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THE ECONOMICS OF CLIMATE CHANGE: A DEVELOPING COUNTRY PERSPECTIVE

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The debate on effective and efficient measures for meeting the threat of climate change is likely to continue for many years. The Framework Convention on Climate Change, on which agreement was reached at Rio in June 1992, provides a very broad framework for actions that need to be taken in protecting the planet and its living species from the threat of climate change. But specific measures that are required to be taken by both developed and developing countries would continue to be the subject of further negotiations. It is hoped that some of the contentious issues involved in this process will be resolved as early as possible and also that innovative solutions would be designed, agreed on and implemented in a manner that conserves global resources, an aspect that becomes increasingly important in an era of growing globalisation and interdependence of economic activities.

The Framework Convention on Climate Change clearly specifies that the developed countries would provide financial resources and facilitate technology transfer in keeping with "agreed full incremental costs" of abatement measures that would be taken by developing countries. The distinctions between the liabilities and responsibilities of the developed countries as against those of the developing countries are based on the historical emissions of greenhouse gases (GHGs), for which the developed countries are primarily responsible. For instance, in an earlier publication by this author (1). it was shown that since the industrial revolution and up to the year 1986, in cumulative terms, developed market economies of the world had contributed approximately two-thirds of the CO_2 emissions during this period, as against roughly 20 per cent by the erstwhile Soviet Union and countries of East Europe, and less than 15 per cent by the developing countries. Having seen the historical benefits produced in the developed countries from greater use of energy through rapid economic development, developing countries are unwilling to forego similar possibilities int he future for their own growing populations by accepting any set of policies or actions that might restrict their energy. The developing countries are, therefore, sensitive to constraints, perceived or otherwise, on energy supply and consumption expressly applied for mitigation of GHG emissions.

There is also a growing feeling that if climate change is to take place in accordance with the projections of the Intergovernmental Panel on Climate Change (IPCC), then several developing countries are likely to suffer from the adverse impacts of sea-level rise and other related problems. Their fear is that a country focusing only on mitigation strategies to the complete neglect of adaptive measures might leave large parts of its population particularly vulnerable to these adverse impacts.

These broad observations highlight the ground realities which explain the position of the Third World with respect to climate change-related measures. They bring forth the importance of institutional

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1. Pachauri, R.K., and S. Gupta (1990), "Proceedings of the International Conference on Global Warming and Climate Change: Perspectives from Developing Countries", New Delhi.

and psychological measures which would ensure a genuine spirit of partnership between the North and the South for implementing a global agenda on climate change. In other words, measures considered should be those that have long-term benefits through the evolution of suitable institutions and acceptance of strategies in all parts of the world, quite apart from the immediate benefits which such actions and the financial resources underlying them would bring about.

One innovative approach, which has been articulated in various forums but has not found concrete shape in the programmes and priorities of specific countries, is the concept of joint implementation. Through this approach a country would effectively receive credit for reduction in emissions of GHGs by assuming financial responsibility for actions in another country, which would result in either lowering emissions of GHGs or their sequestration. This concept, therefore, provides one option by which the developing countries can be included in global actions as full partners on a "no regrets" basis.

The concept of joint implementation and the evolution and functioning of a clearinghouse was first put forward by the Norwegian delegation participating in the deliberations of the International Negotiating Committee (INC) for the Framework Convention on Climate Change. The concept was developed further and presented through the circulation of a paper in the INC by Hanisch, Pachauri, Schmitt and Vellinga (1992).

The broad rationale for joint implementation is based on the simple notion of economic efficiency. This rests on the view that cost effectiveness would be achieved when a given level of abatement can be undertaken at lower costs through joint implementation as against domestic options. Cost effectiveness can, of course, be defined at the level of the individual consumer, the firm, a broad economic sector, a country, a region or at the global level. In general, abatement policies would be pursued by Contracting Parties through an approach that achieves cost effectiveness at the national level. This approach embraces a mixture of taxes, tradeable emission quotas, technical standards, subsidies and information campaigns. For instance, tradeable quotas, which are similar to joint implementation, have been demonstrated to work on account of differences in marginal costs across firms and economic sectors at a national/regional level. The use of cost-effective measures of co-operation can be substantial in magnitude, particularly for relatively energy-efficient countries with limited potential for further efficiency gains in their energy systems. The same would hold true for countries who would like to participate in the global effort on mitigating climate change but are not able to do so due to a domestic resource constraint. The potential for achieving cost effectiveness is likely to increase even further at the global level because of larger differences in marginal costs of abatement measures.

