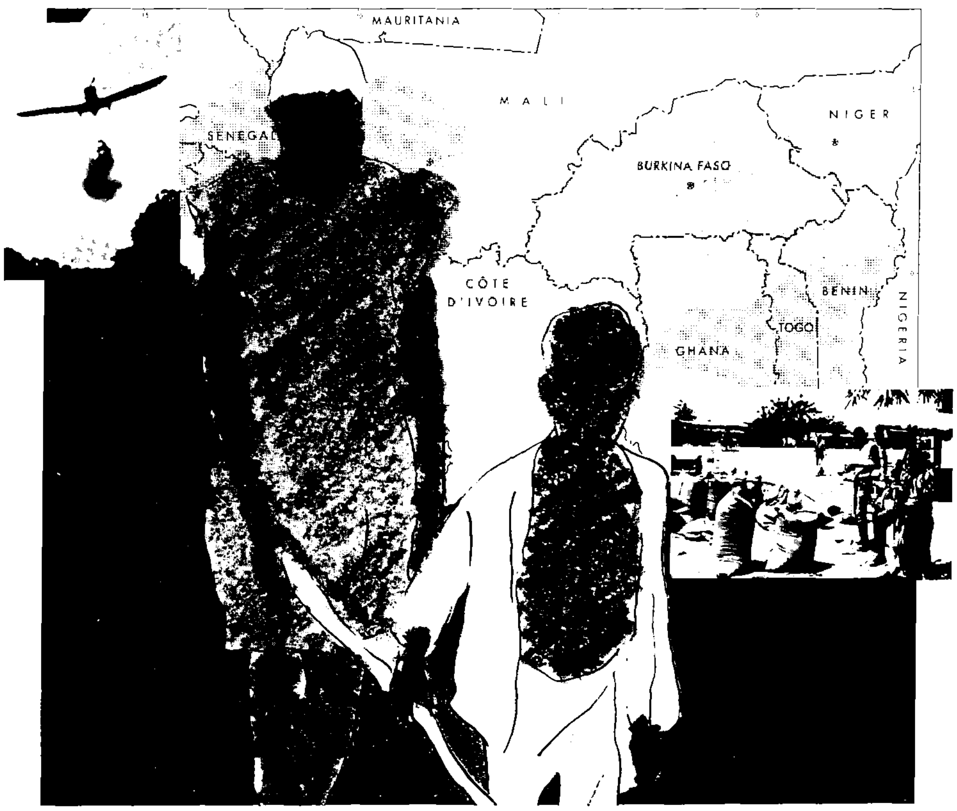
WORLD BANK TECHNICAL PAPER NUMBER 282
SERIES ON RIVER BLINDNESS CONTROL IN WEST AFRICA

Cost-Benefit Analysis of the Onchocerciasis Control Program (OCP)

Aehyung Kim and Bruce Benton



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At the time this paper was written, Aehyung Kim was an economist in the Onchocerciasis Unit, Population and Human Resources Division, Sahelian Department. She is currently an economist in the Infrastructure Operations Division (Country Department III) of the World Bank's East Asia and Pacific Regional Office. Bruce Benton is head of the Onchocerciasis Unit, Population and Human Resources Division, Western Africa Department.

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Foreword

This volume presents a cost-benefit analysis of the Onchocerciasis (Riverblindness) Control Program (OCP), based upon the Program's costs and the measurable economic benefits flowing from successful control of the disease. Cost-benefit analyses of health projects are rare. However, for onchocerciasis, it has long been recognized that the adverse impact of the disease upon rural development was direct and significant. To quote former Bank President Robert S. McNamara when he first encountered the disease in 1972 in Burkina Faso (then Upper Volta) and concluded that steps must be taken to control it:

> "Literally millions of people were at risk of a fate that could be worse than death in that society and time; becoming blind in the prime of life, thus maimed and unable to work and contribute to the society. And the supreme irony was that the disease stopped people from using some of the best land that was available in that dry region. With a dry climate made harsher by drought, this was a terrible obstacle to any prospect for development."

What is presented here is an attempt to quantify the economic benefits from removing this major constraint to development throughout a large portion of West Africa.

