani members, the latter caring more about the loss of cultural identity.[11] This lack of legitimacy may be due to the fact that the focus of the TBGRI has been on the bilateral contractual relationships between the private company and the Kani guides that transmitted the TK about the herb to the Indian scientists, as the original providers of the GR, possibly without paying sufficient attention to the roles of the majority of other community members and the requests

[9] It bears a resemblance to the harvest of entire adult population of *Maytenus buchananni* (a source of anticancer compound Maytansine) by US National Cancer Institute in Kenya for testing its drug development programme (Oldfield, 1984; Reid *et al*, 1993).

[10] In other cases, such as the Costa Rican InBio-Merck agreement, an ABS agreement is signed already at this stage.

[11] Concerns have been raised by the elder tribe members that the expected welfare benefits could be outweighed by the loss of traditional medicinal practices (Ramani, 2001).

by the forest department, which also plays an important role in the valorisation (i.e., adding value) to the GR, contributing indirectly to any possible 'bioprospection' endeavour.

4. Economic valuation of the bioresource from the TK holders' perspective

The classic static model of bioprospection in the case of a GR-TK system, such as in the KMBS case, involves three main actors: (1) the ecosystem as the natural repository of the GR base, (2) the indigenous community acting as stewards of the ecosystem and thus the GR-TK base, and (3) the commercial firm interested in the search of new chemicals from nature. Here we pay special attention to the second node of the chain: the local community as the custodian of TK. The interest is in shedding light on the Kanis' WTP value for protecting their TK with regard to the external appropriation of bioresources and the various household socio-demographic and economic characteristics that affect their implict valuation. We carry out this analysis by employing a contingent valuation model. The results can be interpreted more directly as the level of compensation that representative members of the Kani community demand for their involvement in the *T. zeylanicus* bioprospection activities by the Botanical Garden and the pharmaceutical firm.

The monetary benefits realized from the current Kani ABS scheme reach the community in the form of cash payments to the Trust. Since the rights to the service under consideration (the use of TK) are held by the local community, willingness to accept (WTA) compensation for participating in the biodiscovery process by disclosing their traditional ethnobotanical knowledge would be the appropriate format for value elicitation (Shyamasundar and Kramer, 1996). One difficulty of using the WTA elicitation format is the indirect payments through the provision of public goods to the community by the Trust, making direct elicitation of WTA less precise in reflecting households' preferences. Hence, the question posed to the Kani community members is based on the maximum willingness to pay (WTP) to protect their traditional knowledge from outside illegal appropriation.[12]

The survey for the statistical analysis was carried out in 2004 in the Western Ghats. The statistical sample is made up of 68 households randomly selected from ten settlements of the Kanis and stratified into cultivators (50%) and non-cultivators of *T. zeylanicus* (50%). Using the local language (Malayalam) household heads were invited to report on households' socio-economic characteristics, the management of *T. zeylanicus* cultivation, and various aspects concerning the knowledge and attitude towards the implementation of the bioprospection contract and protection of their traditional knowledge.

The contingent valuation study is based on a dichotomous choice model and the results are shown in Table 1 together with a description of variables. The hypothetical situation presented and question posed to the households is the following one: *"Suppose a pharmaceutical firm markets a herbal medicine using the traditional knowledge of Kanis without asking for your prior consent. In this regard, the Trust or any other NGO (dealing with Kani welfare) has decided to bring this particular firm to court. If the Trust/NGO wins the case, the right on the use of this particular traditional knowledge will rest within the community only, or alternatively the community may get a fair amount of compensation for sharing the knowledge (as in the case of Arogyappacha). The Trust/NGO decides to collect money from Kani tribes to meet the court expenses. In this regard, would you be willing to donate Rs __ to the fund?*[13]*"* This YES-NO dichotomous choice question

[12] The estimated Kanis' WTP value for protecting their TK through the CV study is possibly a lower bound of the true compensation required, as suggested by most studies comparing WTP and WTA values (e.g., Adamowicz *et al*, 1993; Shogren *et al*, 1994; Morrison, 1997).

[13] The bids ranged from Rs 50 to Rs 400 with a constant interval of Rs 50. The amount was specified as one time payment.

was followed up by two more questions which asked respondents whether they would be willing to pay a higher or lower amount, setting upper or lower bounds. Such double bounded dichotomous choice (DBDC) model was shown more statistically efficient than the single bounded approach (Hanemann *et al*., 1991). These questions intend to capture the Kanis' view of the prior informed consent aspect within the ABS system. It should be noted however that even when prior informed consent were granted, the question does not help to resolve how this is obtained or who decides that it is obtained in a legitimate way (Berlin and Berlin, 2003).