Joint implementation thus provides a rather flexible instrument for GHG abatement. Assuming that markets work efficiently, buyer countries can opt for the cheapest option worldwide. In this way the world would move along the global abatement cost curve, rather than individual national curves. Assuming that the global curve is an envelope of national cost curves, joint implementation would ensure economic efficiency.

At the same time it should be remembered that such an arrangement can work only as long as the developing countries emerge as net gainers from the process. So long as they participate in joint implementation they will seek rents to finance other priority activities such as adaptation strategies. Besides, the negotiations at several rounds of the INC have shown that such resource transfers are necessary in any equitable and practical agreement to mitigate GHG emissions. Once rents are not forthcoming, developing countries are likely to opt for the "agreed full incremental costs" provided for under the Framework Convention, with the added advantage of reducing emissions from their own account rather than from that of another country.

The other benefits from joint implementation are that they would allow cost-effective implementation within the shortest possible time and, as mentioned earlier, this approach would also provide funding for climate-related projects for countries in which financial resources are scarce. of course, optimisation at the global level is basically a theoretical ideal, which can never be achieved, because measures to be implemented under this concept would rely on the process of agreement, and perhaps, significant transaction costs which may make the options implemented more expensive than if a country were to implement them on its own. But there would be net benefits from these transactions as long as it is a "positive sum game" for both parties. Besides, by placing a price on GHG emissions, joint implementation would create a continuous incentive to lower emissions, so long as the marginal cost of domestic abatement exceeds the international price of negative carbon options.

Perhaps the greatest advantage of joint implementation is that it constitutes a simple extension of the existing commitments under the Framework Convention and would not require the tedious process of a whole new set of negotiations over targets, allocation, etc.

There are, of course, several criticism of the joint implementation approach. One major concern that has been voiced in several forums is that some countries may find it far more cost-effective to meet almost all of their commitments through actions in other countries, and this may provide them with a "cheap way out". This is an extreme view which would most definitely not be supported by practice. Joint implementation, it must be emphasized, will be considered by countries only after they have exhausted their own "no regrets" options. There is as yet no country in the world that does not have a large bundle of no regrets options. It must also be emphasized that there is no investing party working through the joint implementation process that would not have to incur several costs. And, of course, it is obvious that the party that implements specific projects under the joint implementation process would receive some tangible benefits, too. There would also be an element of risk, which under the Convention would have to rest with the investing party. Developing countries implementing such projects would have to ensure that joint implementation is not dominated by, and does not result in, sole benefits to the developed countries that receive credit for it. There would also have to be clearcut accounting procedures by which credit and compliance are carefully assessed and calculated.

In the identification of projects, several issues will have to be taken into account as a prerequisite. These are:

- The parties to the Convention will have to adopt certain"climate effect" criteria to be met by all projects eligible for joint implementation. There would have to be an assessment of the "bottom line" for the period of contract between the parties. The transparency of information would be critical in the establishment and application of these criteria.

- The investing country would have to furnish, as a part of its national strategy, a catalogue of measures to be implemented within that country and an assessment of marginal costs which define the border between no regrets options (and perhaps some positive cost options) and those where joint implementation could be considered. In the operation of a suitable clearinghouse of information, there could then be a matching of marginal costs relevant to this borderline and specific projects that might be available in other countries for implementation.

- Credits will have to be given to the investing party for the period of the contract, which would generally be the feasible economic life of the particular investment, such as a power project, a natural gas pipeline, etc.

- Contracts for joint implementation will naturally be between member states, but in order to make use of the institutional strengths available in the countries involved, implementation

could be contracted to the private sector. This, of course, would require subcontracting arrangements between the governments concerned and enterprises that are drawn into the process of implementation.