OCP is widely recognized as one of the most successful disease control programs in the history of development assistance. The Program is on the verge of eliminating onchocerciasis throughout an eleven country sub-region of West Africa, nearly three times the size of France. About eight more years are required for the Program to complete its mission. Already, more than thirty million people are now protected from onchocerciasis transmission. Ten million children, born since the Program's inception in 1974, face no risk of contracting the disease. One and a half million people who once had impaired vision and had become severely debilitated have fully recovered and suffer no trace of the disease. And OCP has prevented an estimated 250,000 cases of blindness to date. Clearly the humanitarian impact of OCP has been considerable.

OCP was the World Bank's first major venture into the health field. There were lingering doubts in the early 1970s about whether health interventions contributed to productive development in a way comparable to projects in more traditional sectors such as agriculture and transportation. Furthermore, a large donor community comprising more than 20 governments and international organizations was asked by the Bank to make a long term commitment of more than US$500 million to carry out OCP. Could such a huge investment pay off in economic development terms, even if the program were successful?

The analysis presented here is important because it provides answers to these questions. Secondly, it demonstrates that large scale, well-conceived, health interventions are clearly the business of development. Finally, it suggests that similar regional collaborative partnerships might be considered in addressing other major

diseases or wide-spread regional problems in other sectors.

Jean-Louis Sarbib
Director
Western Africa Department
Africa Region

Abstract

The Onchocerciasis Control Program (OCP) has been operating since 1974 first in seven countries, and then in the mid-1980s expanded to 11 countries. The aim of the Program is to eliminate onchocerciasis (also known as riverblindness) as a significant public health problem throughout a major sub-region of West Africa. The principal control tool of the Program has been "vector control". In other words, its purpose is to control the blackfly that transmits a parasitic worm, which is the source of the disease, from infected to uninfected individuals. The worm causes onchocercal blindness in infected individuals. During the initial phases of the Program, it was estimated that up to 15 percent of the population throughout the 11 country area had been debilitated, disfigured, or blinded as a result of onchocerciasis. With the steadfast support of the international donor community and effective collaboration among the African participating countries as well as the sponsoring agencies, OCP has become recognized as one of the most successful programs in the history of development assistance. The Program largely benefits the rural population by improving their health and living environment. In addition, it helps free previously oncho-ridden tracts of land for settlement and cultivation.

This paper presents a cost-benefit analysis of OCP in terms of net present value (NPV) and economic rate of return (ERR). The costs of OCP are actual expenditures incurred from 1974 through 1993 and projected expenditures from 1994 to 2002—which is the year in which OCP is now expected to be brought to conclusion. Based upon information provided by OCP, WHO, and the Bank, the total (i.e., actual as well as projected) expenditures for the two time horizons, 1974–2002 and 1974–2012, are US$556 million in nominal terms and US$571 million in 1987 constant dollars. This is under the assumption that OCP will cease operations at the end of 2002.

The benefits gained due to OCP are represented by the additional agricultural output produced as a result of the extra productive labor force and agricultural land made available through the control of onchocerciasis. Improved health among the adult population and the newly available oncho-freed land are the largest and most easily observable benefits stemming from onchocerciasis control. This analysis evaluates OCP's net benefits in terms of NPV and ERR over two project horizons: 1974–2002 and 1974–2012. The two different project horizons are used to examine the sensitivity of the benefits to the length of the project. In this analysis, the longer project horizon (1974–2012) is considered a more accurate representation of the net benefits accruing from OCP. The benefits gained due to onchocerciasis control tend to accumulate in the later stage of the project cycle and are expected to continue for at least another 10 years even if no further action were taken to maintain control. This is a conservative estimate based upon the results of the University of Rotterdam/OCP simulation model, ONCHOSIM, which predicts that the period of protection would continue for a minimum of 10 years after active control has ceased. On the other hand, costs are incurred beginning in the first year of

the project. Thus, it is reasonable to use the longer project horizon due to the long gestation period of the Program.