The socio-economic variables assumed *a priory* to have a bearing on respondent's WTP are included in the DBDC-CV model and are presented as Model I in Table 1. Some of the estimated β parameters associated with the explanatory variables are found to be insignificant, and hence, those variables having z values less than unity were omitted and model re-estimated (Model II). The DBDC model tries to capture the effect of various socio-economic factors on Kanis' willingness to donate to the proposed fund as a proxy to their efforts to protect their TK from missapropriation. We include household level variables such as income, education, age structure of the household, and others related to their livelihood activities (e.g., whether households cultivate and are direct consumers of the herb, whether they engage in the collection of non timber forest products), how connected they are to the 'outside world' geographically and through the media).

As expected, the data indicates that respondents' per capita income controls for households' *ability to pay* implying that poorer households are less able to afford a payment for the community's fund to protect TK. On average, a percentage increase in per capita income increases the WTP to the hypothetical fund by Rs.71. (or 0.9% of their per capita income). Hence, the income per capita is close to being unit elasticity with respect to the WTP to protect TK by the Kanis. Interestingly, the a priory expectation that older tribe members would be more likely to donate for TK conservation as they may be assumed to be more attached to traditional community values is not met (albeit its positive sign) given its low statistical significance. Further, although the level of formal education by the Kani members is associated with a lower willingness to donate to the fund, other forms of information channels, e.g., through access to newspapers and television and through direct visits to nearby cities, increase the WTP considerably. As for the livelihood activities carried out by the Kanis, the data suggest that households who cultivate the herb are willing to donate a higher amount to the fund than non-cultivators, which could possibly be the result of direct experience by the former with respect to deriving a tangible use value from trading with the herb. This result may also be corroborate by the positive effect of directly consuming the *Trichopus* fruit. Lastly, it is suggested that those households which hired out labour in the non-farm sector for daily wages, which is associated with a higher opportunity cost of time compared to on-farm operations and NTFP collection, are less willing to donate for the community's TK protection cause.

[Table 1]

Using the coefficients of Model II from Table 1, the mean WTP is Rs. 410 and 246 per household cultivator and non-cultivator households, respectively. The weighted mean WTP is Rs.251 (US$ 5.7) per household

(about 3.3% of their annual per capita income). Notwithstanding the possibly lower bound with regard to the the implicit true WTA value, this amounts to one million rupees (US$ 22,818) by the whole Kani community. If compared to the what the pharmaceutical AVP offered which was shared on a 1:1 basis between the community (through the Trust) and the TBGRI, it is clearly that the community obtained just half of the minimum benefit that thought it deserved from engaging in the bioprospection contract.

The results derived from the contingent valuation model indicate that an important gap exists between the market value that the private pharmaceutical company is prepared to pay the Kani community for the TK through the licence fee and the level of compensation for the shared GR and TK by the local community. The WTP for keeping full property rights over TK is an aggregate value, covering all the Kani tribe members, and these can have very different attitudes towards the Trust fund and the biodiscovery endeavour. Indeed, for some members, it covers the compensation for licensing the property rights on the TK, but for others it consists also in the anticipated monetary return from engaging in cultivation and selling of *T. zeylanicus* or even the WTP for preserving the traditional culture values attached to indigenous healthcare.[14]

6. Conclusion

This paper has focused on the economic incentives for in situ knowledge generation through biodiscovery from the point of view of a dynamic approach to the economic institutions of contracts and property rights. In a dynamic framework, the focus is not on the *ex ante* determination of the optimal allocation of resources under conditions of perfect rationality, but on issues of dynamic efficiency, such as knowledge acquisition and incentives for the preservation of future possibilities of use under conditions of uncertainty. Through applying this dynamic approach to the process of biodiscovery, we attempted to show the importance of analysing the full chain of innovation playing a role in innovation processes.

In this way, our analysis moves away from the position that only considers the difficulties posed by intellectual property rights on genetic resources as being a technical legal issue. At present, in the field of genetic resources, one sees a tendency to create new laws for each sector of activity. This results in the emergence of many specific legal regimes for the protection of genetic resources and related TK: patents for processes relying on genetic manipulation, plant breeder's rights for plant varieties resulting from genetic selection, farmers' rights for traditional farmers' varieties and national sovereignty governing the rights to access and use the natural resources from ecosystems producing biological diversity. Nonetheless, the multiplication of different sectorial laws still falls in a static conception of efficiency and does not really meet the need for an integrated approach to the process of value creation through the whole innovation chain.