There are several other issues that would need to be worked out carefully in any scheme of joint implementation. These include questions relating to the time span of credits, compensation for projects that involve risk and the institutional support required for implementing this concept at the international level. There is a fear that a large bureaucracy may be required for acting as a clearinghouse and performing supervisory, monitoring and other functions. A large bureaucracy, however, should not be necessary, and essentially the core functions of the clearinghouse should involve no more than information exchange between the various parties involved. Consequently, the clearinghouse would essentially be a register of information, specific contracts and information pertaining to joint implementation options. It need not build within its structure the expertise that would be required for evaluation of projects and proposals and for monitoring the success or failure involved in implementation. These tasks could be performed adequately through networking arrangements with existing organisations.

In recent years much work has been done on carbon taxes and their likely impacts. While these taxes would bring about a reduction in CO_2 emissions through responses by the consumers and producers of energy, they would also generate substantial revenues which might make it possible to achieve further reductions through investments in other options. For instance, in a paper by Jorgenson and Wilcoxen (2), it has been estimated that a tax of $39.01 per tonne of coal, $8.20 per barrel of oil or $ 0.98 per 1 000 Cu.ft. of gas would produce $ 75.8 billion in revenues on a global basis. It may be possible to achieve, in a much shorter period of time and at lower cost, reductions in CO_2 emissions through implementation of projects in other countries, after having dealt with no regrets options domestically. Carbon taxes would also have direct impacts on GNP, which would vary across countries. Jorgenson and Wilcoxen have also carried out simulations of various scenarios in this regard to provide a range of quantitative estimates of GNP changes due to specific tax levels. Besides, international carbon taxes would raise thorny equity problems over the disbursal of the revenues raised.

In another study, Grubb (3) has estimated an effective tradeable permit price of $ 20 per tonne of carbon which, as he states, would be sufficient to add perhaps 30 to 50 per cent to the international price of coal. He estimated (with unaltered 1988 emission and population levels) that the transfers this might bring about would amount to 0.42 per cent of GNP in the US and twice this value in the former Soviet Union and East Europe, using GNP estimates on conventional exchange rates. He also estimated that the average transfers from the rest of the OECD countries would amount to 0.16 per cent of their GNP. The benefits to developing countries would be disproportionately higher than the reduction in output caused in the OECD countries. For instance, China would see an increase of 3.4 per cent of GNP as opposed to 1.2 per cent for the rest of the world.

Most research in this field has been based purely on conventional opportunities, options and actions. If adequate information were available it would be possible for countries following mitigation strategies to optimize reductions in emissions with both pricing (i.e. taxation) measures to reduce consumption and production of carbon-intensive fuels and by the inclusion of options available in other

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2. Jorgenson, D.W. and P.J. Wilcoxen (1992), "Energy, the Environment and Economic Growth|, Centre for Science and International Affairs, Harvard University, Cambridge.

3. Grubb, M., J. Sebenius, A. Magalhaes and S. Subak (1992), "Sharing the Burden", in *Confronting Climate Change: Risks, Implications and Responses,* Cambridge University Press, Cambridge.

countries. Unfortunately, very little research has been done in the developing countries to estimate specific possibilities for mitigation of GHG emissions.

A study carried out by the Asian Energy Institute (4) (a network of 12 institutions located in Asia) clearly establishes the substantially lower costs of mitigation or abatement projects in the developing countries as opposed to those that can be implemented in the developed countries. In addition, a Brazilian institution collaborated in the study to provide analysis in respect of Brazil. Some of the conclusions of the study are provided below for illustrative purposes.

Power sector

A cross-country comparison reveals that in the electricity sector of India and Bangladesh, there is considerable scope for reducing the transmission and distribution (T&D) losses. They range from 22 per cent in India to 40 per cent in Bangladesh. If the losses were reduced to 16 per cent by the year 2000 in India, an investment of $ 7.2 billion would be required and the potential reduction in CO_2 emissions is estimated to be 210 million tonnes of carbon (assuming that the entire reduction in CO_2 emissions is attributable to reduced power generation by coal-based thermal plants). On the other hand, if electricity authorities in Bangladesh aimed to reduce the T&D losses to 25 per cent, an investment of $ 82 million would lead to a saving of 2.4 million tonnes of carbon. In Bangladesh, there is no coal-based power generation (it is hydro-, natural gas- and oil-based). For Bangladesh, the present generation level (7 732 GWh) was used to compute the present CO_2 savings, assuming that all generation saved is attributable to natural gas-based plants. If the likely generation in 2000 AD is taken as the reference, the potential savings in CO_2 emissions will be higher.