The NPV of labor and land-related benefits together (assuming 85% labor participation and land utilization) over a 39 year project horizon (1974–2012) ranges between US$3,729 million and US$485 million in 1987 constant dollars at discount rates of 3% and 10%, respectively. The estimated ERR under the same assumptions is on the order of 20%. Using a shorter project horizon of 29 years yields an ERR of about 18%. These are highly respectable ERRs and represent some of the better economic returns among Bank projects over the years in virtually any sector. This cost-benefit analysis confirms the considerable economic benefits of the Program in addition to its major contribution towards alleviating poverty and misery of the rural poor throughout a major sub-region of West Africa.

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Acronyms

ATP	Annual Transmission Potential
AVA	Agriculture Value Added
BESD	Bank Economic & Social Database
CFA	Communauté Financière Africaine
ERM	Economic Mission Review
ERR	Economic Rate of Return
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
JPC	Joint Program Committee
NPV	Net Present Value
OCP	Onchocerciasis Control Program
PAG	Report of the Preparatory Assistance Mission to the Governments of the seven original countries
UNDP	United Nations Development Programme
WHO	World Health Organization

1

Introduction

The Onchocerciasis Control Program

In 1974, the disease onchocerciasis, or riverblindness, was a major public health problem for West Africa. The prevalence of the disease had reached 15 percent in 11 countries. The disease caused disfiguration, severe debilitation, and blindness and forced thousands of people to abandon their villages. In many villages close to rivers, more than half of the adult population had become blind.

Onchocerciasis is caused by a parasitic worm which produces millions of infant worms that migrate throughout the body causing intense itching, debilitation, and eventually blindness. The disease is spread by a small, fiercely-biting blackfly which transmits the microscopic infant worms from infected to uninfected individuals. Once deposited in a person's body, some infant worms may develop into adults, mate, and produce millions of microscopic offspring. The adult worms live and produce infant offspring in humans, on average, for up to 12 years. The microscopic worms migrate throughout the human body and eventually invade the eyes causing progressive loss of sight and ultimately blindness.

In an effort to combat this devastating disease, the Onchocerciasis Control Program (OCP) was set up in 1974. Robert McNamara (World Bank President at that time) was instrumental in initiating the Program following his visit to Burkina Faso (then Upper Volta) in 1972. He proposed that the Food and Agriculture Organization (FAO), the United Nations Development Programme (UNDP), and the World Health Organization (WHO) join the Bank in cosponsoring a multi-donor program to control onchocerciasis, and that the United States back the effort with substantial donor support. Initially nine bilateral and international agencies consisting of Canada, France, the Federal Republic of Germany, the Netherlands, the United Kingdom, the United States, UNDP, the World Bank, and WHO formed the donor community which supported the launching of the Onchocerciasis Control Program.

The original program covered major portions of seven Western African countries (Burkina Faso, Benin, Ghana, Côte d'Ivoire, Mali, Niger, Togo). In 1986, it was expanded to include a total of 11 countries (adding Guinea, Guinea-Bissau, Senegal, and Sierra Leone) once it was determined that it would not be feasible to bring OCP to a lasting conclusion unless program operations were extended to the limits of the breeding sites of the savannah blackfly in the West African sub-region. The Program aims to control the blackfly (vector) by destroying its larvae in riverine breeding sites with insecticides sprayed from helicopters. These insecticides are screened and selected by an independent ecological group and their environmental impact is monitored to ensure no adverse effects upon the local ecology. The Program has also collaborated with the pharmaceutical industry to develop a drug, ivermectin, that is safe and kills the infant worms in the human body thereby preventing impending blindness. However, ivermectin has limited impact on the adult worm and is therefore not a substitute for aerial spraying to eliminate the reservoir of parasites in the human population.

OCP, now supported by 22 donors,[1] is widely regarded as having succeeded in achieving its objectives of eliminating the disease as a major public health problem, preventing onchocercal blindness, and removing a major constraint to socio-economic development in the 11 Western African countries. As a result, there are important new economic opportunities for the population in the region. One easily observable positive outcome is the provision of a healthier labor force for production. Furthermore, onchocerciasis control has opened up considerable additional arable land to resettlement and agricultural production in what were previously disease-ridden areas.

