Is the value of bioprospecting contracts too low?

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In order to regulate the proliferated bioprospecting and protect the biological diversity in the source countries, the Convention on Biological Diversity (CBD) established a legal framework for the reciprocal transfer of biological materials between the interested parties in bioprospecting activities, subject to the Prior Informed Content (PIC) principles and a set of mutually agreed items on equitable sharing of benefits (CBD 1992, Bhat 1999; Ten Kate and Laird 1999; Dedeurwaerdere 2005).

Although interesting and valuable to the cause of conservation, there is a feeling that the 'price' being paid under these arrangements is too low. Somehow ecologists argue that, surely, these materials have a greater value than the few million dollars being paid to national conservation organizations for the protection of the areas where the material are located. In this paper we seek to understand better how a biodiversity resource' use value in production is determined, and how the real value is obscured by the fact that the resource is largely open access. We attempt to analyse how special arrangements, set op top of a basic framework in which the resource open access is limited in what it can achieve and in the 'price' that will emerge from any transaction between the buyers of the rights and the sellers of the rights.

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I. Introduction

There has been considerable interest in using market-based mechanisms to pay for ecosystem services. In the past decades, the traditional tools used to foster biodiversity and ecosystem conservation – namely, indirect support through grants and loans to developing countries to support their domestic, resource management agencies, or to impoverished individuals within those countries – has been questioned. The critics stem from the realisation that a more effective policy would be to make direct payments to landowners, conditional on the maintenance of the land in its natural state. The financial benefits of healthy ecosystems and the environmental services they provide have thus gained increasing attention in the debate on public choice and environmental management (Mayrand and Paquin 2004, Pagiola and Agostini 2004).

There have also now been a number of transactions in which commercial interests, particularly in the pharmaceutical industry have made payments for exclusive access to genetic material. In order to obtain a better understanding such transactions, it is necessary for us to propose an explicit analysis on the contractual relationships, taking account of all the related parties. Therefore, in Table 1 in the annex we review some of the existing bioprospecting contracts and thus provide a general overview of the contractual parties involved and their respective costs and benefits.

As we can see, the contractual relations put forward between different economic agents, notably linked to the industry and to resources suppliers, which are predominantly located in geographical areas where there is a high richness of biodiversity (e.g. Brazil and Costa Rica) are complex. First, Table 1 shows wide variety of private sectors involved in bioprospecting. This leads to different interests in genetic resources, as a crucial input for research and development (R&D), thus resulting in different contractual specifications. For instance, industries of botanical medicines, personal care and commercial agricultural traditionally depend upon plant genetic resources, but pharmaceutical biotechnological companies always acquire material as raw samples, extracts from plant genetic resources or 'value-added' genetic resources (Ten Kate and Laird 1999).

The emblematic bioprospecting contract is the contract signed between the INBio-national biodiversity institute of Costa Rica and the Merck Pharmaceutical Ltd. in 1991. Merck was granted the right to evaluate the commercial prospects of limited number of plant, insect, and microbial samples collected in Costa Rica's 11 conservation areas, from which INBio received US$1 million over two years as well as equipment for processing samples and scientific training from Merck. In addition, a share of potential royalties and technology transfer to develop local sample preparation and screening capabilities was addressed in the agreement. INBio agreed to invest 10% of any payments and half of royalties by Merck into the Conservation Areas (Mulholland and Wilman 1998; Merson 2000; Artuso 2002). More recently, Glaxo Wellcome and Brazilian Extracta have jointly signed a bioprospecting contract where Glaxo paid US$3.2 million for the right of screening 30,000 compounds of plant, fungus and bacterial origin from several regions in the forest of Brazil. In addition, Glaxo will be responsible for allocating part of the royalties derived from market products arising from the discovered compounds in Brazilian university based research groups and in the support of community-based conservation projects.

In order to regulate the proliferated bioprospecting and protect the biological diversity in the source countries, the Convention on Biological Diversity (CBD) established a legal framework for the reciprocal transfer of biological materials between the interested parties in bioprospecting activities, subject to the Prior Informed Content (PIC) principles and a set of mutually agreed items on equitable sharing of benefits (CBD 1992, Bhat 1999; Ten Kate and Laird 1999; Dedeurwaerdere 2005).