In China, improvement of energy efficiency in the power sector has been envisaged through an increase in the shares of Pressurized Fluidized Bed Boilers (PFB) and combined cycle Plants (oil-based) which are more energy-efficient than the conventional plants. An investment of $ 180 million in PFB and $ 192 million in combined cycle plants may result in savings of 9.5 and 5.2 million tonnes of carbon, respectively. In comparison, the gas-based combined cycle plants replacing coal-based plants in India would need an investment of $ 1.7 billion and save 82.5 million tonnes of carbon.

In Thailand, the feasibility of electricity generation from agricultural wastes for rural industries has been identified as an option for limiting CO_2 emissions, with replacement of wood charcoal and electricity (thermal-based) fuelled by gas, or electricity from agricultural waste gasifiers. The specific cost is $ 38/tonne of CO_2.

Industrial sector

In the industrial sector the scope for enhancing energy efficiencies is high in all the countries included in this study, though the particular measures identified in each country differ. In India, improved housekeeping, installation of energy-efficient equipment, and better instrumentation may result in saving 88 million tonnes of carbon, at an investment of about $ 3.5 billion. In Bangladesh, the package for efficiency improvements includes combustion control, process improvements, cogeneration, and simple retrofits, and would require an investment of $ 131.5 million and save 3.4 million tonnes of carbon. In Brazil, the suggested package for industries includes better choice of electric motors (in terms of their size), appropriate design of the internal electricity network, installation of small-size transformers in parallel with

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4. Asian Energy Institute (1992), "Collaborative Study on Strategies to Limit CO_2 Emissions in Asia and Brazil", submitted to U.N. Conference on Environment and Development.

the large ones and correction of load factor, requiring an investment of $1 billion, with a saving of 4.8 million tonnes of carbon. The specific costs are as high as $ 208.4/tonne of carbon.

The specific cost of reduction of CO_2 is the lowest for better housekeeping measures among all the measures identified for the industrial sector in both India and Bangladesh ($ 8/tonne of carbon in Bangladesh and $ 14/tonne of carbon in India). This fact clearly highlights the attractiveness of introducing such simple measures.

In China, the emphasis in the industrial sector is on retrofitting existing industrial boilers and kilns, which would require an investment of $ 6.3 billion and result in a reduction of 252 million tonnes of carbon. The specific costs are $ 19 per tonne of carbon saved int he case of retrofitting boilers and $ 35 per tonne of carbon saved by improving kiln efficiency.

In all these countries, the industrial sector uses a major share of the total energy supplies. Accordingly, steps to improve efficiencies in industry may result in considerable energy savings in absolute terms, and consequently reduction in CO_2 emissions.

Transport sector

The transport sector in India consumes 24 per cent of the total energy consumption. With a decrease in the share of railways in both freight and passenger transport, and an increased share of personal modes of passenger transport, the energy demand in this sector has increased substantially. Hence, the measures that have been suggested for possible implementation by the year 2000 are:

- enhanced urban mass transport, through increasing the bus fleet and introduction of metro rail system; and

- increased rail freight movement.

The total investment of $ 48 billion would save 279 million tonnes of carbon.

In Bangladesh, the best way to conserve energy in the transport sector is through improved road maintenance, as it is the one most easily implemented. This would require an investment of $ 110 million and may save 1.2 million tonnes of carbon.

The Brazilian case is interesting in that transport occupies a key place in the solution to minimize carbon emissions. The transport sector accounts for 32 per cent of the carbon emissions. Fuel substitution (the highly publicized alcohol programme), highway improvements, efficient diesel engines and improvements in vehicle efficiencies are the main options. The highway improvement programme will cost as much as $ 2 954/tonne of carbon as compared to only $ 92/tonne of carbon in Bangladesh. However, it must be reiterated that these specific costs are not comparable. Improved urban transportation through construction of special lanes for buses would cost as much as $ 2 145/tonne of carbon saved.

Some first-cut cost curves indicating the investments that would be required for specific measures in some of the countries covered in the study are also shown in Figures 1 and 2 and Table 1.