Cost-Benefit Analysis of OCP

The purpose of this analysis is to estimate and compare the costs and benefits of OCP in order to assess the economic justifications for this major intervention. Hence, OCP is examined strictly in terms of quantifiable economic costs and benefits over a time horizon spanning the life of the Program. The costs of OCP in nominal terms seem large compared to those of other health projects. One of the major reasons is the long project duration needed to ensure lasting onchocerciasis control, and thereby avoid any recurrence of the disease in the foreseeable future, in the absence of a vaccine or drug to kill the adult worm (macrofilaricide). OCP is a large-scale operation with activities covering 11 contiguous countries. It is the largest intercountry health program in Africa. This multicountry program has had the advantage of economies of scale,[2] spreading fixed costs associated with operational research, pooling large numbers of qualified personnel, and managing aerial spraying of insecticides over some 50,000 kilometers of rivers.

In terms of benefits, OCP has shown substantial positive results even when ignoring the gains from intangible benefits such as the reduction of suffering and improved quality of life by alleviating disability and preventing blindness. The intangible benefits are hard to quantify. However, even if one could attach an economic value to these benefits, there would be other methodological problems of indexing the value of these benefits over a wide range of individual health conditions and different earning abilities.

In this analysis, the benefits of OCP are represented by the additional agricultural output due to additional labor and agricultural land made available through onchocerciasis control over the periods 1974-2002 and 1974-2012.[3] The costs of OCP include actual expenditures from 1974 through 1993 and projected expenditures from 1994 to 2002. In estimating the additional output, a methodology is formulated based upon the assumption of a Cobb-Douglas production function.[4] Since the OCP area consists primarily of subsistence farming, only two factors of production (labor and land) are considered.[5]

The outcome of this cost-benefit analysis indicates that OCP has proven to be an economically

1. Current donors include the African Development Bank, Belgium, Denmark, the European Union, France, Germany, the Calouste Gulbenkian Foundation, Italy, Japan, the Republic of Korea, Kuwait, Luxembourg, the Netherlands, the OPEC Fund for International Development, Portugal, Saudi Arabia, Switzerland, the United Kingdom, UNDP, the United States, the World Bank, and WHO. For a detailed history of OCP, see "Taming the Lion's Stare" by B. Benton, *Bank's World*, Vol.11/No.5, May 1992, pp. 8-10.

2. Economies of scale represent decreases in average costs as the scale of operations increases. Economies of scale usually exist in projects where there are certain costs that can be "spread out" over the scale of operation. These costs do not necessarily increase at the same rate as the increase in the scale of operations. For example, if there are fixed costs of $10 as well as variable costs of $1 per unit of output produced (or benefit received) then output of a 100 units would have an average cost (per unit of output) of $(10+100)/100=$1.10. If the output were doubled to 200 units then average costs would be $(10+200)/200=$1.05 representing a *decrease* as the scale of operation increased.

3. The two different project horizons are used in order to estimate the benefits over the actual project period and the effective project period assuming, in the latter case, that the effectiveness of onchocerciasis control would last at least 10 more years without any additional intervention. Virtually all analyses undertaken by OCP, WHO, and the University of Rotterdam, involving large-scale model simulations, conclude that 10 years is the minimum period one can expect benefits to continue to flow unimpeded by any recurrence of the disease, in the absence of any follow-up action.

4. A production function gives the amount of output that can be produced using any given quantities of inputs. Inputs—also known as factors of production—typically constitute labor, capital, land, and raw materials. Production functions may take many specific algebraic forms. One widely used form of the production function is known as Cobb-Douglas. The Cobb-Douglas formulation of the production function states that output (Q) is related to inputs [e.g., labor (L) and land (K)] in the following way: $Q=AL^{\alpha}K^{\beta}$ where A represents a productivity parameter. The α and β parameters represent the percentage increase in output resulting from a percent increase in labor and land, respectively, when holding the quantities of the other input fixed. Constant returns to scale can be represented by the assumption that $\alpha+\beta=1$ which means that if both land and labor are increased by a certain proportion then output also increases by the same proportionate amount. In other words, a doubling of both labor and land inputs implies that output also doubles.

