OPTIMAL COMPENSATION FOR INDIGENOUS KNOWLEDGE HOLDERS IN BIODIVERSITY CONTRACTS: A CASE STUDY FROM INDIA

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Abstract

The exploration of biodiversity for commercially valuable genetic and biochemical resources is regarded as a potential source for monetary incentives for biodiversity conservation. Bioprospecting is often being described as 'biopiracy' given the predatory behaviour by some commercial companies as regards the use of indigenous communities' knowledge on a myriad of ecological resources. This paper attempts to value the role of indigenous knowledge associated with marginal bioprospecting endeavour. The paper is based on the empirical estimation of socially appropriate economic compensation to a local traditional community from tropical India. The case study is focused on primary data relevant to the experience of the Kani Tribe of Western Ghats. Kani Model of biodiversity contract is universally acclaimed as the first and unique instance in which payments have been made to the IK holders for a successfully developed pharmaceutical product. The willingness to pay by the tribal community for the protection of their traditional knowledge is estimated employing a dichotomous choice model. The results showed that irrespective of low-income status, households were willing to pay a considerable amount of annual income. The average household willingness to pay was US$ 6.5 and 8.4, and the community's aggregate willingness to pay was estimated as US $ 29,400 and 38,000 while using money and labour as mode of payments, respectively. The monetary benefit realized under the present benefit sharing arrangement was considerably low compared to these values. The disparity between monetary WTP and labour WTP indicate that people have many cash demands and few opportunities for earning money. Kani is one among the poorest communities of the world and use of labour as means of payment might be strongly advocated in contingent valuation, if carried out in similar situations.

Keywords: Biodiversity Prospecting, Indigenous Knowledge, Kani Model, Valuation

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1. Introduction

Since material wealth and technology are as concentrated in the North as biodiversity and indigenous knowledge in the South (Macilwain, 1998) and biotechnological progress inevitably necessitates an adequate supply of genetic resources (Plotkin, 1988), a well-formulated global market for biodiversity can naturally be expected. True, the rich biodiversity in conjunction with the grassroot knowledge and innovations of the South often gives rise to technological advancement in the genetic and pharmaceutical sectors of the developed economies (Aylward, 1995; Corner and Debus, 1996; Dutfield, 2002). Nevertheless, the extent and nature of flow of plant based drugs and biotechnology from North to South is not commensurate with the flow of biodiversity from South to North (Khoshroo, 1996; Sahai, 2000). The root cause of this inequity rests with the improperly defined and biased property rights, arguably favouring the influential industrial countries.

Unimproved genetic stock and indigenous knowledge (IK) have always been two important local common resources of the South, which involve a combination of rights and responsibilities among users and thus ensure their sustainable use (Shiva, 1998). By considering them as common heritage (indicating open access) of human kind, and retaining them as ownerless (Reid *et al*, 1993) the international policies not only facilitated free-riding and reckless exploitation, but the stewards of the same are often left uncompensated (Gupta, 1999; Ruiz, 2002). Further, the intellectual property rights (IPR) regime establishes private ownership and monopoly over the products derived with the help of indigenous knowledge (IK) and/or unimproved genetic resources of the South. This, coupled with other trade related policies, accelerates erosion of grassroot knowledge and practices (Huft, 1995; Grenier, 1998; UNCTAD, 2000).

The United Nations' Convention on Biological Diversity (1992) grants sovereign rights to the nations over the genetic resources contained within their borders and thereby poses a progressive Coasian solution to this problem (Barrett and Lybbert, 2000). As market creation for services of biodiversity minimises the 'heavy hand' of government intervention and being theoretically attractive due to the innate notion of efficiency, it has strong support from international development organizations. It is not surprising then that markets for *biodiversity prospecting* or *bioprospecting* — the systematic search for new applications of hitherto unstudied biological species (Barrett and Lybbert, 2000; Weiss and Eisner,

1998) – has become one amongst the most frequently cited motivations as well as means for conserving biodiversity (Rubin and Fish, 1994; Rosenthal *et al*, 1999).

The relevance of ethnobotany as a means of counteracting biodiversity loss and an avenue for discovery of new medicines is often heralded as meaningful in the global market (Gollin, 1993, Sheldon and Balick, 1995), and valuation forms the initial step in the development of market systems for appropriation of wealth through ethnobotanical explorations. A Number of economists have derived a wide range of estimates of bioprospecting value using a wide array of approaches (Principe, 1989; Pearce and Purushothaman, 1992; Simpson *et al*, 1996; Rausser and Small, 2000; Craft and Simpson, 2001). These studies theoretically illustrate the possibilities for bioprospecting, and more importantly address the problem from the bioprospector's (buyer's) perspective alone. Often unrecognized is the fact that the communities, which act as stewards of the biodiversity and holders of IK (sellers), will have preferences on commercializing their local commons. The present research analyzes attempts to value the biodiversity–IK system from the IK holders' prospect. The study is based on the empirical analysis of Kani Model of biodiversity contract – the first and unique instance, in which payments have been made to the IK holders for a successfully developed pharmaceutical product (Anuradha, 1998; Moran, 2000).