One major area of interest to the OECD countries in general is the forestry sector in the developing countries. A recent publication on research carried out by Brown *et al*. (1992) indicates that the potential for carbon sequestration in the developing countries is very high and therefore that there are possibilities for productive investments in this sector which could be financed by the developed countries for implementation in the developing countries. If we take the case of India alone, its current land use

Figure 1. Specific cost of various technologies for reducing CO_2 in Bangladesh

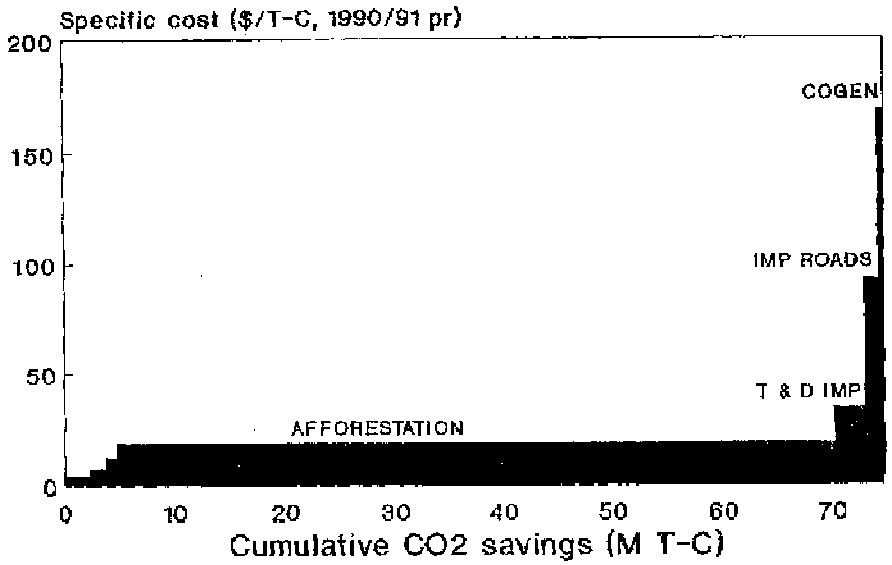
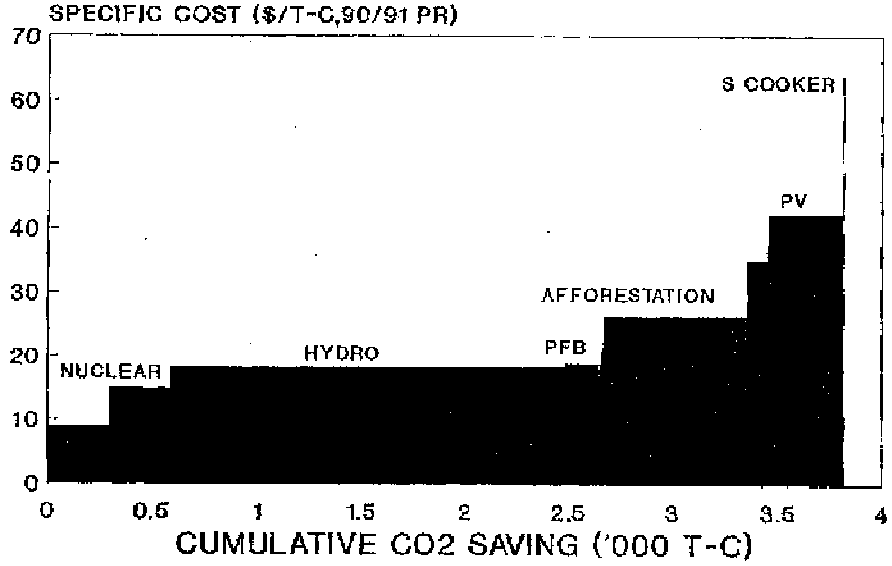


Figure 2. Specific cost of CO_2 abatement in China



Source: Asian Energy Institute, 1992.