5. It is noted that there has been a small but steady increase in the use of technologies and fertilizers, but this factor has a negligible effect on the analysis.

attractive program. In numerical terms, the benefits vary depending on the values of the parameters used in estimating them. The criteria used to evaluate the economic efficiency of the project include net present value (NPV),[6] the economic (or internal) rate of return (ERR),[7] and costs per person protected per annum. The NPV for the effective project horizon of 39 years ranges between US$3,729 million and $485 million in 1987 constant dollars[8] as the assumed discount rate[9] is increased from 3% to 10% (under the assumption of 85% labor participation and land utilization[10]). The analysis estimates the ERR at 20% under the same assumptions. The ERR corresponding to a 29 year project horizon (1974-2002) is 18%. The cost of protecting each person in the 11 country area is US$0.57 per annum in 1987 constant dollars.[11]

In general the discount rates used for evaluating health projects are lower than those used for non-social sector projects. This is because health benefits should be discounted at the "social" discount rate.[12] OCP is no exception in this regard. When a 3% discount rate is used, the NPV is US$3,729 million in 1987 constant dollars for the period 1974-2012 (assuming 85% labor participation and land utilization). The NPV is still positive (US$485 million in 1987 constant dollars under corresponding assumptions) even with the discount rate of 10% that is often used for evaluating projects in the so-called productive sectors, such as agriculture, industry, energy, transport, etc. This means that the ERR of OCP also exceeds the opportunity cost of 10% or the return foregone when not investing funds in successful projects in some of the most productive sectors.

OCP is highly cost-effective based upon this analysis wherein a framework was developed for evaluating the cost and benefits of the Program by incorporating measures that are quantifiable in an economic sense. Beyond the economic justification of the Program, however, it should not be forgotten that OCP contributes importantly to the alleviation of poverty and misery for the rural poor in the 11 West African countries. Indirect benefits generated through OCP will have a positive impact on community development for many years to come. Young children born after OCP are virtually free from any danger of contracting the disease. They will have a better chance to be productive and to become educated because their parents are more likely to be providers rather than dependents. Therefore, OCP, like other successful preventive health care projects, has a discernible impact in terms of improving the well-being of those living under conditions of abject poverty. This is a significant aspect of the Program since, in 1992, more than half of OCP participating countries

6. The net present value (NPV) is the present value of the stream of net returns (benefits minus costs) of a project during its economic life. The present value is determined by discounting expected future net returns at a rate which reflects the cost (interest rate) of borrowing funds or the likely return on the best alternative investments available for those funds. A positive NPV is taken to be an indication that the project is economically sound.

7. The Economic rate of return (ERR)—otherwise known as the Internal Rate of Return (IRR)—is that rate of interest (or discount rate) which makes the present value of the stream of net returns (benefits minus costs) equal to zero. If the ERR is greater than the market interest rate or the cost of borrowing then the project is worth undertaking from an economic point of view. As a general rule within the World Bank, projects with an ERR of 10% or more are considered to be successful.

8. Constant dollars represent adjustments made to nominal figures in order to account for inflation over time. Prices are determined with regard to a base year (1987 in this case) and fixed over time. For example, a 10% increase in costs measured in *nominal* terms from one year to the next may include a component due to inflation. In order to measure the increase in "real" terms (i.e., in terms of quantities of resources), the nominal costs are adjusted so that prices over time are fixed at a certain base year level. A 10% increase in costs in *constant* price terms represents an increase in "real" resource costs.

9. The discount rate enables a comparison of values over different periods of time. It is the rate by which future benefits and costs are discounted in order to reflect *time preferences* and/or *opportunity costs*. For example, the value of one dollar next year is typically less than the value of one dollar in the present. This could be because there is a preference for a benefit now as opposed to receiving the benefit in the future (i.e., there is a time preference). Alternatively, one dollar today could be invested to yield (1+r) dollars after one year where r represents the rate of interest that the investment yields. This implies that one dollar to be received next year is equivalent to 1/(1+r) dollar in the present. The present value of one dollar next year is less than the value of one dollar today (i.e., the interest rate is used as a discount rate to represent the opportunity cost of not receiving the dollar in the present).