Although interesting and valuable to the cause of conservation, there is a feeling that the ‘price’ being paid under these arrangements is too low. Somehow ecologists argue that, surely, these materials have a greater value than the few million dollars being paid to national conservation organizations for the protection of the areas where the material are located. In this paper we seek to understand better how a biodiversity resource’ use value in production is determined, and how the real value is obscured by the fact that the resource is largely open access. We attempt to analyse how special arrangements, set op top of a basic framework in which the resource open access is limited in what it can achieve and in the ‘price’ that will emerge from any transaction between the buyers of the rights and the sellers of the rights.

The structure of the paper is as follows. In section II we provide the basic model for the analysis of an open access biodiversity resource in the presence of many firms with increasing returns to scale over a part of their production function. The model characterising the open access equilibria is presented, and the scope for special arrangements is discussed. In section 3 we work through a model with a simple production structure and obtain closed form solutions for the open access equilibria, the shadow price of the biodiversity resource and the likely price to emerge from any special deals. Numerical examples are provided for plausible parameter values. Section 4 discusses the limitations of the analysis and the range of policy options available and offers some conclusions.

II. Open Access Biodiversity with Competitive Firms

When a resource such as genetic materials is under open access (OA) there are two implications. The first is that it is exploited to the maximum extent possible – i.e. to the point where all that can profitably be extended is so extracted. The second is that such a process of extraction combined with the OA nature of the resource result in damage to the resource base, or at least no attempt by anyone to protect it and enhancing the future values it could provide.

We envisage a world with a large number of firms operating in a competitive market. They have two inputs, one of which is genetic material (b) and the other a composite (called it l). They produce a single output (q)[1].

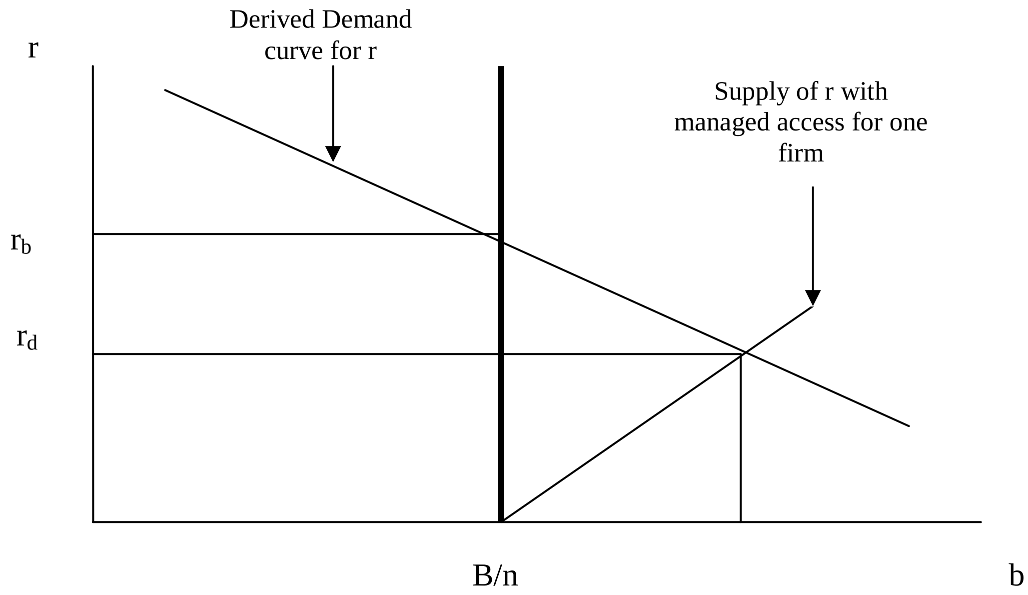
The firms maximise profits but, given the competition condition, the number of firms (n) is such that each makes a zero profit[2]. The genetic material input is available free and, given a total supply under OA of B, each form has B/n. Of course is has a non-zero value to the firm and a shadow price of the material can be computed. Call this r_B.

[1] We plan to extend this later to cover differentiated outputs and a stochastic production structure.
[2] The zero profit constraint implies that firms cannot have a production structure that is one of only decreasing or constant returns to scale. With such a structure either one firm dominates the market or the number of firms increases without bound, with each becoming infinitesimally small. Hence we have to assume that the firms have some section of their production structure that is with increasing returns to scale. The easiest way to do that is to assume set up costs for entering the market and undertaking production.

Now suppose one firm decides to make a deal with the supplier of its genetic material and under the agreement it will pay a certain amount for each unit of *b* extracted. The supplier offers to protect the resource and manage it and the deal is that the greater the amount made available, the higher the unit price will be.

Under this arrangement the single firm will make a payment per unit of *b* to the point where the marginal value is equal to the marginal cost to the owner of supplying the last unit. Furthermore it will only do this if its profits under the special deal are higher than under the competitive solution – i.e. greater than zero.

The analysis can be shown as in the figure below. The OA equilibrium is at [r_b,B/n], while the special deal equilibrium is at [r_d, b_d]. The second equilibrium will, however, only be chosen is profits there are greater than zero.



The model can be represented analytically as follows. Profits **Π** are given by:

$$\Pi = p.q^s(l, \frac{B}{n}) - wl \qquad (1)$$

Where q^s is the production function *p* is the price of q and *w* is the price of *l*.

The first order conditions for a maximum are:

$$\frac{\partial \Pi}{\partial l} = p.q_l^s - w \qquad (2)$$

From (2), *l* is determined as a function of *p* and *w*. Feeding that into (1) gives

$$q^s = \psi(p, w, \frac{B}{n}) \qquad (3)$$

The demand for the output q is given by

$$q^d = \phi(p) \tag{4}$$

With n identical firms we have

$$q^d = nq^s \tag{5}$$

The zero profit condition gives

$$pq^s - wl = 0 \tag{6}$$

Equations (3)-(6) determine $q_{OA}^d, q_{OA}^s, p_{OA}, n_{OA}$ which characterize the OA equilibrium.

Now the special deal equilibrium is characterized as follows. The profits are now:

$$\Pi_{SD} = p.q^s(l,b) - wl - rb \tag{7}$$

Where $b>B/n$.

The FOC for an increase in b require

$$\left.\frac{\partial \Pi}{\partial b}\right|_{b>\frac{B}{n}} = p\frac{\partial q^s}{\partial b} - r = 0 \tag{8}$$

$$\left.\frac{\partial \Pi}{\partial l}\right|_{b>\frac{B}{n}} = p\frac{\partial q^s}{\partial l} - w = 0 \tag{9}$$

Finally there is a supply curve for r:

$$r = \theta(b), b \geq \tfrac{B}{n} \tag{10}$$

Substituting (10) into (8) gives 2 equations for l and b. These will be chosen only if the corresponding profit is positive.

It is possible that the special deal equilibrium will allow the company making it to differentiate its product q in the market and charge a higher price than p_{OA}. In that case the equilibria will be adjusted accordingly.

In the next section we estimate a possible function and see what the equilibria will look like. We can then compare the shadow price of b with the special deal price.

III. Modelling the Equilibria with Specific Functions

Setting out the analytical model
In this section we take the following simple Cobb-Douglas production function for *q*:

$$q = l^{\alpha}\left(\frac{B}{n}\right)^{(1-\alpha)} \qquad (11)$$
$$0 < \alpha < 1, l > l_0$$

Profits **Π** are given by:

$$\Pi = pq - wl - wl_0 \qquad (12)$$

The first order conditions for a maximum give:

$$l^s = \frac{B}{n}\left[\frac{p}{w}\right]^{1/(1-\alpha)} \alpha^{1/(1-\alpha)} \qquad (13)$$

and

$$q^s = \frac{B}{n}\left[\frac{p}{w}\right]^{\alpha/(1-\alpha)} \alpha^{\alpha/(1-\alpha)} \qquad (14)$$

Equation (12) for profits now becomes:

$$\Pi = p^{1/(1-\alpha)} . w^{-\alpha/(1-\alpha)} \frac{B}{n}(\alpha^{\alpha/(1-\alpha)} - \alpha^{1/(1-\alpha)}) - wl_0 \qquad (15)$$

Setting demand q^d equal to supply as in equation (5) where demand is represented by an isoelastic demand function with price elasticity equal to β we have:

$$q^d = Ap^{-\beta} = nq^s \qquad (16)$$

Substituting for q^s from (14) and solving for *p* the OA equilibrium price of *q* we get:

$$p_{OA} = \left[\frac{B}{A}\right]^{-(1-\alpha)/k} w^{\alpha/k} \alpha^{\alpha / k} \qquad (17)$$
$$k \equiv \beta(1-\alpha) + \alpha$$

It follows from (17) that p is a decreasing function of B and an increasing function of w. The solution for *n*, the number of firms is given by substituting for *p* from (17) into (15) with Π set at zero. Rearranging terms and solving for *n* we get:

$$n = \left[\frac{p_{OA}}{w}\right]^{1/(1-\alpha)} \frac{B}{l_0}\left\{(\alpha^{\alpha/(1-\alpha)} - \alpha^{1/(1-\alpha)})\right\} \qquad (18)$$

Where p_{OA} *is* as given in (17). Substituting for it from (17) gives:

$$n = \left[B^{(1-1/k)} \cdot A^{1/k} w^{-\beta/k} \alpha^{\alpha/k(1-\alpha)} \left\{ \alpha^{\alpha/(1-\alpha)} - \alpha^{1/(1-\alpha)} \right\} \right] / l_0 \tag{19}$$

Note that the number of firms n declines as the set up costs l_0 increase. The number also increases with B but only if (1-1/k) > 0, i.e. if k > 1. This requires that β, the price elasticity of demand be greater than one. Indeed that is also a condition for the equilibrium to exist for this particular set of functional forms.

Finally we want to calculate the shadow price of the biodiversity resource *b*, r_b. This is obtained by differentiating the profit function (15) with respect to B:

$$\begin{aligned} \frac{\partial \Pi}{\partial B} &= \frac{1}{(1-\alpha)} p^{\frac{1}{(1-\alpha)}-1} w^{-\alpha/(1-\alpha)} \frac{B}{n} \left\{ (\alpha^{\alpha/(1-\alpha)} - \alpha^{1/(1-\alpha)}) \right\} \frac{\partial p}{\partial B} \\ &+ p^{1/(1-\alpha)} w^{-\alpha/(1-\alpha)} \left\{ (\alpha^{\alpha/(1-\alpha)} - \alpha^{1/(1-\alpha)}) \right\} / n \end{aligned} \tag{20}$$

Note that in differentiating the profits function with respect to B we hold n constant. If n is allowed to vary the change in profit is of course zero, as defined by the profit maximisation and zero profit restrictions. As in the case of *n* profits will only increase with an increase in *B* if β is greater than one.

Some numerical solutions of the OA solution

Since the model is fully solved in closed form we can calculate the solutions for specific values of the parameters. Table One gives the range of values tried with some *a priori* justification for them.

The results are given in Table 2. We make the following observations:

(a) The shadow price of the resource is very sensitive to the price elasticity of demand for the product. An increase in the elasticity from 1.05 to 1.3 raises the shadow price by a factor of nearly 6.

(b) The set up costs have a major impact on the number of firms. A four-fold increase in the set up costs, for example, reduces the number of firms from 42 to 10, thus increasing their market power. Changes in set up costs do not affect the shadow price of *b*. This follows directly from (20) where l_0 does not appear.

(c) Increases in *w* reduce the number of firms (a doubling of w reduces the number of firms by about 50 percent). Increases in *w* also of course in *p*, so that the doubling of *w* increases *p* by about 40 percent. Finally while the shadow price of *b* is not directly affected by *w*, the shadow price as a percent of the price of output declines as *w* increases: the same doubling of *w* reduces the shadow price as a percent of the price of output by 40 percent.

(d) The higher is *α* the lower is the role of biodiversity in the production process and the lower is its shadow price. An increase in the value of *α* from 0.6 to 0.9 reduces the shadow price both in absolute value and as a percent of the price of output by 95 percent.

Table 1: Range of Parameter Values for the OA Equilibrium

Parameter	Values	Reasoning
‘α’	0.6 to 0.9	Determines the share of value of output attributable to factors other than biodiversity. This could vary by application and above range should cover most cases.
‘*β*’	1.05 to 1.3	Has to be greater than one. Elasticity range for products such as drugs can be quite elastic but can also be inelastic. Range chosen is plausible but need further investigation
‘l_0’	0.5 to 2	Chosen so that the set up costs are about 25% of the direct non-biodiversity costs.
‘*w*’	1 to 2	Normalised to be roughly equal to 65 to 75 percent of the price of the output.
B	1000	Chosen so that the number of firms in the OA is in the range 10 to 100 for the different parameter values.
A	100	

Table 2: Results for the OA Equilibrium

		No of Firms	Output	Shadow Price of b (%)*
α = 0.8 ‘l_0’ = 0.5 ‘w’= 1.0	‘*β*’=*1.05*	41	134	1.3
	‘*β*’=*1.10*	41	136	2.6
	‘*β*’=*1.20*	42	138	5.0
	‘*β*’=*1.30*	43	141	7.4
α = 0.8 ‘*w*’ = 1.0 ‘*β*’=*1.10*	‘l_0’ = 0.50	11	138	5.0
	‘l_0’ = 0.75	21	138	5.0
	‘l_0’ = 1.50	28	138	5.0
	‘l_0’ = 2.00	42	138	5.0
α = 0.8 ‘l_0’ = 0.5 ‘*β*’=*1.10*	‘*w*’ = 1.0	42	138	5.0
	‘*w*’ = 1.2	34	117	4.4
	‘*w*’ = 1.4	29	101	3.9
	‘*w*’ = 2.0	19	73	3.0
‘l_0’ = 0.5 ‘*β*’=*1.10* ‘*w*’ = 1.0	α = 0.6	94	204	18.5
	α = 0.7	65	164	8.6
	α = 0.8	41	136	2.6
	α = 0.9	20	115	0.6

Analysing the Special Deal Equilibrium

In the special deal a firm has access to the open access share of the genetic materials but, in addition, negotiates an arrangement to have access to further material on an exclusive basis. It pays for the additional material and the price depends on the amount that is extracted. Mathematically we can then write profits as:

$$\Pi = pq - wl - r(b).(b - \frac{B}{n}) - wl_0$$
$$b > \frac{B}{n}, l > l_0 \tag{21}$$

The first order conditions are given by:

$$\frac{\partial \Pi}{\partial l} = \alpha p l^{\alpha-1} b^{1-\alpha} - w = 0 \tag{22}$$

$$\frac{\partial \Pi}{\partial b} = (1-\alpha) p l^{\alpha} b^{-\alpha} - r'(b)(b - \frac{B}{n}) - r(b) = 0 \tag{23}$$

In the absence of any better information we choose a linear form of the function *r(b)*:

$$r = a + db \tag{24}$$

Replacing *r* and the derivative of *r* from (24) in (23), and substituting for *l* from (22) into (23) we get:

$$b = \frac{(1-\alpha) p^{1/(1-\alpha)} w^{\alpha/(1-\alpha)} \alpha^{\alpha/(1-\alpha)} + d\frac{B}{n} - a}{2d} \tag{25}$$

It follows from (25) that *b* decreases with *a* and also with *d*. Note also that this quantity and the corresponding price of r is independent of *β*, the overall elasticity of demand. This is because the single producer is not assumed to influence the market price though the special deal.

It is difficult to determine the nature of the *'r'* function (24), but it is an important one and more effort is needed to understand better its structure. In the calculations we below we use the linear form and select the parameters *a* and *b* as follows:

i. 'a' is chosen as somewhere between zero and the shadow price of *b* in the OA. A value of around 1-25 percent of the typical shadow price is taken.

ii. 'd' is chosen so that the elasticity of the supply price with respect to *b* is around 0.5 at the point where *b = B/n*. Recall that the elasticity with respect to price is of course the inverse of the elasticity of quantity with respect to price, which is set at around 2. We test for sensitivity to this price elasticity below.

The main results are as follows:

(a) For the 'base case' numerical values of α = 0.8, 'l_0' = 0.5, '*w*'= 1.0, β = 1.1, we find that a special deal can be struck if the supply function starts at a value of around one percent of the shadow price of *b*, when the price elasticity is 0.5. If the price elasticity falls to half that (i.e. the slope of the r function declines), the starting value for the price function can rise to as much as 3.5 percent of the shadow price of *b*.

(b) In this base case the final price for the special deal purchase of *r* – i.e. *r(b)* is around 80 percent of the shadow price of *b*. This value will, however, fall to around 30 percent if the price elasticity of output increases from 1.1 to 1.3 and will rise to even above the shadow price if the price elasticity of the final product approaches unity. So the extent to which the special deal price is a good or bad approximation for the 'true' value of the biodiversity depends critically on the elasticity of demand for the final product.

(c) The amount of b bought under the special deal will depend crucially on the elasticity of the r function. For an elasticity of 0.5 the amount is small – between one and eight percent of the amount obtained under OA. For an elasticity of 0.25, however, it can rise to around 100 percent of the OA amount.

(d) There is no guarantee that a special deal can be struck. That depends on a number of parameters. In general terms a deal is more likely the lower the value of a in the r function, the lower the slope of the r function, the lower is w, and the lower is α.

If the special deal has the added advantage of increasing the price that the firm will receive for its output the implications of that are straightforward. The amount of b the firm will be willing to buy increases, and the price paid for it both in absolute terms and as a percentage of the shadow price of b will increase. As an example, we assume that the price that can be charged goes up by 5 percent or 10 percent. The increases in the amount of b bought under the special deal goes up by 8 percent and 13 percent respectively. The price at which the deal is struck as a percentage of the shadow price of biodiversity, however, increases by only one and two percentage points respectively.

4. Some Concluding Remarks

In this paper we have explored the way in which a firm may negotiate for a special deal to obtain genetic material by bioprospecting, with a background in which such material is available effectively on an open access basis. We believe this characterizes the current situation in this field. The open access equilibrium has been set out with firms facing increasing returns to scale in the initial stages of production because of set up costs. The OA equilibrium has been further explored using specific functional forms for the production and demand functions. It turns out that the shadow price of biodiversity is very sensitive to the price elasticity of demand for the final product. It is also sensitive to the value of α, which measures the degree to which factors other than biodiversity are important in determining the final output of the firms interested in bioprospecting. Not surprisingly the lower the role of biodiversity, the small its shadow price relative to the price of output.

When we look at the special deal we find that such deals can be struck, in the sense that the firm gains an increase in profit relative to the OA equilibrium, in which it makes zero profits. The presence of such a deal, however, is not guaranteed. It depends of the parameters of the 'r' function, which determines how the price of the biodiversity increases as the amount bought increases. The lower is the starting value of this function and the lower the slope of the function the more likely it is that profits under the special deal will be positive. They are also more likely to be positive, the greater is the role of biodiversity in the production process (the lower is α), and the lower is the wage relative to the price of output.

One can question a number of the assumptions of this analysis. One of the most obvious is that if a special deal works for one firm, why does it not work for all, and thus why do we not move to a private equilibrium. The answer that immediately comes to mind is that the arrangements under which the deals are worked out are not easy or transparent and resources are needed to achieve the deal and to keep it operating. To some extent any returns to the arrangements are then returns to the initiative of negotiating under uncertainty and in a risky environment. As these risks decline, we will see a move away from OA, but that is not the current situation.

We should also explore the possibility that, as the deal is struck, the amount of materials that can be extracted will vary according to the kind of deal. Under carefully managed conservation resources it may be possible to get much more material than under a looser agreement to bioprospect in a given area. To some extent the *r* function is intended to capture that but it does so in a rather mechanistic way.

Finally we can look more closely into the production structure of firms interested in bioprospecting and in particular model the role of uncertainty, which is critical to the activities of such firms.

To conclude we return to the question posed in the title of this paper. We judge the value of bioprospecting contracts relative to the shadow price of biodiversity in the OA equilibrium in which they are embedded. We find that, under a range of conditions the price will be fraction of that shadow price. But it can be higher than the reference price. Much depends on the price elasticity of the output and a number of other parameters, whose values are not available easily from the empirical literature. More work is needed to determine what are the real values. From that a more precise set of answers may be possible.

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ANNEX:

Table 1 A review on the existing bioprospecting contracts

Contractors	Year (Duration)	Renewal	Monetary Benefits	Non-Monetary Benefits
INBio & Merck	1991 (2 years)	Yes	- Costa Rica government earned US$1.2 million of revenues and conservation funding - INBio obtained over US$2.5 million from bioprospecting	- Merck was granted the rights of exclusively commercial using the samples (about 2000 has been collected) from the 11 Costa Rica's conservation areas - Lead to improvement in Costa Rica's scientific, technical, and institutional capacity
ICBG & Bristol-Myers Squibb, Monsanto, and Glaxo Wellcome	1993 (5 years)	Yes	- ICBG was paid US$1 million for screening	- In 1997, total 4000 species and over 7000 samples have been collected and screened. More than 140 samples were identified for further investigation, over 170 samples were recollected and more than 35 leads have been found -Benefit sharing between ICBG and host country
U.S. Phytera &European botanical gardens	1996 (N.M.)	No	- Phytera paid US$15/plant specimen and 0.25% of the profit as royalty	- Phytera obtained seeds and tissues from tropical plants in the gardens' collection
TBGRI &AVP &The Kani community	1996 (8 years)	No	- TBGRI provided a subsidy of Rs1,000(US$22.5)/household for cultivating T.zeylanicus - Total licence fee was Rs1millioin(US$23,000), and 2% on ex-factory sale of the products against royalty - The Kanis was granted Rs20,000 of the licence fee under the ABS agreement	- TBGRI carry out drug manufacturing by using T.zeylanicus leaves from both collection and cultivation by the Kanis community
Yellowstone National park &Diversa	1997 (5 years)	No	- Diversa paid US$100,000 to the park service; US$75,000 for the rights of conducting research on microorganisms, and annual $35,000 against the royalty - Annual revenues of Diversa from Taq enzymes are over $100 million	- Agreement on the extraction of Thermus Aquaticus (Taq) enzyme from the hotsprings in Yellowstone National Park

Continued

Contractors	Year (Duration)	Renewal	Monetary Benefits	Non-Monetary Benefits
CSIR (South Africa) & foreign research organizations and multinational companies and traditional healers	1998 (N.M.)	No	- Benefits sharing with traditional healers - CSIR got revenue from the commercialized genetic resource	- Evaluate the pharmaceutical potential of all 23,000 species of vascular plants native to South Africa - CSIR has obtained technical assistance from foreign institutes (e.g. USNCI) for screening biological extracts - Sharing the developed database of information on traditional uses of South African plants
Glaxo Wellcome & Brazilian Extracta	1999 (3 years)	No	- Glaxo paid US$3.2 million for the right of screening; 25% of royalties to the university research group; 25% of royalties to support community-based conservation, health and ecducation projects, and all the research and development cost in Brazil	- 30,000 compounds of plant, fungus and bacterial origin from several regions were granted to be screened and licensed to any product arising from the discovered compounds

Note: N.M.= Not Mentioned

Sources: (Breibart 1997; ICBG 1997; Mulholland and Wilman 1998; Neto and Dickson 1999; Ten Kate and Laird 1999; Merson 2000; Simpson 2001; Nunes and Bergh 2001, Artuso 2002; Greer and Harvey 2004; Dedeurwaerdere et al. 2005)