In the case of the KMBS, the trust fund is already an example of an institution for coordinating the different social demands coming from the community. However, as we have seen, it largely remains

[14] The importance of the preservation of culture value in *in situ* conservation is also confirmed by an interesting case study of Dyer et al. (2000) on local seed markets in Mexico. The introduction of new crop varieties caused a diversification of the farmers' activities. Nevertheless, because of local traditions and culture, they still continue to grow the classical varieties, despite the fact that from an economic point of view one can show that they have no reason to do so (Dyer et al., 2000).

insufficient, because no social learning is generated that allows to bridge the conservation interests of the forest department and the interests of (a part) of the community involved in the benefit sharing agreement. Further, within the community a great deal of uncertainty remained on the appropriate protection of the traditional knowledge. Other means for enhanced institutional coordination that are currently being considered in international *fora* are the creation of an international *system of* certificates of origin for monitoring the flow of genetic resources (Barber et al, 2003), the establishment of collection societies for traditional knowledge registries (Drahos, 2000) or the creation of partnerships between research institutions and community based breeding programs (Brush, 2002). In the field of IPR, Reichman (2000) proposes to evolve from a paradigm that functions by hybridization of existing tools, based essentially on patent and copyright, to a paradigm in terms of a liability regime, allowing the *ex post* compensation of the prior link in the innovation chain. These proposals all include mechanisms that aim at diffusing incentives through the whole production chain and maximizing the future choices of development. They consider the necessity of new legal tools and governance mechanisms, but also the importance of the associated institutional means for social learning and information sharing.

The *rationale* of the focus in this chapter on the full economic value is thus not so much on the necessity to replace the bilateral market approach to bioprospecting contracting with a different approach, based for instance on public involvement, or to do away with the voluntary mechanism of benefit sharing of the KMBS. Rather, it proposes to look for a more balanced view, where the bilateral market approach viewed in a dynamic and second best institutional-economic setting combines institutional means for coordination between the different actors involved in the innovation chain, ranging from informal norms for building trust between the actors through self-regulation to formal legal means allowing appropriate sanctioning of opportunistic behaviour and collective learning.

Table 1. Variable definitions and estimated Double Bounded Dichotomous Choice model[15]

Variables	Description and measurement (mean±std. deviation)	Coefficient (Std. error)	
		Model I	Model II
Constant		-706.46 (535.16)	-414.67* (230.53)
Per capita income#	Per capita annual income of household in '000 rupees (7.73±6.61)	98.38** (42.16)	71.47** (33.66)
Age#	Chronological age of the respondent in years (33.31±12.00)	45.54 (108.32)	--
Education#	Formal education attained by the respondent in years of schooling (4.00±4.14)	-95.79** (49.19)	-95.83** (47.21)
Household size#	Number of members in the household of respondent (4.03±1.47)	23.62 (99.00)	--
Farm size#	Size of farm managed by the household of respondent in acres (2.97±1.94)	-20.84 (52.01)	--
Wage labour	Dummy varialble: 1 if respondent was hiring out labour for wages, 0 otherwise (63%)	-159.62** (64.68)	-146.71*** (57.35)
Remote#	Distance between respondents' household to public transport facility in kilometres (9.27±3.89)	107.99 (89.49)	83.81 (76.33)
City#	Frequency of visiting nearby city by respondent in number per month (8.34±4.91)	126.79** (64.67)	112.50* (58.62)
Adults	Proportion (0-1) of adult members in the family size (0.77±0.32)	-50.38 (114.61)	--
Community development	1 if the respondent actively engaged in community development activities, 0 otherwise (32%)	-5.42 (67.50)	--
Read	1 if respondent read news papers regularly, 0 otherwise (46%)	182.53 (116.12)	173.48* (100.52)
Radio	1 if respondent listen to radio programmes regularly, 0 otherwise (78%)	94.46 (67.74)	70.85 (61.09)
Television	1 if respondent watches Tele Vision programmes regularly, 0 otherwise (54%)	166.52*** (63.14)	174.59*** (59.15)
Cultivator	1 if respondent was engaged in *Trichopus* cultivation, 0 otherwise (50%)	106.26* (59.03)	97.50* (55.07)
NTFP	1 if respondent engaged in non timber forest product collection, 0 otherwise (81%)	70.84 (80.53)	--
Herb Consumption	1 if respondent consume *Trichopus* fruits regularly, 0 otherwise (87%)	113.71 (87.76)	153.99** (78.68)
Log likelihood function		-65.04	-65.88
χ^2		36.86	35.17

[15] Sample size, N = 68. Coefficients can be directly interpreted as marginal effects. *, **, and ***: statistically significant at 0.1, 0.05 and 0.001 levels, respectively. #Variables are taken in their natural logarithmic form.

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