10. In other words, it is assumed that, on an annual basis, 85% of the additional labor and new land available as a result of OCP partakes in the production process. Results for other labor-participation and land-utilization rates are also reported in the tables.

11. This is assuming that OCP has a 39 year period of protection. It is also assumed that the average population in the 11 country OCP area is 25.9 million over the life of the Program. The cost per person protected assuming a 29 year project horizon is US $0.76 per annum in 1987 constant dollars. See Benton and Skinner (1990).

12. The social discount rate takes into account additional benefits that may accrue to society as a whole from undertaking a given project. In the case of health projects, the social discount rate is typically lower than the market discount rate in order to reflect additional unaccounted for society-wide gains that frequently result from such projects. These gains occur in the case of OCP by enabling family members to join the labor force who might otherwise be forced to care for blind relatives.

fell among the group of 10 countries with the lowest social indicators in the world.[13]

The ensuing analysis is divided into three parts. The paper considers the costs, labor-related benefits, and land-related benefits of OCP in separate sections. Each section describes the measurement procedures used and presents the outcomes. In some cases, the sensitivity of the results to the assumed values of various parameters is also examined.

Measuring the Costs of OCP

The costs of OCP are calculated simply as the sum of actual OCP expenditures incurred from 1974 through 1993 and projected expenditures from 1994 through 2002. The projected expenditures include a five-year phasing-out period (1998 through 2002). All recent analyses conclude that OCP can be brought to a definitive and lasting conclusion by the end of 2002. The OCP budget is approved annually by the Joint Program Committee (JPC), the Governing Board of the Program, based upon an annual plan of action set out within the context of a six-year plan of operation. At the end of each year the actual expenditure is reported. For this analysis, the costs include only the expenses directly associated with control of the disease. There are other indirect costs that may be incurred by individuals living in the OCP area who have been the subject of epidemiological surveillance activities. This includes time taken away from production while complying with the surveillance procedure. However, we do not include these indirect costs as they are assumed to be virtually negligible for the purpose of this study. Individuals participate in epidemiological surveillance activities for less than one day per person per year in the Program area.

Based upon information provided by OCP, WHO, and the Bank, the total projected OCP expenditure for the period 1974-2002 is US$556 million in nominal terms and US$571 million in 1987 constant dollars. The nominal costs have been adjusted to reflect the January 1994 devaluation of the CFA franc, which has had the effect of significantly reducing the cost of locally produced and procured goods and services.[14] The costs in nominal and real terms are summarized in Table 1.

Table 1. Expenditures of OCP (1974–2002) in US$ thousand[a]

Year	*Current US$*	*Average Deflators[b]*	*1987 US$*
1974	2,735	40	6,838
1975	6,133	46	13,243
1976	10,586	50	21,008
1977	10,167	56	18,172
1978	12,051	60	20,193
1979	14,296	65	21,974
1980	16,506	72	23,043
1981	16,648	78	21,396
1982	16,646	84	19,890
1983	16,776	88	19,014
1984	19,348	94	20,625
1985	20,709	96	21,538
1986	25,600	97	26,354
1987	33,380	100	33,380
1988	27,920	103	27,215
1989	27,190	105	25,992
1990	30,770	108	28,485
1991	32,810	111	29,633
1992	31,716	113	27,946
1993	26,514	116	22,793
1994	25,000	119	20,967
1995	24,000	122	19,638
1996	23,000	125	18,360
1997	22,000	128	17,134
1998	15,220	132	11,564
1999	13,967	135	10,353
2000	12,725	138	9,203
2001	11,552	142	8,151
2002	10,367	145	7,136
Total	556,332		571,237

a. Expenditures from 1974 through 1993 are actual. Those from 1994 through 2002 are projected.

b. The major currencies of OCP expenditure are French francs, US dollars, and CFA francs with shares of 8%, 49%, and 43%, respectively. The average deflators are calculated as a weighted average of regional deflators based upon the currency share of OCP expenditures. From 1992 onwards, the average deflators are assumed to increase by 2.5% per year. This assumption is relaxed in later sections to assess the sensitivity of the results to various inflationary scenarios given the fact that the devaluation in 1994 is expected to be inflationary and that would especially impact the CFA franc-denominated portion of the expenditures.

