Problems with the Use of Nontimber Tropical Forest Products in Ecodevelopment: A Bioeconomic Approach.

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Abstract:

Hall and Bawa (1993) warn that using Non-Timber Forest Products (NTFP's) as an alternative source of income in ecodevelopment schemes may lead to the same over-harvesting problems that tradition timber products have suffered in the last century in the tropics. They suggest that careful monitoring and management may be necessary to avoid biological over-harvesting of these new eco-resources. Monitoring and managing these resources may overcome the problems of biological over-harvesting, but it may not come cheaply. This paper, therefore, takes their warning a step further by showing that the economic potential for local management will only exist under a certain combined set of ecological and economic conditions. Well-intended development schemes that fail to account for the renewable nature of these resources, the economic characteristic of the market for these goods, and the social characteristics of the manager/harvesters may be self-defeating.

Introduction:

Habitat degradation in the tropics has been a problem since biblical and pre-biblical times. The writers of the old testament complain of common resource conflicts in the book of Ezekial. About the same time in the Indus valley, the writers of the Maha Bharata tell of the god Indra's anger of over the destruction of the Kandava forest (McCrindle 1896). Recently, the problem has been given apocalyptic status as the destruction of the forests has been linked to global warming, the fouling of rivers, and the cascading depletion of biodiversity. In short, many environmental advocates argue that the destruction of the forest bodes destruction for life on planet as we know it (Wilson 1992, Maganini 1994, Miller 1994, Forti 1995)

Attempts to manage these problems are an historical companion to the problems themselves. These attempts are as wide and varied as the cultures that have tried them. The water temples of Bali (Lansing 1993); the protected forest of the Buddhist Monasteries in Meghalaya (Chandrakanth et. al. 1990); and the six gun and the barbed wire of the American west (Anderson and Hill 1977) are a few diverse examples of local solution to habitat degradation. While the diversity of solution types is extensive, they seem to follow a rather consistent set of themes (Ostrom 1990, Elster 1989, Gadgil and Iyer 1989, Feeney et. al 1990). The four classical themes have included: privatization, limiting access by law, local common management institutions, and joint or co-management by an exogenous governing body and the local users.

Privatization has been in vogue for centuries. Early monarchs and royalty of many nations declared large tracts of habitat closed to the commoners to protect huntable and other valuable species (Deacon 1994, Thirgood 1982). The level of privatization has varied from actual fencing and the use of patrols, sheriffs and guards to the expectation of voluntary compliance. One classic case is the use of barbed wire to fence the grasslands of the western United States in the middle of the nineteenth century (Anderson and Hill, 1977). Privatization is the favorite remedy of most economists and has been one key recommendation of Garret Hardin (Hardin and Baden 1977).

Other management attempts have limited access by fiat, but have tried to partially maintain the communal nature of the resources. The Zodiac forests of India had heavy use restrictions on defined areas, yet allowed the poor some gleaning rights as early as 2000 BC, for example (Chandrakanth 1991). When the problem of over-harvesting was particular to a given species, access to the area was still allowed, but restrictions were placed on certain valuable species. Teak was declared a royal tree in parts of southern India, for example, and violation of that decree was a capital offense (McCrindle1896). Other systems had mixed approaches. The Roman Republic had a mixed scheme of leases, reserves, and grazing along with associated penalties and fines for infractions (Thirgood, 1981). The government takeover of common forests in Nepal in 1957 is another often cited example (Arnold and Campbell, 1986). Such schemes have often fallen prey to high monitoring and enforcement costs when the resource was large and or remote, however (Ostrom 1990, 1993).

Local common and corporate management schemes have existed for several centuries as well. (McKean 1986, Feeney et. al. 1990, Ostrom 1990). These management schemes have evolved into a variety of forms. McKean describes Japanese mountain villages that used a high degree of social pressure and public embarrassment to deter violation of communal resources to excessive personal benefits (McKean 1986). Netting reported Swiss Mountain Villages that formed a public corporation where a manger was hired to protect and prolong the use of forest and range habitats (Netting 1976). Gadgil and Iyer describe Indian communities that partitioned various parts of the natural resource in such a way that the externalities of overuse would fall more heavily on the smaller user community (Gadgil and Iyer 1989). Finally, Berkes presents a management system the Northern Cree used a unique set of indicators to determine when they should switch primary prey species (Berkes 1987). These are just a few examples of the many successful local common property management regimes. The success stories are usually mirrored by failures as well (Hardin and Baden 1977, Feeney et. al. 1990, Ostrom 1990).

Co-management arrangements for forests have existed at least since the British Taungya experiments which started in Burma in the mid 1800's (Haussler 1994). The patron in these arrangements collects a certain proportion of the yield and the worker/manager collects another proportion of the harvest plus rights to certain usufruct species, grazing permits, etc.. These Taungya systems were one of the earliest attempts to use NTFP's as reward for managing the 'more valuable' timber species. The success of these programs has been highly variable (Francis 1908, Haussler 1994). Francis claims the success of the programs was more related to the dedication of the outside manager assigned to the project than the fundamental dynamics of the Taungya system (Francis 1908).