Table 1. **Potential and cost of various CO_2 emissions reduction options for India**

	Potential for	Investment cost	Specific cost of CO_2
Increases in energy utilisation efficiency			
Electricity sector:			
Electricity generation			
- Coal washing	192.3	0.58	3
- Replacement of coal TPS by gas combined cycle TPS	82.5	1.68	20
Transmission and Distribution (T&D)			
- Reduction in T&D losses	210.0	7.21	34
Industrial sector:			
Improved housekeeping	28.0	0.38	14
Installation of energy-efficient equipment, better instrumentation/control	35.0	1.15	33
Upgradation of technology	25.0	1.92	77
Transport sector:			
Enhanced urban public transport			
-Increasing bus fleet	9.4	0.83	88
-Metro rail systems	122.4	14.9	121
Enhanced rail freigh movement	147.0	32.4	221
Agricultural sector:			
Pumpset rectification	50.6	5.10	101
Domestic sector:			
Improved firewood chulha	6.0	0.08	14
Improved lighting			
-Replacement by tube fluorescent	37.2	0.44	12
-Replacement by compact fluorescent	35.7	3.06	86

Table 1. (continued)

	Potential for reduction	Investment cost	Specific cost of CO_2
Deployment of renewable energy technologies			
Biogas plants:	18.4	6.41	348
Solar thermal systems	96.0	1.83	19
Electricity from other renewables:			
Biomass	128.9	4.80	37
Wind	43.0	4.50	105
Small hydro	51.6	2.40	47
Sewage sludge	1.4	0.08	54
Distillery effluent	4.0	0.03	7
Municipal solid waste	4.6	0.32	70
PV pumps	1.1	0.09	82
Windpumps	0.3	0.06	182
Solar energy	5.7	3.60	628
Afforestation	1,540.0	42.0	27

Table 2. **Land use pattern in India**

Land use	Area ($x10^6$ha)	% of total area
Agriculture/area cropped	154.70	47.0
Forests (area officially recorded as forests)	75.18	22.8
Permanent pastures and other grazing land	12.15	3.7
Land under cultivable tree crop and groves	3.91	1.3
Cultivable wasteland	16.64	5.1
Land under other non-agricultural uses	17.53	5.3
Barren and waste land	24.60	7.5
Area for which no records exist	24.09	7.3
	328.80	100.0

Source: The State of Forest Report (1987).

pattern shows large areas under both cultivable wasteland and barren wasteland, as brought out in Table 2 (5). However, it would be unrealistic to believe that mere investments in forestry projects will bring about substantial increases in the biomass stock in these countries and, therefore, in the rate of carbon sequestration. A recent publication by Johnson and Cabarle (6) identifies the institutional problems, the need for developing human resources and in general a revised approach involving local communities as the most important prerequisites for successful implementation of forestry projects in the developing countries. This brings out an important aspect of joint implementation activity, namely that of capacity-building and reducing uncertainties from future investment. Undoubtedly, successful ventures in forestry and several other sectors which are designed to bring about the mitigation of GHG emissions would require innovative action, suitable research and development, and identification and implementation of demonstration projects. Consequently, there is an urgent need for promoting joint R&D activities to create models of success and reduce the areas of uncertainty, whereby larger investments can be made with greater confidence.

The Framework Convention on Climate Change, therefore, requires a flexible funding arrangement whereby greater R&D and demonstration can be promoted through partnership efforts between organisations and institutions in the developed as well as developing countries. Given the fact that the only financing mechanism at present for tackling global environmental problems is the GEF, it is essential to structure something similar to the pilot phase of the GEF for continuation over the next five years. However, it would be necessary to allow for a different governance structure in this programme, because the pilot phase of the GEF has been plagued by an undue haste in implementing several unsuitable projects which were pushed largely for political purposes rather than technical or economic merit. Also, the decision-making and funding procedures required turned out to be far more cumbersome than would be necessary for innovative solutions. What is being proposed, therefore, needs to build on the experience of the GEF and go much beyond the experience of its pilot phase. The central purpose of such a programme should be to build capacity in the developing countries and create models of success (while learning from failures, which are inevitable) for replication.

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5. Ravindranath, N.H., B.S. Somasbekhar and M. Gadgil (1993), "Carbon Flows in Indian Forests", presented at the Workshop on Climate Change: An Indian Perspective", April 18-20.

6. Johnson, N. and B. Cabarle (1993), "Surviving the Cut: Natural Forest Management in the Humid Tropics", World Resources Institute, Washington.

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