Sources: 1. Expenditures: OCP, "Plan of Operation for the Fourth Financial Phase," 1991, and other OCP and World Bank financial documents. 2. Deflators: Bank Economic & Social Database (BESD), World Bank.

13. These are Guinea, Burkina Faso, Sierra Leone, Niger, Mali, and Guinea-Bissau. The rankings based upon social indicators are taken from UNDP's Human Development Index (HDI).

14. In January 1994, the CFA franc was devalued. The exchange rate changed from 50 CFA francs per French franc to 100 CFA francs per French franc.

2

Estimating the Economic Benefits of OCP

Labor-Related Benefits

Labor-related benefits are represented by the additional output produced because of the increase in labor resulting from the reduction of onchocercal blindness by OCP in 11 West African countries.[15] Since OCP has operated in rural areas, the marginal product of labor is estimated as the additional income gained in the agricultural sector through increasing the supply of productive labor. To estimate the additional output of labor accrued through prevention of onchocercal blindness, methods based on the Cobb-Douglas function were used.[16]

The following parameters are considered relevant in estimating the additional output of labor in the agricultural sector: the length of the project horizon, the size of population at risk, the number of cases of blindness prevented by OCP (the difference between the number of cases of blindness without OCP and with OCP), the number of years of productive life added, the percentage increase in the labor force, the agricultural value-added at factor cost,[17] and the output elasticity of labor[18] in the agricultural sector. As in the analysis of costs, output figures are measured in 1987 constant US dollars for consistency of comparison between costs and benefits. The following sections describe how each of these parameters was estimated.

Project Horizon

OCP was launched in 1974 and is expected to continue until the end of the year 2002. This includes a five year phasing-out period (1998 through 2002). Hence, the Program has a 29 year actual project horizon. In addition, it is estimated that the effectiveness of the intervention will last for at least another 10 years from the last year of onchocerciasis control. This implies a 39 year effective project horizon from 1974 to 2012. Onchocerciasis is a slowly accumulating disease unlike most other vector-borne diseases. Also,

15. It should be noted that this analysis only includes the benefits related to the reduction of blindness through OCP, although there are other benefits related to the alleviation of severe loss of energy, disability, or nuisance effects that may be substantial. The reduction of lost production time by family members when providing care for the blind and improved parental care for children on whom the future productivity of labor will depend are other benefits not directly accounted for in the analysis. They are excluded because of their complexity and the uncertainty regarding their measurement. Therefore, the estimated labor-related benefits accruing only from blindness prevention should be regarded as a lower-bound approximation to their true value.

16. The Cobb-Douglas function is particularly appropriate to apply to this cross-country study with two factors of subsistence agricultural production (labor and land), given the constraints in collecting data and generalizing information. For recent empirical evidence applying the Cobb-Douglas production function to data pertaining to Africa, consult the study on the macroeconomic impacts of AIDS by M. Over (1992, p.12).

17. The agricultural value-added at factor costs is the cost of inputs.

18. The elasticity is an indication of the relative responsiveness of output to changes in input levels (in this case labor). A high elasticity of output with respect to labor indicates that a unit increase in labor input results in relatively large increases in output levels. On the other hand, a low elasticity would mean that output changes are not very sensitive to changes in labor inputs.

the disease will not recur in any significant way before 2012 even if there is some recrudescence. These two separate time horizons are used in the analysis to observe the sensitivity of benefits with respect to varying project horizons. The longer time horizon substantially increases the NPV of benefits using a 3% discount rate (it more than doubles), because the benefits gained in the later years are weighted considerably higher in present value terms compared with NPV results when using discount rates of 10% or more.