While de facto local management probably accounted for the bulk of actual management, there was an explosion of the central control of natural resources that occurred post World War II. This may have exacerbated the rate of habitat destruction, but it certainly did not start it. The central control approach found highly limited success, however, as population grew and the value of the resources increased as well. The increasing habitat destruction and other environmental problems gained wider public attention with the emergence of an environmental movement precipitated by Silent Spring (Carson 1961), the Tragedy of the Commons (Hardin 1968) and other works. Since that time, there has been a scramble for new approaches and new products that would take the pressure off the natural resource base while meeting the need a and enriching the wealth of the resource dependent poor of the world (Fernandes et. al. 1988, Arnold and Steward 1989, Chambers 1994).

Yet the new to answers to the most recent failures have all been tried. The previous set of examples illustrates this point. Each new breed of development professional and resource managers tend to discard past failures or replicate past successes without looking of root causes of the success or failure. It is summarily believed that the success or failure of a project is primarily a function of the project itself rather than social, economic, and ecological environment conditions. This paper will take one new solution and analyze the necessary underlying ecological and economic conditions necessary for its success. It will also, hopefully, provide a framework of analysis for other development schemes aimed at natural resources.

The new approach we will analyze is the use of Non-traditional Forest products to help protect the integrity of the canopy species while improving the economic position of the human inhabitants of those areas. The potential economic benefits at current prices are enticing (See Table 1). Some of these NTFP approaches also proselytize for the use of local management arrangements that are at least somewhat democratic. That is, the local people either have complete decision making authority over the rules, harvest schedules, and fines for violations, or these are set in conjunction with an extralocal governing body or development agency.

Unfortunately, the scientific and theoretic background behind these approaches is mostly anecdotal or based on a few cases (Feeny et. al. 1990, Roe 1993). Hall and Bawa (1993) warn of the potential ecological problems that might occur under NTFP based programs. Deacon (1994) warns of the potential self-defeating nature of attempting to capture the potential economic rents when economic conditions are not amenable. Finally, Ostrom (1990, 1993) warns that the local institutions must be structured in such a way that they do not provide participants in the management scheme perverse incentives to over-harvest or underinvest in maintenance of the resource. This paper will graphically present a synthesis of the ecological and economic factors that determine whether sufficient potential gains exist to pay for the management of such a natural resource, and who will be required to underwrite the cost of that management.

II. A model of a resource harvesting community

A model for harvesting NTFP's must accurately reflect biological dynamics, resource harvesting dynamics, and economic factors. The standard model for a rational actor harvesting a renewable natural resource has some of the characteristics needed to model such a situation. While there are many objections (and some of them reasonable) to rational actor based models, they do provide useful insights into the potential for the economic success of a primarily economic venture. This paper will therefore use a basic model from bioeconomics (Clark 1990).

The model starts with value function--that is, what the decision makers in the resource harvesting community get from harvesting the resource This is usually represented in terms of cash revenue or an equivalent. The harvesters are however constrained by the biological dynamics of the resource they are harvesting. That is, a hectare of functional forest can only produce a certain amount of a particular product given certain environmental conditions. They are also subject to the available resource harvesting technology. The effort put in using the available technology also bears a certain cost to the harvester. Finally, the renewable nature of the resource requires the harvester to make tradeoff between what will be harvested now, and what will be left to increase the productivity of future harvesting. The model assumes that the harvester is rational. That is, they are goal driven, and will attempt to do the best they can. It also assumes that the harvesters have a time preference or discount rate. That is, they would prefer to have something now rather than later. Their time preference rate is the rate of increase in the value of a resource the decision-maker demands in order to forgo harvesting it now. Thus the resource harvesting community is trying to maximize the present value of all future benefits of the resource given the ecological dynamics, the cost of harvesting, the harvesting technology and their own time preference. (A mathematical representation of the model appears in Appendix 1 (Not yet in HTML version).

Figure 1 graphically reflects this situation for a standard renewable resource model in bioeconomics. Figure 1 represents the effort return curve for the NTFP harvesting community. Most NTFP's will show some form of density dependence in their growth rate--that is, as viable patches or space is taken up, the growth rate will slow noticeably. Thus, there are increasing return to harvesting when the resource is plentiful, but as the harvest increases the returns fall off and the greater and greater effort is required to achieve any more yield. After a point increasing efforts lead to declines in yield. This is the region of biological over-harvesting. When the resource is harvested beyond this point (which is typically beyond MSY) the result is preferred to as economic over-harvesting.

The supply curve related to such a production process will be backward bending. Figure 2 relates the amount of the resource a harvesting community will bring to for a given price for given harvesting technology. The curve bends backward for three reasons: 1.) the renewable nature of the resource; 2.) The time preference of the resource harvesting community (RHC); and 3.) the risk of destruction due to environmental causes or loss of legal tenure. Prior to reaching the MSY point of the resource the supply curve exhibits the standard upward sloping behavior where the higher the price the more the harvesting community is willing to bring to market. Once effort increases beyond the maximum sustainable yield point of the harvesting curve, supply can no longer increase, but a higher price can entice the harvesters to work harder to deplete future growth for current returns. Thus the supply curve starts to bend sharply upward at this point,. This supply curve represents the type of situations that exist for an NTFP resource harvesting community whose members are often faced with high interest rates, significant environmental variability, and uncertain legal tenure.

How sharply the supply curve bends back depends on

- whether the resource is open access or managed,
- the time preferences of the RHC--that is how much they would rather have something now rather than later,
- the risk of the resource being destroyed, and
- the growth rate of the resource.

When the resource is completely open access, the curve will bend back very sharply because there is no guarantee that the resource will be there in future periods to harvest (The supply curve drawn in Figure 2). Thus no harvester has the incentive to forgo current harvest for future reward. The same is true for resources with extreme risk levels. That is, those that are very likely to be destroyed by natural causes or are simply ephemeral in nature,. This is the limiting case for the renewable resource supply curve.

In a managed setting, future harvests are more reliable since the risk of other harvesters capturing the resource is reduced. Thus the supply curve will bend back less quickly than the open access curve. The sharpness of the backward bend is determined by interest/discount rates and the risk of destruction by environmental factors. When interest rates (or discount rates which usually at least exceed the interest rate) are very high, then the curve bends back more sharply because the harvesters would rather forgo growth in the resource for present consumption.

When interest rates are high, a sizable return can be made by cashing out the resource and banking the money.

Box 1: Non-Timber Forest Products: The Treasure Under the Trees.

Non-Timber Forest Products (NTFP's) such as neem seeds, tendu leaves, and mahua flowers have taken a back seat to their more glamorous cousins, timber and paper products. Recently, however, rural income generation and fiscal trouble in forest departments are bringing these stepchildren of the forest some respect. In India alone Ford Foundation, Development Alternatives, Center for Science and Environment, M.S. Swaminathan Foundation, Aga Khan Rural Support Project, and The Action Research Unit are all looking at using NTFP's to generate the rural income necessary as incentives in social fencing programs. (See Table 1 for examples)

Sitarampur, a village in West Bengal, collected NTFP's from a co-managed forest and was able to glean Rs. 2800 per hectare per year. This seems low compared to the Rs. 21,000a per hectare that can be earned at the end of a seven year rotation for fast growing fuelwood cum paper species. Yet a proper comparison of the two requires discounting the benefits that are earned in the future. The present value (PV) of Rs. 21,000 seven years in the future at 10% interest is a mere 9,900 whereas the present value of the NTFP's alone is 14,900b.

This advantage in favor of NTFP's still underestimates their potential since the prices used were those received by the local harvesters--typically 1/5 to 1/10 of the market value. The neem from a single hectare of natural mixed species forest could bring a healthy sum of Rs. 800-1000/hectares/yr if processed by the harvester. The table below lists a few of the potential NTFP's found in the Eastern Ghats, their market value, and potential sustained production from 20 hectares of thriving natural forest. The bottom line is a whopping Rs. 5,000/hectare which easily beats out the timber and pulp value of fast growing tree species.b

Simply adding up the rupees still undervalues these NTFP's. As allopathy loses its stranglehold on western medicine, and the big pharmaceutical companies start to appreciate the potential profits from naturally produced plant compound, the value of intact forests ecosystems will even further surpass their timber value. A Palni Hills Conservation Council study notes an additional 103 NTFP's which are commonly used by local villagers over and the 20 that are currently marketed. The lists of the medicinal and botanochemical wealth under the canopy and outside the bolewood are growing and will continue to grow.

b. One of the main reasons farmers are going in for these fast growing trees is that they are relatively hassle free. That is once they are planted the need for labor and the problems associated therewith are minimized. This is only a problem for wealthier or absentee farmers who do little of their own labor and can afford to wait for the returns in the future.

c. These comparisons are only partially applicable because the investment and harvest costs have not yet been properly analyzed. A proper analysis will be completed as the actual costs and revenues are available from ongoing RRA's.

The demand curves in figure 3 represent the quantity of the resource the market will demand at a given price. Since NTFP's are a standard good the higher the price, the lower the quantity demanded in the market. The slope of this curve is dependent on the necessity of the good and other market conditions. If the curve is very steep, then the a small change in the quantity on the market will lead to a large change in the price. If the slope is very flat, then relatively more of the product can be dumped on the market without affecting the price. If the price is fixed the curve will be perfectly flat.

The entire market situation can be represented by combining the supply and demand curves. The market will settle where the two curves intersect. This shows both the resource harvest level and the price. The graphic also gives additional useful information. The area above the equilibrium price and below the demand curve is called consumer surplus. That is, many people are getting a good deal because they would willingly pay a higher price for the good than is currently charged in the market. If each individual is charged their willingness to pay then there is no consumer surplus.

III. Problems for NTFP based ecodevelopment:

We will now use this model to address some potential problems for using NTFP's as a primary source of income generation in ecodevelopment projects. While far from exhaustive, the primary problems include:

- the potential for over-harvesting,
- the effect of various management regimes on the resource, and
- the primary beneficiaries management.

The Potential for Over-harvesting:

Figure 3a represents the current state of affairs in many natural NTFP harvesting communities. Demand is currently fairly low due to poorly development marketing and distribution schemes. Thus prices and harvests are both low. The resources therefore are not being biologically over-harvested. Since there are virtually no returns to management in the low demand situation, the resources are usually open access. Problems can arise however when ecodevelopment schemes plan to increase the demand for the NTFP's by improving the marketing and distribution of these products or by increasing the value added at the local level. This has the potential to shift the demand curve out into the region of biological over-harvesting (Figure 3b). In extreme cases, the curve could shift enough that the resource would quickly be driven to extinction--or at least extreme rarity.

Different Management Regimes:

The impact of increasing demand will depend largely on management regime in place at the time. Typically these resources are open access. Thus increasing demand has the potential to drive the market clearing point well up the backward bending side of the curve into the over-harvesting region(see Figure 3). This is primarily the situation that concerned Hall and Bawa. They recommended that the resources need to be monitored and managed. Since we are dealing with ecodevelopment schemes, I will not cover the case of complete monopolization here, but I will go through the potential for optimal social management. That is, when the benefits of harvesting the resource are maximized for both the consumer and producer communities.

Once the resource is being managed, resources left in the ground have a higher probability of being there for future harvest. Thus the scramble competition of open access can be overcome, and the supply curve will now bend back less sharply (see Figure 3.b.). The new equilibrium in the managed situation will have a higher output, a lower price, higher profits, and more consumer surplus. This seems like a win-win situation, but management is not costless. The monitoring the health of the resource, setting restrictions, enforcement, etc. must either be covered by the increased profits generated by the management scheme or subsidized from an alternate source.

The gains to managing the resource will depend on the steepness of the demand curve, the relative riskiness of the resource, the interest and discount rates. Whether these increased profits will be sufficient to cover the increased management costs will vary by local situation. Agarwal (1994) however has shown that the more successful small scale resource management spend more than 50% of the total costs on organization, monitoring, and enforcement costs. These factors will also determine the primary beneficiaries of the management policy. The rest of this section will discuss the impact of these factors on the success of the management process for the high demand situation.

Demand Characteristics:

The gains to management can be represented as the difference in the market clearing situation with optimal management and the market clearing situation with open access. Figure 4.a. illustrates the difference between the optimally managed resource harvesting regime and the open access regime where the managers have a fairly low discount rate and the demand curve is relatively steep. The gray shaded area represents the gains to consumers of the product. The revenue gains to the producers is the difference between the previous price*quantity and the current price times quantity. In this graph the actual revenues do not increase, but the costs associated with that point of production lead to and increase in overall profits--albeit that the amount is small. The heavily shaded regions of the discounted supply curves in Figure 4 reflect the price output combinations that would provide sufficient profits to cover the management costs as reflected by Agarwal (1994). Thus while there may be large social gains to management and the added benefit of ecological protection, there are few incentives for the RHC to pay the costs of the management. Thus we should not expect local management regimes controlling resources that have very steep demand curves to pay their own way. There may be added social benefits that justify the management, but the bill for managing the resource will have to come from a source external to the RHC.

If the demand curve is much flatter--as in figure 4.b.--there is a substantially higher incentive to manage because cutting back production leads to a substantial increase in revenues as well as a reduction in harvesting costs. The model that generated these graphs gives doubling of the profits to the RHC. In this situation there were sufficient economic incentives to pay the cost of managing the resource under the Agarwal criterion. Furthermore, development agencies may be able to expect the RHC to eventually pay its own management costs.

This concern over the slope of the demand curve is more than a theoretical problem. Many of the community woodlot schemes in India failed because they did not take into account the massive drop in price for fuelwood that would occur once supplies were increased (Poffenberger et. al. 1990). They were also fraught with tensions about the correct harvesting time from members of the community who had highly different discount rates. The managers wanted to delay harvesting the trees until the recommended 8-10 year rotation when the growth rate is about 10% per year. The poorer people in those communities often wanted to harvest the trees at about 6 years when the growth rate is about 25% per year. This reflected the differential in the interest rates typically charged to the different groups. Established wage earners paid between 10-15% interest in India; whereas poorer villages pay the money lenders anywhere from 25-100% interest (Fernandes 1986).

Interest and discount rates of the resource:

The discount rate is the personal interest rate of the harvester. That is, the rate of increase in the value of a resource that they require to leave that resource in the ground for another period. How and why this is determined is the subject of much debate (Lowenstien and Elster 1992). It is often difficult to estimate as well. It is, however, usually higher than the market interest that the members of the RHC face. Local money lenders are able to determine what each individual is willing to pay to get something in return for a higher payoff later. While interest rates may be determined by a number of non local factors, they really do set a lower bound for time tradeoffs since they provide a relatively riskless alternate investment. Thus, I will use the term discount rate from here on out, but interest rate could be substituted as the same arguments apply for either interest rates or discount rates.

Figure 5 shows the gains in revenue due to management with a flat demand curve for resource harvesting communities with two different discount rates. The revenue gains to management when the discount rate of the managers is relatively low is the rectangle ABGH. If however the discount rate was much higher (revenues=ABEF), the returns begin to approach those of the open access situation (revenues=ABCD). Thus the returns and equilibrium supply for an RHC depend on its time preference. In periods or communities with very high interest rates, we would expect to see higher harvest rate and lower returns to management. We should also not typically see locally evolved management regimes where discount rates are traditionally very high. Thus before expecting great gains from a management program, proponents need to know the time preferences of the management group. Since these can be notoriously difficult to estimate, at the very least it would be wise to know the local money lending rates to the RHC. The result also suggests that the choice of managers should take account of factors that have traditionally been associated with low discount rates--i.e. age, female, gender, stable income, health of children (Rodgers, 1994).

Risk:

The risk of losing a resource to environmental causes can be modeled very much like the discount rate. Figure 5 shows the return to management for a very risky vs. a very safe resource (just substitute 'risk' for discount in the figure). The expected returns to management for an ephemeral resource become nil as that resource becomes more risky. Hence resources that are subject to high environmental variability are not particularly good candidates for paying their own management. In such cases the development agency should expect to pay the bulk management costs. If the riskiness of the resource is endogenous to the behavior of the resource harvesting community however, then management may be able to make greater gains by focusing on the behavior leading to the increased risk. The regular and perpetual setting of fires to improve fodder quality in forests is one key example. It highly increases the risk for many other forest products, and thus provides incentives to harvest them quickly. When NTFP schemes are put into place, the simultaneous control of fire setting may lead to reduced overall risk for the system, and thus increase the potential benefits of management.

Growth Rates:

The growth rate also determines how quickly the supply curve bends backward. Higher growth rates lead to a slower backward bend. Lower growth rates lead to a faster backward bend. Figure 6 shows the payoffs for a fast vs. a slow growing resource. The faster the resource grow the better it is to leave it in the ground and let the natural growth bring greater profits later. Hence we should see greater management success for faster rather slower growing resource. This may bode well for NTFP's since they typically grow much faster than canopy species. Unfortunately, this is the same incentive to clear forest and grow crops with faster return. Thus when proposing and supporting NTFP harvesting and production, the returns on those resources should also be linked to the health of the canopy.

IV. Conclusions:

While this paper is primarily descriptive and graphic, the graphs are based on mathematical models of optimal behavior for the various scenarios described herein. These mathematical models, which represent realistic resources and human economic situations, require accurate knowledge of the biological and economic parameters involved. The biological model used to derive these graphs is the very simple logistic model. The demand curves are linear. The real world is no doubt more complex. Even in this simple resource harvesting arena, however, the outcome of any proscribed development scheme for NTFP's is uncertain, and has been shown here to be potentially counterproductive. This is particularly true when development leads to increased demand for a renewable natural resource such as NFTP's without providing any management structure. To avoid these counterproductive situations, development efforts must be accompanied by management which accounts for local biological and economic dynamics. Furthermore, this simple analysis has shown that management may bring sufficient returns to pay its own way when the resource is

- resistant to price fluctuations
- highly productive
- easily harvested
- resistant to high environmental fluctuations

In these cases, the development agency can reasonably plan to turn the management over to the local community once initial setup cost has been paid. In other cases where the benefits to greater production through management fall primarily to the public, the management costs will have to be born by an extralocal entity or perhaps by some tax. Finally, when a resource is risky, slow growing, and the discount rate of the harvesting community high, one should hold little hope of funding the management resource from within the RHC. The development agencies should plan to pay the bulk of the management costs in perpetuity from an external source. NTFP development schemes that do not account for the extra complexities of managing a renewable resource in dynamic framework may be destined to repeat the mistakes of the past.

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Tables and Figures:

Figure 1. Standard Yield Effort Curve

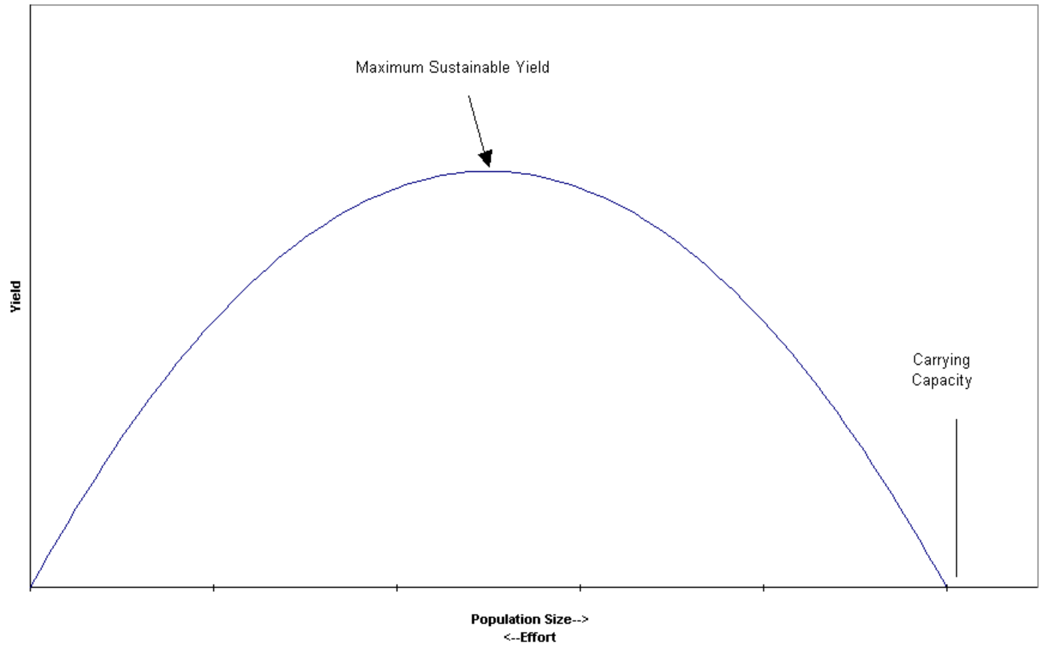
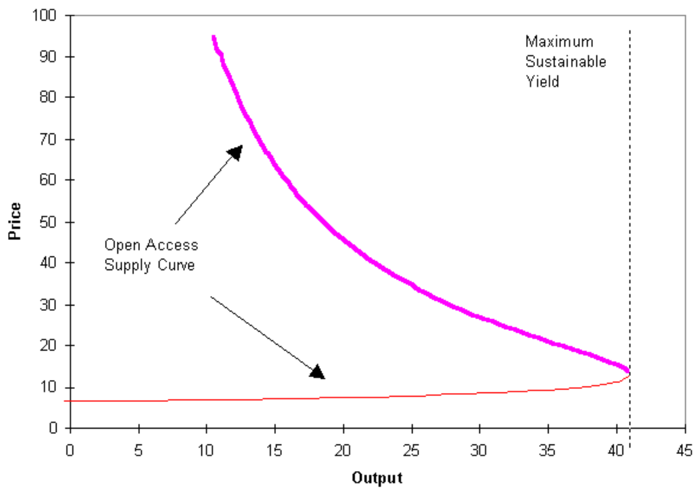
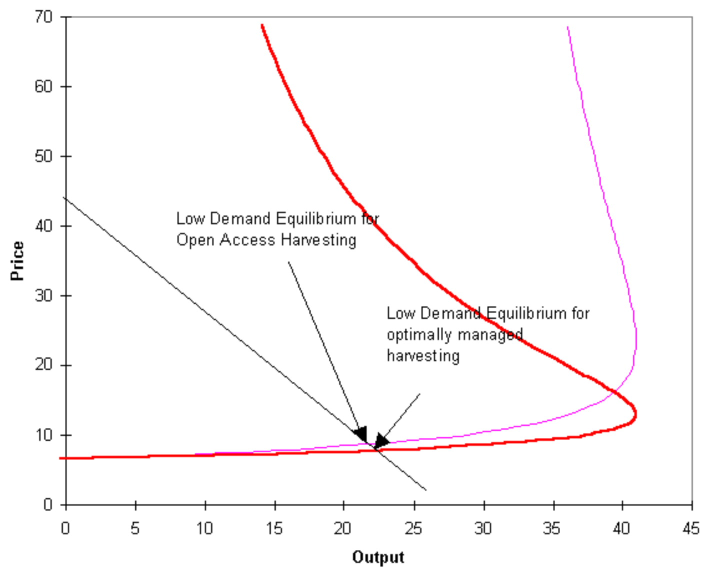


Figure 2: Renewable Resource Supply Curve



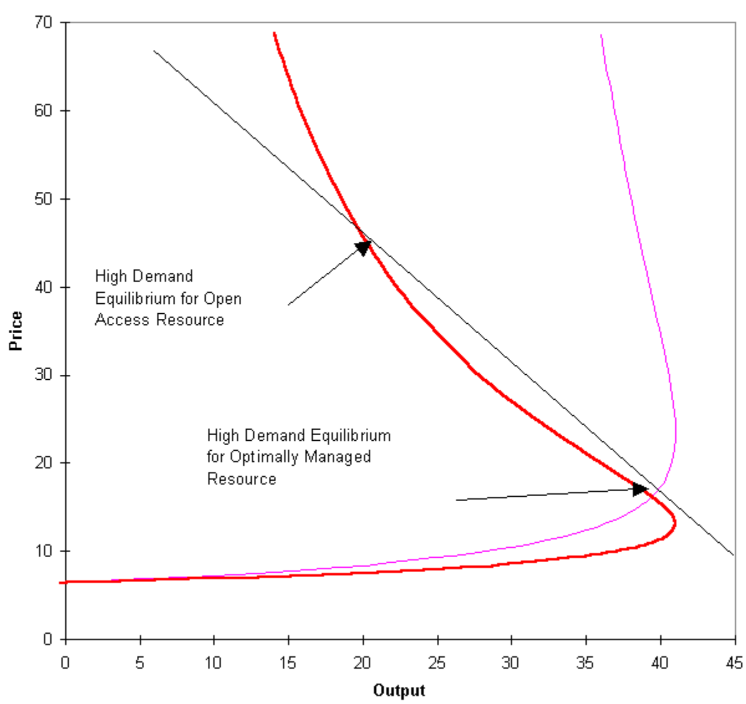
The supply curve bends backward due to the feedback from the renewable resource into the harvesting process. As the resource becomes depleted, the appropriators must work harder and harder to obtain the same level of the resource. Thus there are two prices that will lead to the same supply in the market. A low price that spawns a low effort, but does not stress the resource, and a high price which spawns a high effort but stresses the resource--the heavily shaded 'critical' region.

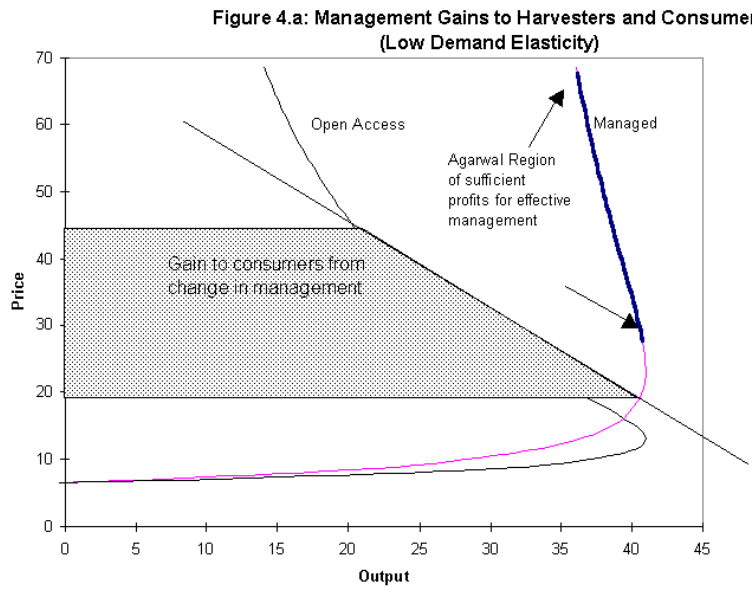
Figure 3.a: Optimally Managed vs Open Access Supply and Demand (Low Demand)



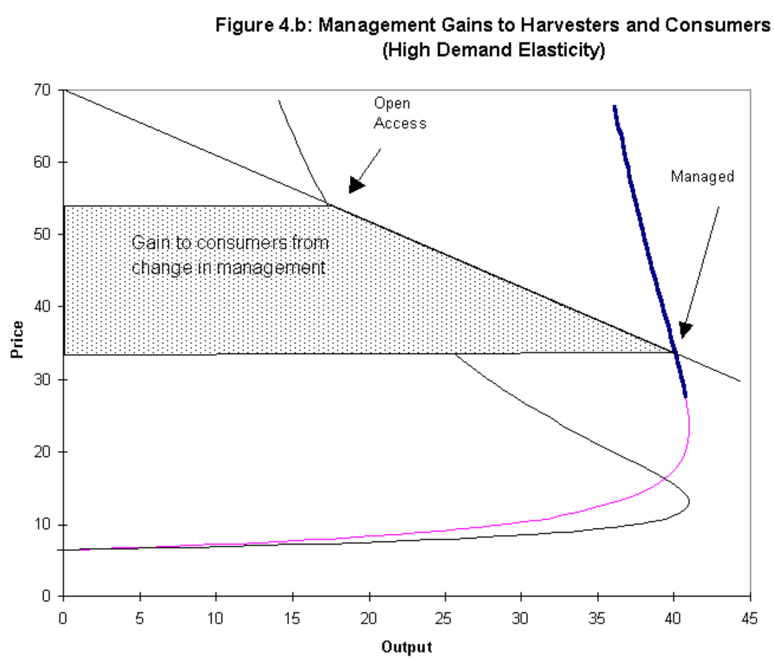
Note: The difference between the optimally managed and the open access situation in the low demand environment provides only small returns to pay the cost of management. The revenues and costs are nearly identical for the community of harvesters (albeit that long run rents become positive). There are also low consumer benefits to be tapped. Development schemes planning to raise demand levels however need to consider the potential for management once demand is increased (see Fig. 3.b. below).

Figure 3.b: Optimally Managed vs Open Access Supply and Demand (High Demand)



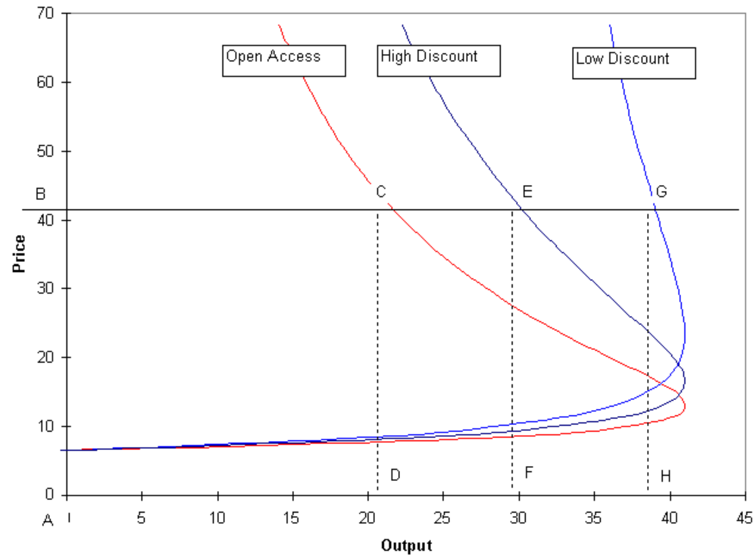


Note: The gain to consumers here is substantial (The entire shaded area). In this hypothetical example, harvesters actually lose yearly revenues, but costs go down more than proportionally. The incentive to manage this resource internally is actually quite small the gains from management overcome the costs but only slightly. The heavily shaded portion of the line represents the region of the managed supply curve that is likely to cover the management costs for village India. The potential political and social gains are however substantial.



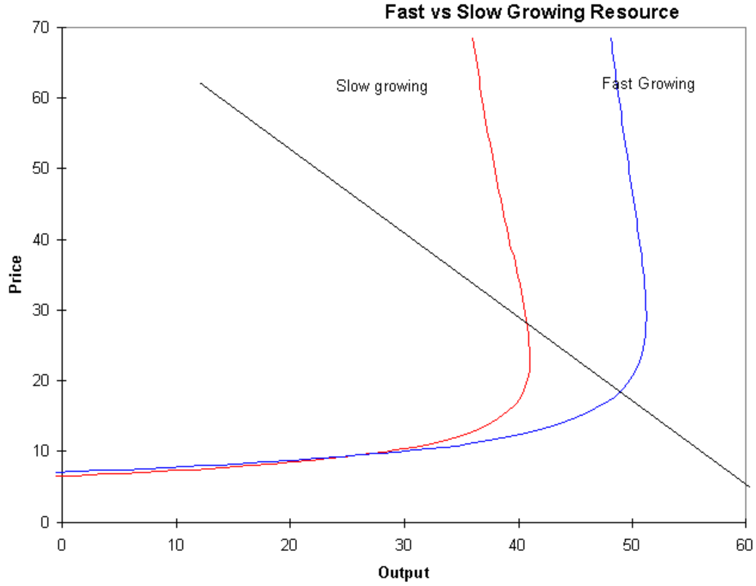
Note: The gains for the consumer are much smaller here than in the previous figure, but the gains to the producer are in fact much higher. In this stylized model the revenues increase by 50% while costs drop as well. There may be sufficient internal incentives for an entrepreneur to capture this potential by paying the OME costs. Also the flatter this demand curve the higher the potential for internally financing the management. The heavily shaded portion of the line represents the region of the managed supply curve that is likely to cover the management costs for village India.

Figure 5: Renewable Resource Supply Curve
High vs, Low Discount Rate



Note: This figure assumes a fixed price for the sake of comparison. The open access revenues are the area abcd. For the high discount rate manager, the revenues would settel at area ABEF. For the low discount manager, the revenues would settle at area ABGH. Recall that this does not truly reflect the total gains, because costs will also decline. Thus the lower the discount rate of the Resource harvesting community, the greater the potential to inernally finace the managment costs.

Figure 6: Renewable Resource Supply Curve
Fast vs Slow Growing Resource



Note: This chart shows the optimal equilibria comparing two resource bases in similar markets. The fast growing (i.e. highly productive) resource is being harvested with very little biological over-harvesting. The slow growing resource is however being biologically over-harvested into the critical region.

Table NTFP 1.

Species Name	Common Name	Part	Value	Unit	Collection	Rs./day	Days	Yearly Total
Emblica Officionalis	Nelli	Fruit	12	tin	3	36	120	4320
Terminalia chebula	Kadukka	Fruit	15	tin	3	45	90	4050
Sepindus emarginatus	Neikottai	Fruit	20	tin	3	60	120	7200
Acacia sinuata	Seikaikai	Fruit	30	tin	2	60	180	10800
Magnifera indica	Mamaram	Fruit	20	Sack	2	40	210	8400
Themeda cymbaria	Bothai Pull	Leaves	20	Bundle	1	20	90	1800
Lichens	Marapasam	All	30	kg	20	600	10	6000
Helicteres isora	Valampuri	Fruit	30	Sack	5	150	120	18000
Ipomea Herdifolia	Kanvalikilangu	All	40	tuber	5	200	120	24000
Lantana camera	Unni	Stem	5	basket	10	50	360	18000
Azidirachta indica	Neem	Seed	4	kg	5	20	210	4200
Total								106770

a. 1 R.s (Rupee)=.$0.03 US.