2. Evolution and Development of Kani Model of Benefit Sharing

The Kani tribe is primarily a semi-nomadic community, who now leads a settled life in the forests of the Agasthiyar Hills of the Western Ghats in Kerala State of India. Being the habitat of rare and endangered plant species, this area is designated as a reserved forest, by which the Forest Department of the State Government strictly regulates the access and use of the forest. The current population of Kanis is estimated to be approximately 18,000 spread across 30 settlements and villages. A Kani settlement is typically a cluster of few families living interspersed with the forest, isolated from any public transport facility. The individual family size is small (average of 4 persons), in tune with the general pattern of Kerala State. But in contrast with the high literacy rate of Kerala society (around 92 %), the Kani community is comprised largely of illiterates – 47 per cent cannot read and write[1]. This is very much related to the subsistence nature of the tribal economy, where child labour also is required to sustain the family, as also to the inadequate schooling facilities.
The Community has a tribal chief called the *Moottukani*, who used to combine the role of lawgiver, protector, dispenser of justice, physician and priest, although such traditions have been eroded now (Pushpangadan, 2000). But even today, the role of tribal physicians is significant and they are known as *Plathi*, who cure ailments through a combination of various traditional drugs and tribal rituals. Some tribal physicians are also appreciated by the 'modern world' as people from outside the community seek treatment for diseases, incurable in purview of modern medicine. The herbal lore of this tribal community of a large number of wild plants found in flora-rich Agasthiyar forests holds a great potential for the future (Gupta, undated).

Even with such a rich ethnobotanical tradition, the economic conditions are of extreme impoverishment with an average annual per capita income of Rs 7 727 only (≈US $ 172). The tribal community is abstained from the basic necessities, like well-thatched hut, public transport facility or drinking water availability. The living standards are not on par with the disposable income, as the variation in income flow is greater across the year and saving being negligibly low. Kani as a community is largely deprived of basic necessities of life and it is reported that the much-acclaimed decentralization to *Panchayat* (the village councils) level in Kerala have failed to make any major impact on the lives and choices of tribes in this area (Gupta, undated). In this juncture, by providing economic incentives for their rich tradition in herbal medicine sector, bioprospecting holds special significance.

The incidental discovery of the therapeutic properties of the herb, *Trichopus zeylanicus* ssp. *Travencoricus*[2] (locally known as *Sathan Kalanja* or *Arogyappacha*)[3] by a team of scientists on 1987 laid the foundation for globally acclaimed Kani Model of benefit sharing (KMBS). The All India Coordinated Research Project on Ethno-biology (AICRPE) in the Western Ghats of Kerala observed a unique practice

[1] Source: Primary data collection.

[2] *T. zeylanicus* is a small, rhizomatous, perennial herb distributed in Sri Lanka, Southern India and Malaysia. The subspecies *Travancoricus* is found at an altitude of around 1000 meters in India (Anuradha, 1998). The characteristics of *T. zeylanicus* match with the description of *Varahi*, one of the 18 divine drugs described by ancient physicians, Charaka and Susrutha (Source: personal communication with Dr. Rajasekharan, TBGRI).

[3] Malayalam names, mean *left by the devil* and *the green of health* respectively. The former indicates the concern for the protection of the indigenous knowledge on use of the herb from outsiders of community.

of Kani tribes consuming dry fruits of a particular herb, later identified as *T. zeylanicus*, to reduce fatigue. The AICRPE team lead by Dr. Pushpangadan and Dr. Rajasekharan felt "full energy and vitality" upon chewing the same (Pushpangadan *et al*, 1988). The phytochemical and pharmacological studies of *T. zeylanicus* in the Regional Research Laboratory (RRL), Jammu revealed the presence of certain rare glycolipids and non-steroidal polysaccharides with profound adaptogenic, immuno-enhancing, antifatigue properties, and subsequently five process patents were filed on behalf of the RRL.

After two years of research in the Tropical Botanical Garden and Research Institute (TBGRI, Thiruvananthapuram), a scientifically validated standardized herbal tonic *Jeevani* ('Provider of Life') was formulated with *T. zeylanicus* in combination with three other medicinal plants. The production technology had then been transferred to Arya Vaidya Pharmacy Coimbatore Ltd (AVP), an Ayurvedic drug manufacturing company, in 1996. The AVP licensed *Jeevani* as a tonic to bolster the immune system and provide energy, while the TBGRI agreed to share the licence fee and royalty with the Kani Community on 1:1 basis. The conditions for technology transfer agreement specify a total licence fee of Rs. 1 million (USD 23,000 approximately) and royalty of 2 % on ex-factory sale of the product. Through discussion of the TBGRI scientists with the experts, the idea of a trust fund for Kani tribes – *Kerala Kani Samudaya Kshema Samithi* (KKSKS or Kerala Kani Community Welfare Trust) – was conceptualized. In September 1997, the KKSKS was registered with nine members, all of whom were tribes and the President and the Vice-President of the Samithi were the two Kanis who imparted knowledge regarding *T. zeylanicus* to the scientific community. The amount due to the Kanis was transferred to this trust with the understanding that the interest accruing from the licence fee and royalty shall be used for the welfare activities of Kani people.[4]

The proliferation of domestic as well as international markets for *Jeevani* necessitated regular supply of fresh leaves of *T. zeylanicus*. Since the wild collection being both inadequate to meet the market requirements and ecologically unsustainable and the herb being habitat-specific (the therapeutically active compounds are produced only when the herb is cultivated in and around its natural habitat), the AVP proposed to the Kerala Forest Department and the Tribal Welfare Department a plan for the cultivation of *T. zeylanicus.* According to this plan, the AVP would pay the Kanis initial seed money for the cultivation of the plant and enter into an arrangement with the Kanis to buy the leaves harvested from the cultivated plants. The firm was prepared to buy five tonnes of leaves per month. The TBGRI trained 50 Kani households through Integrated Tribal Development Programme (ITDP) on 1996 for pilot level cultivation by availing a subsidy of Rs. 1,000 per household.

Due to the lucrative nature of *Trichopus* leaf sale, the tribes started collecting the whole plant from its natural habitat and, ultimately the Forest Department proscribed the cultivation fearing the extinction of the species. Although the TBGRI tried to develop a propagation technique through tissue culture seedlings, it was a partial success only. After six years of negotiation process, during 2003, the Forest Department issued consent to cultivate the herb and the tribes were in a position to bargain for a better price for their produce. But being the contract with the pharmaceutical firm lasting only for another six months, the AVP was unwilling to engage in any new price contract.

Monetary compensation from the KMBS scheme

The KMBS received the Equator Initiative award from the UNDP for developing a novel benefit-sharing model, during the World Summit on sustainable development, held at Johannesburg, South Africa on 2002. Despite the universal acclamation, the Kani model of benefit-sharing scheme has not yet achieved its full potential due to various institutional impediments. The TBGRI as a part of the State Government had licensed AVP to manufacture the drug, whereas the Forest Department, which is also a part of the State Government was not facilitating the manufacturing process (Anuradha, 1998). The reason being attributed by the forest department is the illegal harvesting from the natural habitat of the plant and subsequent loss of biodiversity and threat of extinction. Hence, improper organization amidst various governmental bodies made the execution of the scheme to be partial and the Kanis could not benefit out of their IK wealth.

The benefit-sharing scheme began prior to the establishment of KKSKS and on September 1997, the due amount of Rs 519,000 was transferred to the account of KKSKS, in which Rs 500,000 was the 50 % of the licence fee and rest was the first instalment of royalty. The KKSKS had power to decide the ways of utilising only the interest amount accrued over the licence fee and royalty. Up to 2003, a sum of Rs 100,000 was obtained as royalty from the sale of the drug. The inadequate supply of *T. zeylanicus* leaves was the reason for

[4] Personal communication with the KKSKS trustees

the low amount of royalty accrued during this period[5].

However, the major source of income from this benefit-sharing scheme would have been the supply of *T. zeylanicus* leaves for drug manufacturing. Unfortunately, the tribes could harvest only two crops (in 1996) before the Forest Department banned the cultivation. The pilot level cultivation started by involving 50 households, and witnessing a significant addition to their income, more families started cultivation during the second season. The planting material was collected from the forest and the opportunity cost of family labour was the only expenditure incurred by the tribes. The price offered by AVP was comparatively meagre for the first purchase (Rs. 25 per Kilo gram fresh leaves), but the tribes could bargain for a better price after the second harvest (Rs. 75). The average size of farm was 23 cents (0.09 hectares) and households were able to produce an average output of 17 kg during first harvest and 14 kg for second harvest and generated net revenue of Rs 1123 and Rs 849, respectively, in 1996[6]. The import of this additional monetary benefit can be better appreciated by recognizing the monthly per capita income of Kanis as only Rs. 644. Two to four harvests could be taken annually, though more agronomic studies are needed to estimate the optimum harvest frequency.

It is interesting to note that had the scheme been implemented according to the firm's proposal (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 even at a leaf price of Rs 75.[7] Even if one does not account the associated increase in royalty (due to the increased raw drug supply and resulting higher level of production and sale), it can be seen that the amount forgone for Kanis is many times greater than what they have achieved.

At present, the KMBS faces an entanglement exist due to the higher price demanded by tribes for their produce. The survey shows that most of the Kanis think the offered price of Rs 75 is inadequate, and the optimum price in their viewpoint would be around Rs. 150. Due to the limited time for the contract to expire, the AVP was not willing to accept this demand at present, but expressed their concern once the contract is rejuvenated. Both Kani tribe and the pharmacy anticipate the successful implementation of the scheme in the future under a renewed contract.

[5] The firm, AVP, is currently using a limited quantity of raw drug from Western Ghat region of nearby state, Tamil Nadu.

[6] Subsidy given by ITDP (Rs 1,000) is primarily responsible for the higher net revenue for the first crop.

[7] Annual herb turnout of 60 000 kg of fresh leaves at a price level of Rs 75 per kg. As family labour was the only input, Kani households would have realized the entire amount – either as wages or as profits.

3. Research Design and Analytical Tools

A simple model of bioprospecting involves at least three main actors – the natural resource base, the indigenous community acting as stewards of the IK base, and the commercial firm interested in the search of new chemicals from nature. In this framework, the present study is focused on estimating the optimum compensation for indigenous peoples in a bioprospecting endeavour from the community's (supply side) perspective.

As no market exists for the services from the IK base, a contingent valuation (CV) technique can be employed. As such, the values that are derived are 'contingent' upon the realization of hypothetical, but realistic scenarios (Swallow and Woudyalew, 1994). While CV is popular to place values on ecological services, to my best knowledge, there is no study dealing with the valuation of services from the flow of IK.

In the context of a contract between the bioprospector and the indigenous people, the value to the genetic and IK resources is estimated as the bioprospector's maximum willingness to pay and compared it with the indigenous community's minimum willingness to accept. The study addresses the issue of estimating the WTA of the community and could be better carried out in an institutional set up, where the IK holders have experienced monetary compensation from a prior biodiversity contract. The unique benefit-sharing scheme working amidst the Kani Tribes of Western Ghats, India was subjected to the present analysis. To examine the benefit-sharing scheme from the beneficiary's perspective and to estimate the value of future bioprospecting endeavours through preference elicitation of indigenous communities, primary data was collected from Kani households.

The population frame for this study was the set of Kani households situated in Agasthiyar Forests of Western Ghats. The Kani Tribe, primarily a nomadic community, now leads a settled life, in forests of Thiruvananthapuram District of Kerala State. The population of the tribal community is estimated to be 18,000, spread over 30 tribal settlements and nearby villages. Relevant information was collected from 68 households randomly selected from the 10 tribal settlements. The population was stratified into cultivators (34 households) and non-cultivators (34 households) of

Trichopus zeylanicus, based on the indigenous knowledge of which the existing biodiversity contract is framed.

Pre-coded interview schedule was prepared with questions regarding (i) socio-economic characteristics of households (ii) economics of *T. zeylanicus* cultivation (iii) the respondent's knowledge and attitude on implementation of biodiversity contracts and protection of indigenous knowledge, and (iii) willingness to pay to protect the indigenous knowledge (Appendix I). Head of the households were interviewed using structured surveys in January 2004 by six experienced enumerators. Surveys were conducted in the local language (Malayalam).

Together with the primary data on valuing indigenous knowledge, information was gathered from the Tropical Botanical Garden and Research Institute (TBGRI, Thiruvananthapuram) and the Kerala Kani Samudaya Khema Samithi (KKSKS), on the *modus operandi* of the benefit-sharing scheme.

Valuation of IK from the Knowledge Holders' perspective

There are two important methodological considerations that emerge with special relevance in this study because of (i) the nature of utilization of monetary benefits out of current indigenous knowledge sharing scheme, and (ii) the subsistence nature of the tribal economy. The former explains the use of willingness to pay (WTP) format rather than willingness to accept (WTA) (although the ultimate research goal was estimation of compensation community deserve in a bioprospecting endeavour). Secondly, the subsistence nature of tribal economy necessitates a change in the mode of payment under the CV method.

The monetary benefits realized from the current benefit-sharing scheme reach the Community in the form of public goods, and the KKSKS has the right to decide about the interest accrued on royalties and licence fees. Since the rights to the service under consideration are held by the tribal population, WTA is the appropriate format for value elicitation (Shyamasundar and Kramer, 1996). Nevertheless, the intricacy of indirect payment through the provision of public goods makes direct elicitation of WTA less precise in reflecting the households' preferences. In order to value the IK base, the question asked to the Kanis was on the maximum WTP to protect their traditional knowledge from illegal appropriation.

As various studies comparing WTP values with that of WTA (Adamowicz *et al*, 1993; Shogren *et al*, 1994; Franciosi *et al*, 1994; Eisenberger and Weber, 1995; and Morrison, 1997) showed the latter invariably as greater than the former, the compensation required by the Kani tribe will be equal to or greater than their WTP for protecting IK base. The feasibility analysis of socially optimal biodiversity contracts in this research can be build based on this particular assumption.

The DC model is adopted for estimating monetary WTP, expecting a substantial improvement in the statistical efficiency (Hanemann *et al*, 1991). A DC question presents each respondent a bid randomly and asks for a 'YES' or 'NO' vote on whether the respondent's WTP equals or exceeds each proposed bid (Loomis *et al*, 2000). The report by NOAA Panel (1993) endorses the use of dichotomous choice questions. In the context of CV methodology, a review of six CV studies that have compared values from open-ended and DC questions (Schulze *et al*, 1996) revealed that the latter almost always produces larger value estimates. Therefore, a DC model has been used to elicit monetary WTP and an open-ended format has been employed to obtain the WTP estimates in labour units. The hypothetical situation presented and question posed to the 68 households is as follows:

"Suppose a pharmaceutical firm markets a herbal medicine using the traditional knowledge of Kanis without asking for your prior concern. In this regard, the KKSKS or any other NGO (dealing with Kani welfare) has decided to bring this particular firm to court. If the KKSKS/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 KKSKS/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?

YES / NO

Instead of paying money, would you be willing to offer free work (as a hired agricultural labour for land preparation)? (The wages will go for the Trust). If yes, for how many days?"

The bids ranged from Rs. 50 to Rs.400 with a constant interval of Rs.50.

Model specification for measuring monetary WTP

Suppose individual *n* is faced with a choice between two alternatives from a choice set *Cn* {i,j}, where i represents choosing to contribute an amount of Rs. A for Traditional Knowledge Protection Fund (T) and alternative j represents choosing not to contribute Rs. A towards T. That is, T = 1 if i, and T

= 0 if j (Hanemann, 1984). Assuming consumer utilities U_{in} and U_{jn} can be formulated as,

$$U_{in} = V_{in} + e_{in} = \nu(1, Y_n - A_n; S_n) + e_{in} \quad (1a)$$
$$U_{jn} = V_{jn} + e_{jn} = \nu(0, Y_n; S_n) + e_{jn} \quad (1b)$$

where, V_{in} and V_{jn} are assumed non-random, systematic components of the U_{in} and U_{jn}, respectively, while e_{in} and e_{jn} are assumed random components of the same in that order (Turcin, 2001). S_n represents vector of observable attributes of individual *n* that might affect his/her preferences, A_n represents the contribution (bid) of Rs. A that respondent *n* is asked to pay towards T and Y_n represent per capita income. It is assumed that the individual *n* will accept the alternative *i* to maximize his/her utility under the following condition (Hanemann, 1984):

$$\nu(1, Y_n - A_n; S_n) + e_{in} \geq \nu(0, Y_n; S_n) + e_{jn} \quad (2)$$

and will accept j otherwise. The utility difference ($\Delta\nu$) can be described as follows:

$$\Delta\nu = \nu(1, Y_n - A_n; S_n) - \nu(0, Y_n; S_n) + (e_{in} - e_{jn}) \quad (3)$$

The DC format of CVM has a binary choice dependent variable, which requires a qualitative choice model. Though probit and logit models are the commonly used qualitative choice methods, because of its relative simplicity, the logit model has been preferred to the former in many fields of non-market valuation (Lee, 1997; Lee and Han, 2002).

Under the assumption that $e_n = e_{in} - e_{jn}$ is logically distributed, the probability $[P_n(i)]$ that the individual n will accept to contribute amount An can be expressed as following:

$$P_n(i) = 1/[1+\exp(-\Delta\nu)] = 1/[1+\exp(-BK)]$$
$$= \frac{1}{1+\exp\{-(B_0 + B_1X_1 + B_2X_2 + \ldots + B_kX_k)\}} \quad (4)$$

which is a binary logit model. Vector X = (x_1, x_2,…,x_k) consist of k significant explanatory variables in the model and the task is to estimate the vector of parameters B = [B_0, B_1,…,B_n]. Following Hanemann (1989), mean WTP can be estimated using the formula:

$$\text{Unrestricted Mean WTP} = \frac{(B_0 + B_2X_2 + \ldots + B_kX_k)}{|B_1|} \quad (5)$$

($B_0 + B_2\overline{X}_2 + B_3\overline{X}_3 + \ldots + B_k\overline{X}_k$) is referred to as a grand constant. It represents indirect utility function, when X_1, which represents the bid amount of Rs. A equals zero (Loomis *et al*, 2000; Turcin, 2001). This model implies that mean WTP can assume both positive and negative values. When unrestricted, WTP is an area under the cumulative distribution function of individuals' true maximum WTP and above the X-axis. When restricted, the area in the limits between minus infinity and zero is subtracted from the total area of the unrestricted WTP. To rule out the negative values of mean WTP, we have to truncate the estimate of expected WTP to zero.

Restricted Mean WTP

$$= \frac{1}{|B_1|}.\ln(1 + e^{B0 + B2 + \ldots + Bk}) \quad (6)$$

The disadvantage of truncation rests with overestimation of the true WTP. Nevertheless, this approach is often used in practice to solve the problem of negative mean WTP.

The marginal effect of a unit change in probability (value of regressor, P_i) is given by: $B_j{*}P_i(1 - P_i)$, where B_j is the coefficient of the jth regressor (Gujarati, 1995).

Estimation of WTP in labour units

The subsistence economy of the surveyed population called to express their support for the programme in non-monetary units due to the lack of cash income. Following Swallow and Woudyalew (1994) and Shyamasundar and Kramer (1996) in the present study, alongside monetary WTP, households were asked to express their WTP in labour units. In order to elicit the WTP in labour units, an open-ended question was used and respondents were asked if they were willing to contribute as hired labour[8] (instead of money), the wages of which would go to the fund for indigenous knowledge protection. The days of hired labour, households were willing to contribute, were converted to monetary units by multiplying with the prevailing wage rate (Rs. 110 per man day; due to the well-organized trade union activity, the cross sectional variation in wage rate is limited at a time). The monetary WTP was compared with WTP as hired labour.

Due to the absence of studies indicating suitable conversion factor for estimating WTA value from WTP, assumption is made that the bioprospector has to pay at least a minimum amount equal to the WTP of Kani tribes to protect their IK base as compensation in biodiversity contacts employing the same. Though we can estimate the WTP of Bioprospector following Simpson *et al* (1996) and Rausser and Small (2000), the assumptions made in those studies do not suit for analysing the Kani Model of Benefit Sharing. Further studies are needed to estimate the exact WTA of the IK holders.

[8] For ensuring uniformity, the kind of labour was specified as that of agricultural land preparation.

4. Definition of variables and empirical estimation of the model

With data obtained from 68 Kani households, the WTP was computed using dichotomous choice (DC) format. In this model, the respondents are asked to state their willingness to contribute the bid amount in YES - NO format. A full statistical model including all survey demographic and attitude (towards KKSKS, TBGRI, and Transfer of IK) variables was initially estimated. To conserve space, only the model with independent variables significant at least at 0.10 level retained. Attitude variables were largely insignificant and these are not included in the final model.

The final statistical model was:

$$[\log(yes)/(1\text{-}yes)] = B_0 - B_1.BID + B_2\ INCOME - B_3.FSIZE + B_4.\ AGE + B_5.\ CULT + B_6.\ SCH$$

where 'yes' is the dependent variable and records if a person was or wasn't willing to pay the amount asked during the interview (Bid amount). The number 1 records a yes vote, and 0 records a no vote. Forty-five households voted positively for contribution, while 23 were reluctant to contribute the elicited amount. The function was statistically significant with a log likelihood ratio of (–) 22.43. The elaboration of the independent variables is given in Table 1.

[Table 1]

Interpretation of the regression results

(i) BID
The 'BID' is statistically significant at the 1 per cent level. The negative sign denotes that higher the amount the respondent was asked to pay, lower would be the probability that the respondent would contribute for protection of IK base. Marginal change of dependent variable for unit change in bid was estimated to be (–) 0.0029.
(ii) PER CAPITA INCOME
The co-efficient of per capita income (Rs/year) is positive indicating that the rich tribes were more likely to pay the elicited bid amount. The variable is significant at 5 per cent level. Marginal change in probability due to unit change in per capita income was estimated to be 0.00008.
(iii) FAMILY SIZE
The variable's co-efficient is negative indicating that the larger families were less likely to pay an amount toward conserving IK, compared to the smaller households. The variable is significant at the 5 per cent level.
(iv) AGE
The positive sign suggests that compared to the youngsters, older people were more likely to donate for IK conservation. This variable was significant at the 10 per cent level.
(v) CULTIVATORS
The variable is significant at 1 per cent level. The cultivators of herb *T. zeylanicus*, were more likely to donate for a cause of IK protection.
(vi) YEARS OF SCHOOLING
Higher education leads to higher level of awareness about exploitation and hence is associated with a higher probability to vote 'yes' for paying the elicited amount. Variable is significant at 5 per cent level.

Using the formula in Eq. 5, mean WTP was calculated at the mean of the other independent variables. Using the coefficients given in Table 2, the WTP was separately elicited for two subgroups of cultivators and non-cultivators of *T. zeylanicus* (Table 3). Due to the experience of direct monetary benefits out of trading their IK, the WTP for former group for protection of IK base from illegal appropriation was greater – that is, Rs.576.42 per household. The WTP of non-cultivators was estimated as Rs.285.35 per household.

[Table 2]

[Table 3]

[Table 4]

To compute the total WTP of the Kani households, estimated mean WTP of two these subgroups were multiplied with their respective share in total Kani population. The cultivators, though having a higher WTP to protect their IK base, comprise only 3 percentage of the total Kani population. The aggregate WTP of Kani community (with approximately 4500 households) was thus estimated to be Rs.1.32 million. This is the minimum amount the bioprospector should pay to make use of IK from the community[9].

Fewer studies address the use of CVM in the developing countries and no single study valuing indigenous knowledge could be traced out, making comparison of the results impossible. But the fact that the mean household WTP is more than 3 per

[9] The total WTA may be 1.5 to 8 times the WTP (Adamowicz *et al*, 1993; Shogren *et al*, 1994; Franciosi *et al*, 1994; Eisenberger and Weber, 1995; and Morrison, 1997). So in practice the compensation amount that the community demands for imparting their IK could be greater than Rs.1.32 million.

cent of annual per capita income underlines the importance Kanis attach to their IK wealth.

Kanis' WTP in Labour Units

Along with money, labour also was used as the numeraire in the CV question taking into account of subsistence nature of the tribal economy. The majority of respondents (54 households; 79% of the sample) were willing to pay a contribution towards the protection of IK as through hiring out their human force. Among the surveyed households, 26 per cent (18 households) offered to donate one to two days' labour, and forms the *mode* of distribution. (Figure 1). Eleven households were willing to contribute equal to or more than a weeks' labour. The mean WTP was computed for sub-groups (Cultivators and Non-Cultivators) and the results are presented in Table 5. Here the WTP is considerably higher compared to their monetary WTP; Cultivators were willing to donate labour worth Rs.546.76, whereas Non-Cultivators had WTP of Rs. 375.29.

[Figure 1]

[Table 5]

Similar to the computation process of monetary WTP, the share of subgroups in Kani population was multiplied with the respective WTP values to compute the aggregate WTP. Total WTP of Kani Community was estimated to be Rs. 1.71 million, which is 29 per cent higher than its counterpart in monetary units. The Kanis' economic backwardness can be cited as an important reason behind this disparity. Following the previous studies (Schulze *et al*, 1996), use of open-ended questions would have resulted in a lower WTP compared to its DC counterpart. But as the tribal people were willing to contribute labour than money, one can infer that such strong preference eclipsed the probable opposite effect owing to the use of open-ended format. This might indicate that people have many cash demands and few opportunities for earning money. This finding coincided with that of Swallow and Woudyalew (1994). Kani is one among the poorest communities of the world and use of labour as means of payment might be strongly advocated in CV, if carried out in similar situations.

Considering the demand side, the WTP of bioprospectors for access to natural organisms necessitates assessing the bioprospecting value from the firm's perspective. Search procedures are becoming more selective, favouring particular areas with known prior information (including the existing indigenous knowledge). What is the impact of IK that affects the demand and supply of genetic material on the price that bioprospectors are willing to pay for access to it? Further studies are needed to elicit the bioprospectors' WTP for employing the IK base from tribal communities of Western Ghats.

The present study is an initial attempt to analyse the issue of optimal compensation for IK knowledge holders in bioprospecting endeavours, using tools of environmental economics. Further empirical as well as theoretical analysis is needed to derive a strong foundation for estimating compensation for local communities of developing countries in the biodiversity contracts.

5. Conclusion

This research was an attempt to value the attributes of indigenous knowledge associated with marginal bioprospecting endeavour. Though currently partial in implementation, the research indicates greater adaptability of KMBS in the developing country perspective, where research in the public sector develops products with the help of IK and markets the outputs through the private sector. Along with the risk of public protest against the private sector bioprospecting, it is also found to generate socially optimum compensation for IK holders. Important herbal drug manufacturers of South India expressed their willingness to compensate the IK holders and research institute over and above the cumulative sum of Rs. 6 million in return for developed herbal formulation (Source: Personal communication with the firms).

The willingness to accept of indigenous community for *marginal* bioprospecting endeavour is greater than the WTP of bioprospector. But when the *total* value of bioprospecting is considered, the minimum WTA of IK holders may be lower than the maximum WTP of bioprospector. As indicated in contingent valuation literatures, the WTP for protecting *n* services from IK will be far less than *n* times WTP for protecting single service of IK. Hence further studies are needed to elicit the WTA of community. The research does not suggest a particular value as optimal compensation. Instead, it indicate a range over which the value can fall into. Since theory suggest that the optimum compensation lies in a region higher that its WTP value, the monetary benefits realized under the present benefit-sharing scheme is certainly inadequate. But still there is a ray of hope for improvement once the institutional impediments are eliminated by a co-ordinated activity.

Acknowledgement

This research received financial assistance from Department for International Development Shared Scholarship Scheme.

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Table 1. Description of Variables for Dichotomous Choice Estimation

Variable	Description
BID	Amount about which the household was asked to elicit preference (Rs)
INCOME	Annual per capita income of the household (Rs)
FSIZE	Family size (numbers)
AGE	Chronological age (years)
CULT	1 for Cultivators; 0 for Non-cultivators
SCH	Years of schooling

Table 2 Binary Discrete Choice Model Estimation [Logistic Regression]

Dependent Variable: 1 – Willing to pay the bid amount
0 – Not willing to pay the bid amount

Response Information

Variable Value	Count
1	45
0	23
Total	68

Variable	*Coefficient (Standard Error)*	*ρ Value*
CONSTANT	-0.615 (2.499)	0.806
BID	-0.01294 (0.00490)	0.008
INCOME	0.00037 (0.00018)	0.034
FSIZE	-0.5604 (0.2815)	0.047
AGE	0.07444 (0.04627)	0.108
CULT	2.7276 (0.9372)	0.004
SCH	0.2815 (0.1434)	0.050

Marginal change of dependent variable for unit change in
(a) BID = – 0.00290
(b) INCOME = 0.00008

Log-Likelihood = – 22.429

Measures of Association (Between the Response Variable and Predicted Probabilities):

Pairs	Number	Percent	Summary Measures	
Concordant	964	93.1%	Somers' D [A]	0.87
Discordant	67	6.5%	Goodman-Kruskal Gamma[B]	0.87
Ties	4	0.4%	Kendall's Tau-a [C]	0.39
Total	1035	100.0%		

[A] An asymmetric measure of association in a contingency table where row and column variables are measured on an ordinal scale. The measure is appropriate when one variable is considered dependent and the other independent.

[B] A symmetric measure of association for observations measured on an ordinal scale. The measure ranges from −1 to +1 and takes into account only the number of untied pairs.

[C] A nonparametric measure of association between two ordinal variables. It is based on the number of inversions (interchanges of ranks) in one ranking compared with another. It is calculated as P − Q where P is the number of concordant pairs, i.e., pairs with rankings in the same direction, and Q is the number of discordant pairs, i.e., pairs with rankings in the reverse direction. It is especially appropriate for small sample sizes.

[Source of description of summary measures: McGraw-Hill High education (http://www.mhhe.com)]

Table 3. Estimation of Mean WTP from Logit Regression

Variables	Mean Values	
	Group I [Cultivator]	Group II [Non-cultivator]
BID	217.65	230.88
INCOME	8888.57	6565.31
FSIZE	4.24	3.82
AGE	33.38	33.24
CULT	1.00	0.00
SCH	4.71	3.29
Estimated Mean WTP (Rs per household)	**576.42**	**285.35**

Table 4. Mean WTP of Kani Households (Monetary Units)

Group	Share of Kani Population	Household WTP (Rs)	Mean WTP of Kani Household (Rs)
Cultivator	0.03	576.42	294.08
Non-Cultivator	0.97	285.35	

Aggregate WTP of Kani Community = 294.08 x 4500 = Rs. 1.32 million

Figure 1 Frequency distribution of households' WTP in labour units

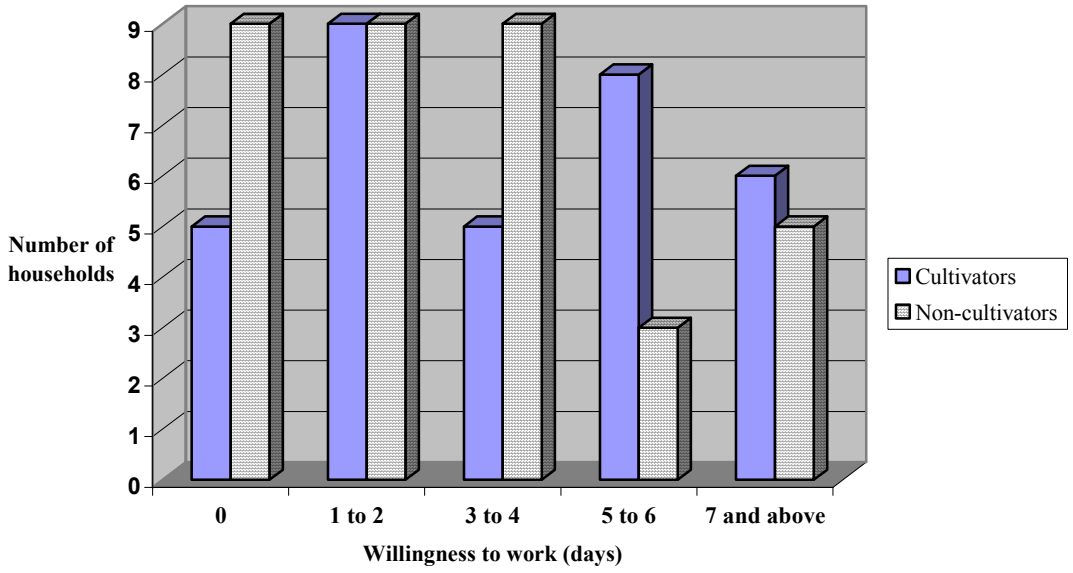

Table 5 Mean WTP of Kani Households (Labour Units)

Sub-Group	Share of Kani Population	Household WTP (Rs)	Mean WTP of Kani Household (Rs)
Cultivator	0.03	546.76	380.44
Non-Cultivator	0.97	375.29	

Aggregate WTP of Kani Community = 380.44 x 4500 = Rs. 1.71million