Population at Risk

Estimates of the population at risk incorporate two elements: 1) the initial population size, and 2) the population growth rate. At the beginning of OCP, the initial population in the original OCP area was estimated at about 10.6 million based upon information given by the Report of the Preparatory Assistance Mission to the Governments of the seven countries (PAG, 1973).[19] By 1984 the population size had increased to about 17 million with the addition of a southern extension in Côte d'Ivoire. In 1986, the size of the Program population had increased to 25 million by extending onchocerciasis control into the western extension countries (Guinea, Guinea-Bissau, western Mali, Senegal, and Sierra Leone), and into the southeastern extension which included the southern portions of Ghana, Togo, and Benin.[20]

The Program has expanded three times in terms of the area and population covered. The total population is divided into three clusters: original area 1, original area 2, and extension areas. An effort was made to ensure realistic estimates of population size. This is because the population size, through calculations based upon incidence, directly affects estimates of the number of cases of blindness prevented in a given year. At the same time, the incidence of blindness decreases according to the number of years of intervention. For example, in 1990 the incidence of blindness was much lower for original area 1 (1.2%) than for original area 2 (1.8%). The analysis incorporates the fact that there is no change in the incidence of onchocercal blindness during the first years of implementation of onchocerciasis control (minimal effectiveness of transmission prevention). The number of cases of blindness prevented is estimated for each population cluster. These are then aggregated to obtain estimates of the total number of cases of onchocercal blindness prevented by OCP.

The analysis assumes that the population grows at 1.7% per year. This estimate of the annual population growth rate is relatively conservative, considering that the average population growth rate of these 11 countries has been between 2.5% and 3% per year over the last three decades. Furthermore, the average annual growth rate of the OCP countries' rural population during the period 1974-1990 was around 2.4%. A lower annual population growth rate was used for the onchocerciasis zones. New settlements have grown slowly in the once onchoendemic areas. This can largely be attributed to a residual presence of the disease, and lack of infrastructure in the OCP region. Furthermore, there has been a continuing pattern of net outmigration from rural to urban areas.[21]

Number of Cases of Blindness Prevented

Taking the estimated size of population at risk as given, the number of cases of blindness prevented each year is calculated based upon the incidence level of onchocercal blindness before and after onchocerciasis control. Prost & Prescott (1984) estimated that 4 people per 1000 became blind due to onchocerciasis each year in the hyperendemic areas and 0.8 people per 1000 per year in the mesoendemic areas of Burkina Faso before vector control.[22] During the period 1975-80, the incidence decreased to 0.3 per 1000 and zero per 1000 in the hyperendemic and mesoendemic areas, respectively (Table 3 of Prost & Prescott, p.797). At the same time, Remme (1989) reports that after 10 years of intervention,

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19. The population data were based on national censuses conducted during the years 1970-71 for these seven original OCP countries (Burkina Faso, Benin, Côte d'Ivoire, Ghana, Mali, Niger, and Togo).
20. Source: Economic Mission Review (ERM), World Bank, 1978; other OCP documents.

21. The same population growth rate of 1.7% was used in previous studies related to onchocerciasis: OCP's cost-effectiveness in Upper Volta (Prost & Prescott, 1984) and Economic Review Mission (World Bank, 1978).
22. Annual Transmission Potential (ATP) is the number of parasites that a person would receive in one limited area (known as "capture points" where flies are captured and dissected to determine their rate of infectivity) over a year. Hyperendemic areas are defined as those areas with an ATP for onchocerciasis greater than 800; mesoendemic areas comprise those with less than 800. In hyperendemic areas, it was considered that more than 60% of the population carried the parasite (Younger & Zongo 1989, p.31).

the annual incidence of onchocercal blindness was less than 0.15% and exclusively involved cases of people who already had severe eye lesions in 1975. Based on this epidemiological information, the total number of cases of blindness prevented by onchocerciasis control from 1974 to 2012 is presented in Table 2a.[23]

The formula for the number of cases of blindness prevented for a given year is calculated as follows:

Cases of blindness prevented = Cases of blindness without OCP - Cases of blindness with OCP

where:

Cases without OCP = Incidence level without OCP x Size of population at risk

Cases with OCP = Incidence level with OCP x Size of population at risk

Number of Productive Years Added

Prost & