Valuation of Bioprospecting Samples: Approaches, Calculations, and Implications for Policy-Makers

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ABSTRACT

In this chapter, the revenue consequences of varying collection fees and royalties with regard to germplasm prospecting contracts are demonstrated. Principal factors are the uncertainty of finding marketable products and the value of these products. Negotiation factors are finding a good balance between collection (initial) fees as opposed to royalty (delayed) payments. Emphasizing collection fees reduces total payments except when national interest rates are very high. Reducing the risk of failure through in-country screening, including the use of indigenous knowledge, is a potentially valuable activity. Issues for contract negotiators are outlined and the implications for biodiversity conservation discussed. Conceptually, the highest valuation approach, royalties, will most encourage conservation, but as the future is typically heavily discounted, collection payments may get more attention and be most effective. Policy considerations for national governments, nongovernmental organization (NGOs), and development agencies are reviewed and it is concluded that grants/loans and training/equipment for in-country screening should be given a high priority as a potentially viable activity in the long term.

It should be noted that the figures and calculations in this chapter are merely for illustration. The valuation of samples, and by extension a country's biodiversity, is a negotiation and will depend on many factors, including alternative investment options by a company, alternative technologies that could be used for lead compounds, interest rates, and a range of risk factors, such as the political situation in a given country surrounding the national debate on bioprospecting. The latter point is a key factor: valuation is always a calculation that has important political consequences. Another complicating factor is the need for confidentiality with which a country and company will hold its overall business estimates. Neither a company nor a country will be likely to share their valuation basis purely for negotiation purposes and because neither want to tip off other entities about the opportunity. It is therefore concluded that, from a practical perspective, the proper valuation is the one that (1) provides the country with compensation and other benefits such that it does not feel taken advantage of and can withstand criticism from its constituents and (2) provides the licensee (typically a company) with a reasonable cost of obtaining the crucial raw or semifinished goods it requires as an input to its business.

1. INTRODUCTION

Since the adoption of the Convention on Biological Diversity (CBD) in 1992, the legal status of traditional knowledge is in the focus of international debate. Concurrent with CBD, Merck & Co. and INBio, the National Biodiversity Institute of Costa Rica, made a deal,

Note: While we have been careful in pointing out throughout this chapter that the monetary figures used in the examples are illustrative, it is important to urge that these figures not be used in actual negotiations. In the authors' opinion, one of the main reasons for the overall low level of interest in bioprospecting deals is that expectations based on the market potential for a blockbuster drug may scuttle a deal on samples to be used for an industrial application with a much lower market potential.

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which was widely publicized, for the payment of fees and royalties for germplasm collected inside Costa Rican conservation areas. Importantly, the agreement was renewed in 1994, 1996, and 1998 in similar terms and by 2004 has led to the filing of more than 27 patents based on the collaboration. Studies to determine the potential use of a limited number of extracts of plants, insects, and environmental samples have been completed, and the agreement has given INBio access to technology, teams, and training. It marked the first of a series of deals made by INBio (Table 1).

Such collection activities, so-called bioprospecting, have received considerable attention in the literature and have precipitated discussions on payments for collected samples and chemical extracts from samples. But the subject is generally treated in generalities, focusing on research needs, basic rights, and moral obligations. CBD itself is famous for broad language with multiple interpretations possible. On the subject of payments, CBD proposes "*sharing in a fair and equitable way the results of research and development and the benefits arising from commercial and other utilization of genetic resources … upon mutually agreed terms*" (Article 15(7)). There is no attempt to identify appropriate payment approaches or a system for valuing germplasm for specific uses. Even a full decade after the entering into force of CBD, the topic still receives attention, and 15 years since its passing has not been resolved. Evidently, there cannot be resolution on actual terms and payments, since these will be a function of market conditions, alternative technologies (such as recombinatorial chemistry, to name one), and other factors. We hope to shed light on the approaches that could be used to calculate royalty rates and collection fees.

The purpose of this chapter is also the provision of information on the revenue consequences of alternative payment arrangements for collected germplasm. We do not attempt to present actual market values for the material, although approximate figures are used for illustrative purposes. Commonly, germplasm-rich countries charge for samples in the form of a fixed initial payment (collection fee), a delayed payment based on sales of the resultant commercial product (a percent royalty, that is, a form of sharing of benefits), or combination of the two. Here it is demonstrated that when the likelihood of finding a commercializable product is small (the risk of failure great), emphasizing initial payments can be done only at the expense of a significant reduction in the royalty rate and, hence, in the expected overall revenues. The importance of the failure risk is such that reducing it through preliminary in-country screening can improve the revenue prospects greatly. Whether that is a viable approach depends on in-country skills, facilities and costs, which are not evaluated here. Use of indigenous knowledge of plants is another means of reducing the failure rate and can add value to the samples that might be used in determining an appropriate payment to indigenous groups for sharing their knowledge.

The examples used herein apply to pharmaceutical prospecting for medicinal products, the basis of the Merck/INBio agreement. Pharmaceuticals are typically high-value products so the revenue is potentially greatest. The approach developed here, however, is general and can be used as well for other products, such as crop varieties and cosmetics. The variable likelihood of finding useful germplasm and values with respect to the resultant products could lead to somewhat different conclusions. For example, the long standing (but possibly evolving) practice of placing plant varieties in publicly accessible germplasm collections limits the market value of that material.

This chapter does not attempt to identify a specific market value for germplasm. Most efforts to do so, thus far, date back well over a decade and have been conceptually general or relevant only to specific examples from developed countries. It is, nevertheless, well established that biodiversity provides two types of values. These are:

1. **direct value**
   - consumptive-use value (that which derives from such activities as sport fishing, subsistence hunting, gathering)
   - productive-use value (that which derives from such activities as logging)
2. **indirect values**

Table 1: Main Collaborative Research Agreements Signed by INBio from 1991 to 2002

Industrial or academic partner	Natural resources accessed/Objectives	Field of primary application	Research activities in Costa Rica
Cornell University	INBio's capacity building	Chemical prospecting	1990-1992
Merck & Co.	Plants, insects, micro-organisms	Human health and veterinary	1991-1999
British Technology Group	DMDP, compound with nematocidal activity*	Agriculture	1992-present
ECOS	*Lonchocarpus felipei*, source of DMDP*	Agriculture	1993-present
Cornell University and NIH	Insects	Human health	1993-1999
Bristol Myers & Squibb	Insects	Human health	1994-1998
Givaudan Roure	Plants	Fragrances and essences	1995-1998
University of Massachusetts	Plants and insects	Insecticidal components	1995-1998
Diversa	DNA from bacteria	Enzymes of industrial applications	1995-present
INDENA SPA	Plants*	Human health	1996-present
Phytera Inc.	Plants	Human health	1998-2000
Strathclyde University	Plants	Human health	1997-2000
Eli Lilly	Plants	Human health and agriculture	1999-2000
Akkadix Corporation	Bacteria	Nematocidal proteins	1999-2001
Follajes Ticos	Plants	Ornamental applications	2000-present
La Gavilana S.A.	*Trichoderma* spp*	Ecological control of pathogens of *Vanilla*	2000-present
Laboratorios Lisan S.A.	None*	Production of standardized phytopharmaceuticals	2000-present
Bouganvillea S.A.	None*	Production of standardized biopesticide	2000-present
Agrobiot S.A.	Plants*	Ornamental applications	2000-present

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Table 1 (continued)

Industrial or academic partner	Natural resources accessed/Objectives	Field of primary application	Research activities in Costa Rica
Guelph University	Plants*	Agriculture and conservation purposes	2000-present
Florida Ice & Farm	None*	Technical and scientific support	2001-present
ChagasSpace Program	Plants, fungi*	Chagas disease	2001-present
SACRO	Plants*	Ornamental applications	2002-

* These agreements include a significant component of technical and scientific support from INBio.

Source: Cabrera Medaglia 2004.[1]

- nonconsumptive-use value (that which derives from such activities as tourism)
- option value (that which derives from the delaying of destructive use until the use and value are better understood)
- existence value (bequest value; that which derives from leaving a resource for consumption by future generations)

Valuation is complicated because, with the exception of productive-use value, none of these forms of use involves a marketed product from which value can be ascertained directly. Rather, indirect measures, such as travel expenditures, are used or, in cases of option and existence values, quite esoteric measures, the interpretation of which is not fully clear. Yet valuation is important because it indicates a potential economic justification for preservation or, more precisely, in the case of germplasm prospecting, for substituting sustainable use for destructive uses like logging.

Further complicating valuation is the discussion of appropriateness of adding opportunity cost, the value option foregone when another mutually exclusive use is selected (an opportunity cost of clear cutting is germplasm prospecting, for example). Opportunity costs are sometimes calculated (companies making mutually exclusive investment choices do this routinely) but, traditionally, never are subtracted from the value of the selected use as it is sometimes argued they should be. Conceptually, there is no reason to limit opportunity cost to a single alternative use where many likely exist, nor is there a reason indirect benefits (for instance, those derived from logging open land for farming or grazing) should not be added to the use value. There is the further issue of discount rate for future income—the reduction akin to an interest rate—in the value of delayed consumption compared to present consumption. Typically, private (personal and corporate) discount rates are greater than social rates, although the determination of the social rate is open to different interpretations. Yet, as anyone who has paid off a loan over a ten- or 20-year period recognizes, small changes in the interest rate have major implications on the outcome. Indeed, the use of opportunity cost is a complex matter yet to be resolved.

2. PRICING CHOICES

The Merck/INBio agreement of the early 1990s utilized a combination of the two principal payment alternatives: collection fees and royalties. Merck paid to INBio a fee of US$1.1 million and an undisclosed royalty rate for resulting product sales. A collection payment can be (and in the Merck/INBio case was) paid in total, or in part, in services, such as providing training to national scientists in screening procedures, or as equipment. The purpose here is to demonstrate how total revenues are affected by an emphasis on initial, as opposed to delayed, payments.

Delayed (royalty) payments are preferred by the contracting company, which, for the purposes of this article, we shall assume is a multinational pharmaceutical company. Delaying payments means the company has no interest costs, which are required if payments are made before the product is marketed and revenues flow. Pharmaceutical products can take up to 12 years to bring to the market in the United States, so the

Table 2: Estimates of Variables for the Base Agreement

	Per-sample basis		
Item	Value used in calculations	Range	Comments/Reference
Collection fee	US$50	50–200	Figures are intended to cover actual costs (packaging, transport and related costs) but not return a profit
Royalty payment	5%	1%–5%	Royalty of gross sales
Developing-country interest[a]	15%	10%–25%	Discount rate used by developing countries with hard currency shortages (a likely minimum figure)
Corporate interest rate	7%	5%–9%	Corporate interest rate charged to and by major corporations; lower than developing country rate because of better credit rating and more efficient credit markets in developed countries
Product value	US $500 million	100 million–1 billion +	Total worldwide sales once developed and over the life span of the product. Below an expected market of US$100 million, returns generally do not cover development and regulatory costs
Development delay	10 years	10–12 years	–
Hit rate	1:12,000	1:6,000–1:30,000	Frequency with which collected material will result in a marketable product

a This figure represents interest on a hard currency loan such as one denominated in dollars. It does not reflect the occasionally very high rates - up to and exceeding 100% - for local currency loans during inflationary periods.

interest cost could be considerable. As important, making initial payments shifts the risk of failure to the company, which will have expended the collection and screening costs as well as development charges. With a successful product found in only one of some 12,000 tries and average product development costs of US$230 million including the costs of failures, the risks are indeed large. Because of these risk and interest factors, along with tight budgets and scarce foreign exchange, contracting countries prefer initial payments to subsequent and uncertain royalties. However, the contracting companies will seek compensation in the form of lower overall payments for accepting additional risk. Here we explore how much that compensation is likely to be.

For the purposes of this article a base agreement is computed on a per-sample basis (in U.S. dollars). This agreement is intended to represent the outcome of careful negotiations, with both sides reaching a minimal acceptable position from which they are unwilling to move without concessions from the other party.

Table 2 shows the estimates of the variables required for a bioprospecting agreement. As we are developing different variations, we call this the "base" agreement.

From Table 2, the expected return per sample collected can be computed as shown in Table 3 (figures are rounded for convenience). Total value for a 12,000-sample contract is also included.

Of course, most samples would pay $50 with, on average, the 1/12,000 paying off $25 million. In other words:

5% royalty of $500 million = $25 million

This is a general average with the likelihood of a hit[2] having a wide latitude. Thus, countries selecting this approach would be operating in a "boom or bust" mode. The collection fee covers costs so that no real revenue comes in until and unless a hit is scored. No attempt was made here to determine the range (frequency distribution) with regard to the estimated 1/12,000 hit figure. The present value

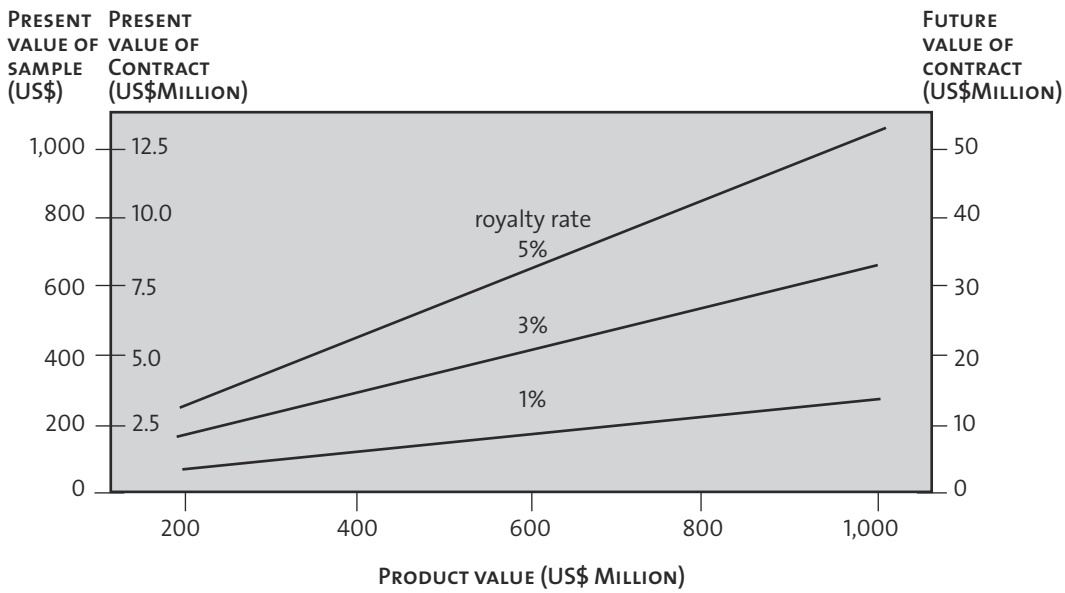
Table 3: Computing Expected Return for the Base Agreement

Item	Per-sample basis			Full contract 12,000 samples
	Calculations	Equation [b]	Return	
Collection fee	_	_	50	0.6 million
Royalty fee paid in year 10	5% x $500 million x $\frac{1}{12{,}000}$	[1]	2000	25.0 million
Present value of royalty fee[a]	$\frac{2{,}000}{(1+i)^n}$	[2]	500	6.0 million
Total present expected value	50 + 500		550	6.6 million

a Where i=15% (developing-country interest level) and n=10 years (development delay).

b Refers to numbered equations in text.

Figure 1: Present and Future Value of Contract as a Function of Product Value and Royalty Rate



Note: Collection fees of $50 per sample are included in the calculations. Other variables are 15% developing country interest rates, 10 years development delay, and 1/12,000 hit rate.

of the $25 million figure is only $6 million because of the high interest rate used (15%) and the ten-year delay involved. Figure 1 gives an indication of how these values are affected by royalty rates and product value.

3. EMPHASIZING COLLECTION FEES OVER ROYALTIES

What would be the ramifications of shifting fees forward, emphasizing current collection payments at the expense of longer term royalties? Suppose for our example the collection fee was increased by $150, to $200 per sample. What would change? We shall assume that the basic revenue situation remains unchanged and that only the schedule is altered. Since there are just two payment parameters (collection fee and royalty rate), increasing one necessitates reducing the other.

The point about raising collection fees necessitating a reduction in the royalty rate has several components. First, there is a direct transfer of dollars. Second, the company, which, in this example, is making payments today instead of ten years in the future, will add an implicit interest charge (technically, a discount) to those payments. The third component, and the most complex to calculate, is the change in the risk undertaken by the company. Under the base agreement, the selling country accepts most of the risk; if no marketable product is forthcoming no royalty payments are made. The 1/12,000 hit-rate figure used here is an average and an approximation. It is possible that 12,000 samples will yield no marketable products or ones with low values. Shifting royalty payments to collection fees means, in effect, that some of the royalty has been "prepaid" so that the failure of a product to materialize is a loss for the company. That is, the company is taking on an additional risk of a loss. In this regard, the contracting company will act like a banker, and indeed like any private corporation, which is a risk/reward managing entity, by demanding to be compensated financially for accepting additional risk. That required compensation can be estimated.

Raising the collection fee by $150 would increase the expected costs for the company by $1.8 million. In other words:

$150 for 12,000=$1.8 million

Moreover, the payments would be made today as opposed to 10 years hence so that the company would have total (including interest) costs of $3.5 million, that is:

From Table 3, Equation [2]: $\$1.8 \text{ million} \times (1+ 7\%)^{10} = \$3.5 \text{ million}$

The company is then willing to pay only $21.5 million (25 - 3.5) in royalties (from Table 3) so that the effective royalty rate becomes:

Equation [3]:

$$\frac{5\%}{\$25 \text{ million}} = \frac{x\,\%}{\$21.5 \text{ million}} \longrightarrow x = \frac{107.5}{25} = 4.3\%$$

But the company accepts additional risk ($1.8 million worth) and will want to be compensated. The amount can be computed using the following the equation:

Equation [4]:

$$\text{size of risk change} = \frac{\text{change in payment}}{\text{payment}} = \frac{\$3.5}{\$21.5 / (1.07)^{10} + \$0.6} = \frac{3.5}{11.5} = 30\%$$

Thus the company is willing to offer a royalty rate 30% lower, that is:

Equation [5]: $4.3\% \times 0.3 = 1.3\%$

The new royalty rate is now 3.0%, that is:

Equation [6], from [3]: $4.3\% - 1.3\% = 3.0\%$

This is a reduction of 40% of the original value. The new present value of the expected payment per sample can now be computed as:

Equation [7] (from Table 3, Equations [1] and [2]):

$$\$200 \text{ collection fee} + 3.0\% \times \$500 \text{ million} \times \frac{1/12{,}000}{(1.15)^{10}}, \text{ or } \$200 + \frac{\$1{,}250}{4.045} = \$500$$

Hence, the country is giving up $50 ($550 - $500) or 9% per sample to ensure timeliness of the payment.

Table 4: Impact of Country Interest Rate on Total Expected Present Values under Different Interest Rates

Interest Rate	10%	15%	20%	25%
Collection fee	50	50	50	50
Present value of royalty fee[a]	775	495	325	215
Total expected present value/sample	825	545	375	265
Collection fee	200	200	200	200
Present value royalty fee[b]	465	300	195	130
Total expected present value/sample	665	500	395	330
Country loss/gain[c]	-160	-45	+20	+65

a $2,000/(1+i)^{10} from Table 3, equation [2] (results rounded)

b $1,250/(1+i)^{10} from Table 3, equation [2] (results rounded)

c Total expected value/sample for $200 collection fee - total expected value/sample for $50 collection fee.

An important insight can be derived from this example. The penalty for the germplasm-providing country declines as its interest rate increases, or more correctly, as the gap between its interest rate and the corporate rate of the contracting company (7% in this example) increases. This penalty is shown in Table 4 where, using the figures described above, the penalty declines to zero at a country rate near 20 percent; at higher rates the country is actually better off. The company is borrowing money at a preferential rate and lending it to the country at the same rate, plus risk premium. This approach might be an efficient way for the selling country to finance itself, but several additional factors must be considered.

First, the contracting company must be agreeable to such an arrangement (not all will be). Second, a 15% figure is quite a high discount rate and involves a significant discounting of the future. Note that the country is paying the company 7%, along with discounting the future by 15% for a total discounting of 22%, which reduces any future royalty payment by a factor of 7 that is (from Table 4, Equation [2]):

$$\$25 \text{ million} / (1 + 0.22)^{10} \text{ or } 25/7.3$$

Third and finally, the country is effectively borrowing against the future; should a hit come, less additional revenue will be collected. While that may be undesirable for future generations, this approach does increase the awareness of the value of germplasm resources. Referring again to the Merck/INBio agreement, the more than US$1 million collection fee (a rather insignificant amount) received all the public attention while the level of the royalty figure has never been made

public and potentially could represent a much greater figure.

It should be noted that it is very difficult to come up with an appropriate discount rate without knowing specific country circumstances. It may also not be an objective figure. The concept of personal discount rate, that is, what the person on the other side of the table has internalized about risk, as well as political and economic instability and immediate need for money could all play major roles in the choice between collection payments and royalties.

4. PAYMENT FOR SCREENING

One of the emphases on germplasm prospecting in the CBD, and elsewhere, is the performance of the maximum number of services in country (value added) as opposed to the export of raw germplasm materials. That emphasis not only increases payments but also enhances national scientific expertise while moving away from dependency on commodity-type exports. Here we examine the revenue ramifications of such an approach. No attempt is made to determine the practicality of such a step that depends on the country of origin having adequately trained staff and adequate facilities to be able to complete screenings in an accurate, timely, and cost-efficient manner. Screening near the source of origin has some advantages due to the cost of packaging and transport and the volatility of some compounds. On the other hand, some screening procedures are technically complex or, for infectious diseases, involve high standards for isolation facilities. Those screenings would not be feasible away from a major company's laboratories, at least for the present.

The development of a marketable pharmaceutical product passes through several stages beginning with a primary screening and, if successful, progressing through secondary screening (including isolation and preliminary toxicological evaluations) and proceeding to the several stages of drug development. For purposes here, assume in-country collection with primary screening costs of $200 per sample. Prescreened samples in this example have a 1/3,000 chance of being a hit (four times the unscreened rate) because the least promising samples have been eliminated. The rate depends on several factors, including the stringency of the screens. This rate presumes relatively nonstringent tests that would be most appropriate for a range of developing countries.

Of course, screening does not change the underlying probability of finding a commercializable product. Screening merely increases the value of the retained samples, because they have a higher probability of viability than the collected samples. There is a cost for this: every retained sample represents four screened samples, so the per-sample-retained cost is $800. It is assumed the country will collect the out-of-pocket costs, or $200 per sample, but because these represent actual costs, the country does not make a profit as in the earlier second example. Payments can be computed following the royalty-rate calculation method shown earlier, using the hit rate of 1/3,000 and a collection and screening fee of $800 (figures are rounded):

Equation [8] (from Table 3, Equations [1] and [2]):

Present value of royalty:

$$5.0\% \times \$500 \text{ million} \times \frac{1/3{,}000}{(1+i)^n} = 5.0\% \times \frac{\$167{,}000}{4.04} = \$2{,}100$$

Total expected value per sample: $800 + $2,100 = $2,900

The total expected value per sample is now more than five times the base payment.

It should be noted that both the royalty rate and the risk factor remain unchanged. The additional "collection" fees are merely a transfer of expenses from the company's in-house screening cost to the developing country, and this does not change the basic value of the contract. The calculations assume, however, that the quality of cost screening in the developing country is identical to that of the company. If the quality in the developing country is inferior, the value of the screenings is questionable, and the pharmaceutical company is likely to reject this option. Especially in the case of false negative results (improperly rejecting a potentially viable compound), inaccurate or inconsistent results must be repeated. If the total cost of screening in developing countries is less than that of the pharmaceutical company (a plausible situation due to lower wages and shipping costs), then the selling country can take the difference as profit. For the example just mentioned, imagine further that a screening by the pharmaceutical company costs $150, while in the country of origin it is $100. Total costs including the $50 collection fee are then $200 versus $150. The company should, in theory, be willing to pay the full $200 cost to the developing country, which would yield it a "profit" of $50 per sample ($200 payment - $150 costs). As discussed in the preceding example neither the royalty rate nor the risk factor would change.

Now, however, imagine the costs are reversed, $100 for the pharmaceutical company and $150 for the selling country. This could happen for a number of reasons, such as a high cost of maintaining specialized equipment or simple inexperience and/or inefficiency. If the country still covered costs by negotiating a $200 collection plus screening fee, the company would treat $50 of it ($200 payment - $150 costs) as a higher fee, along the lines of the second example. Rather than repeating those calculations, note that the fee increase here is one-third ($50/$150) of the amount shown in the second example. The royalty-rate reduction would likewise be one-third of that amount, or:

From Equation [6]: 0.33x(5%-3.0%)=0.66

This gives a final rate of:

Equation [9]: 5%-0.66=4.34%

While the amount is not huge, it represents a penalty and would likely not represent a viable option in the long term.

These calculations, of course, are only illustrations and say nothing about the practicality of screening in-country. Actual cost and result figures will be required for such computations. The exercise does suggest that economical in-country screening is a potentially valuable value-added activity. Screenings in countries, following this strategy must, as noted, be less costly than contracting-company screenings, and less accurate. Indeed, to the extent screening in-country is less expensive due to lower salary levels, savings on shipping costs, and other factors, all parties may benefit. However, countries must invest in training and equipment/infrastructure before offering this service. Several sources of funds are possible, including the use of collection fees (as is provided to a small degree in the Merck/INBio agreement) or through a grant or loan from a bilateral or multilateral agency.

5. INDIGENOUS KNOWLEDGE

Indigenous knowledge of plants can be an alternative to preliminary screening. Plants that can be identified as free from insect damage, for example, likely contain potent alkaloids, called the most important group of medical chemicals. If plants identified by indigenous peoples as having particular attributes are collected, the probability of a hit is increased. Here, for simplicity, we will assume the increase is to 1/6,000. Some argue that the success of screening could double or triple if information based on traditional knowledge was utilized. Further, it is assumed that the cost of a single specimen collection is $100 because of the additional difficulty of finding selected plants. Payments are then (again rounded):

Collection fee: $100

Equation [10] (from Table 3, Equations [1] and [2]):

$$\text{Present value of royalties} = 5\% \times \$500 \text{ million} \times \frac{1/6{,}000}{4.04} = 5\% \times \frac{\$8{,}330}{4.04} = \$1000$$

The royalty level in this example is the same as the base situation because:

$$\$50 \times 12{,}000 = \$100 \times 6{,}000$$

So there is no change in the timing of payments. Similarly, the risk factor is unchanged:

Total expected value per sample: $100 + $1,000 = $1,100 (double the base level of $550)

Again, while only hypothetical, this example does indicate the potential value of indigenous knowledge, at least for plants (it is less indicative for microbes and insects with which indigenous cultures are typically less familiar). The additional amount of $500 per sample (Equation [11]), can be paid to indigenous groups for the value of their knowledge, but a suitable transfer mechanism must be developed.

Equation [11] (from Table 3, Equation [2]):

$1,100 - $100 collection fee - $500 present value of royalty = $500

6. CONCLUSIONS

The negotiating of terms for germplasm collection is a complex matter, made more so by the absence of a generally accepted value of the material in its raw form. This article is directed to a related issue: how any payments should be divided between current (collection) fees and future royalties. The two are different because of the ramifications of who accepts the risk of finding a usable product and the capital cost/value of sales to be made ten or more years into the future. The examples shown here suggest, but do not guarantee, that increasing collection rates is costly in terms of overall expected payments. However, for countries short on foreign exchange and, hence, with high interest rates, raising collection fees is an economical means of "borrowing" from the contracting company. Seemingly more favorable is in-country screening, but costs, feasibility, and acceptability of results must be considered carefully before choosing this option. Utilizing indigenous knowledge is, according to the example used here, also remunerative along with the prospect of providing equity payments to numerous groups otherwise far removed from market systems. However, to be utilized by companies, indigenous knowledge must be less costly than mass screening.

Overall, the aggregate payments for collected germplasm, given the current state of knowledge, appear limited. Similarly, the payments to indigenous groups will likely be fairly modest compared

to the needs of those groups. These issues make careful valuation and contractual negotiation all the more critical.

Negotiators need to consider, at least, two additional factors, which have not been discussed here. First is the granting of exclusivity for the samples. Companies, of course, will be hesitant to invest in a product when the possibility exists of a competitor bringing the technology to market first or obtaining the patent. Therefore, companies will seek exclusivity. Countries, however, will wish to find additional markets; certainly, the possibility of multiple products from the samples is there. Thus, countries will opt against exclusivity. As a compromise, countries should (1) charge more for granting exclusivity and (2) set a time limit (it is four years in the Merck/INBio agreement).

Second, negotiators must evaluate their level of trust in the opposite party. One way to consider contracts is as a means of reducing the need for trust by specifying obligations in a way that can be adjudicated. However, it is not feasible to specify all aspects, so some level of trust is required. With germplasm prospecting perhaps the most critical issue is identifying whether the material used in developing a product was derived directly or indirectly from a sample provided under the agreement. Unscreened samples, with the myriad compounds they could provide, and the numerous analogs to them, will be virtually impossible to track thoroughly. Preliminarily screened samples are described in more detail and hence easier to track, but documenting a claim in court could still be difficult and expensive. Thus, considerable trust in the integrity of the contracting company would seem to be critical, but perhaps some checks should be included in the agreement.

In a broader context, this analysis suggests several policy considerations for national governments, nongovernmental organizations (NGOs), and international donors, such as foundations and bilateral and multilateral agencies. These considerations involve both the allocation of payments between collection fees and royalties and in-country screening. If the examples used herein are substantiated at all by actual cost figures, in-country screening is attractive financially as well as for its effects on development and skills improvement. However, considerable investment will be required before such efforts are possible. With adequate in-country funds lacking, international donors should seriously consider loans or grants for training and equipment purchases since in-country screening will be economically rewarding in the long term. Unlike numerous potential projects, there appears to be a ready market for the product, a preliminary-screening service. More, broader conclusions from INBio on their experiences are given in Box 1.

The allocation of funds between collection fees and royalties can affect conservation incentives. While a thorough treatment of that issue is outside of the scope of this article, it does warrant mentioning. Conceptually, the highest valuation approach—payment of royalties—will encourage conservation the most in the long term. However, people typically discount the future heavily so that up-front (collection fee) payments may get more attention and, in the long run, do most to encourage conservation. This is a matter of perception and not of business or economics, which needs exploration through other methodologies. ■

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1 Cabrera Medaglia J. 2004. Bioprospecting Partnerships in Practice: A Decade of Experiences at INBio in Costa Rica. *IP Strategy Today* No. 11-2004. Pp. 27-40. www.bioDevelopments.org/ip.

2 A hit rate is the number of expected lead compounds divided by the number of samples to be screened to obtain the given lead compounds.

Box 1: Lessons Learned from a Decade of Bioprospecting Partnerships at INBio in Costa Rica

A. **There must be a clear institutional policy** for the criteria demanded in prospecting contract negotiations. For INBio, these include the transfer of technology, royalties, limited quantity and time access, limited exclusiveness, no negative impacts on biodiversity, and direct payment for conservation. This policy has led to the stipulation of minimum requirements for initiating negotiations, and these requirements have meant rejecting some requests (e.g., very low royalties, unwillingness to grant training, etc.). This institutional policy also provides greater transparency and certainty for future negotiations. These same policies must also be taken into consideration when local communities and indigenous peoples, such as the Kuna's in Panama, adopt legal outlines in the contractual arrangements entered into by them. They should include other relevant ideas, such as those related to the impossibility of patenting certain elements, licensing instead of a complete transfer, etc.

B. **The existence of national scientific capabilities,** and consequently the possibilities of adding value to biodiversity elements, increases the negotiating strengths and benefit sharing stipulated in contract agreements. As we previously mentioned, the need to grant an aggregated value to material, extracts, etc., is crucial if one wishes to be more that just a simple genetic resource provider. In this regard, the development of important human, technical, and infrastructure capacities through laboratories, equipment, etc., together with the institution's prestige, have permitted better negotiation conditions.

   The existence of relevant traditional knowledge for operations, which INBio has not yet experienced, implies greater scientific capacity and, consequently, should lead to better compensation conditions.

C. **Knowledge of operational norms** and of the changes and transformations taking place in the business sector, as well as the scientific and technological innovations that underlie these transformations, helps to define access and benefit-sharing mechanisms. It is essential to know how different markets operate and what access and benefit-sharing practices already exist in these markets. These vary from sector to sector: the market dynamics for nutraceuticals, ornamental plants, crop protection, cosmetics, and pharmaceuticals are complex and different. This knowledge is needed to correctly negotiate royalties and other payment terms. How can we otherwise know if a percentage is low or high? It is also crucial to be informed about the operational aspects of these markets. When INBio began negotiating new compensation forms, such as advance payments or payments on reaching predefined milestones, with Eli Lilly and Akkaddix, it was vitally important to know the approximate amounts the industry was likely to pay in order to negotiate appropriately. Otherwise, one will likely request terms that are completely off the market or accept terms that are inadequate.

D. **Internal capacity for negotiations**, which includes adequate legal and counseling skills about the main aspects of commercial and environmental law. The Institute now recognizes that negotiations involve a scientific aspect (of crucial importance to define key areas of interest such as a product, etc.), a commercial aspect, a negotiation aspect, and the respective legal aspects. These latter are composed not only of national trade law but also international environment law, conflict resolution, and intellectual property. For these reasons, creating interdisciplinary teams is crucial. At the same time, the need for such a team is one of the most important criticisms of the contractual mechanisms. Solutions such as facilitators or others that pretend to "level the negotiation power" have been proposed by several authors. Unfortunately, until appropriate multilateral mechanisms exist, benefit sharing and contractual systems must go hand in hand. The absence of an interdisciplinary team keeps one of the parties at a disadvantage, particularly given the enormous legal and negotiation capabilities of pharmaceutical companies.

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Box 1 (continued)

E. **Innovative and creative ideas** for obtaining compensation. An ample spectrum of potential benefits exists. In the past, interesting benefit-sharing formulas were developed through appropriate negotiations. Such formulas included, for example, fees for visiting gene banks, collecting material, etc. The contractual path fortunately permits parties to adapt themselves to the unique situation of each concrete case and to proceed from there to stipulate new clauses and dispositions.

F. **Understanding in such key subjects as:** intellectual property rights; the importance of warranties for legality; clauses on ways to estimate benefits (net, gross, etc.); requirements and restrictions on third-party transference of material (including subsidiaries, etc.) and the obligations of such parties; precise definitions of key terms that condition and outline other important obligations (products, extracts, material, chemical entity, etc.); precise determination of property and ownership (IPR and others) of the research results, joint relationships, etc.; confidentiality clauses in the agreements and how to balance them in relation to the need for transparency in the agreement; termination of obligations and the definition of the survivor of some obligations and rights (e.g., royalty, confidentiality, etc.); conflict resolutions.

   As sub-clause D makes very clear, negotiated agreements are complex. For example, the outcomes that give rise to benefit sharing, such as royalties, will depend on the nature of the definitions for "product," "extract," "entity," etc. A more comprehensive definition will lead to a better position. Further examples of aspects that must be specified include delimiting the areas or sectors where samples can be used, the net sales, and what is possible to exclude from them. In addition, the procedures and rights in the case of joint and individual inventions are of interest (preference and acquisition rights, etc.), as are the conditions for the transfer of material to third parties (under the same terms as the main agreement? need for consent or information? transference to third parties so that certain services can be performed? etc.).

G. **Proactive focus according to institutional policies.** There is no need to remain inactive while waiting for companies to knock on the door to negotiate. An active approach to negotiations based on the institution's own policy for understanding national and local requirements has produced important benefits. INBio's Business Development Office and its highly qualified expert staff, the attendance of seminars and activities with industry, the distribution or sharing of information and material, and direct contacts, all of these empower an institution to deal with challenges. The current policy is based on the idea that it is not enough to wait to be contacted or to be available at the behest of a company; instead, one should possess and maintain one's own approach.

H. **Understanding national and local needs** in terms of technology, training, and joint research. International strategic alliances must be struck. Even when an institution or community possesses adequate resources to face a concrete demand, knowing the national situation and the strategic needs will permit it to reach better agreements and fulfill a mission that goes beyond merely satisfying the institution's interests. It will permit the prospecting to benefit society as a whole and demonstrate that it is possible to improve quality of life.

I. **Macro policies and legal, institutional, and political support.** For prospecting to succeed, so-called macro policies have to exist; that is to say, there must be clear rules about the "bioprospecting framework," which requires biodiversity inventories, information systems, business development, and technology access. One reason for Costa Rica's success is that institutions not only have experience in negotiation but also in setting policies and actions in this area overall. This includes, for example, a current biodiversity inventory rated as "successful"

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Box 1 (continued)

that enables us to know what we possess. It is the first step in the quest to use this resource intelligently. Our relevant experience also includes a National Conservation Area System that assures the availability of resources, the possibility of future supplies and provisions, mechanisms that contribute to the conservation of biodiversity as part of the contractual systems, etc. At the same time, the possibility of possessing adequate instruments to manage information, systems of land and property ownership, etc., contribute jointly with the existing scientific capacity to create a favorable environment for bioprospecting and to make possible the negotiation and attraction of joint enterprises. To this should be added other elements, such as the existence of trustworthy partners, which is one of the most relevant aspects in joint undertakings.

Lastly, one crucial topic is the constant denouncement of the business community because of the uncertainty caused by the new access rules (mainly in terms of who is the competent authority, the steps to be taken, how to secure prior informed consent, etc.). The emergence of these new regimes, together with the fact that the intention is to essentially control genetic information, its flow, supply, and reception—a topic where little national, regional, and international experience exists—has caused concern because of the possibility of contravening legal provisions. This has led to the establishment, as a policy, of the inclusion of clauses related to the need to fulfill local regulations, to demonstrate the contracting parties' right to fulfill their obligations pursuant to national laws, to present the appropriate permits and licenses, etc. In some cases, this topic has generated important discussions and analyses in negotiations. At an international level, various bio-prospecting agreements around the world are the target of complaints, claims, and lawsuits precisely due to the lack of legal certainty. This has created problems and discrepancies that hinder activities and joint ventures. A few examples would be complaints about the Agreement between Diversa and the Autonomous University of Mexico (which is still being litigated); or the deal between this company and Yellowstone National Park; or criticisms of the agreement between the Venezuelan Ministry of the Environment and the Federal University of Zurich.

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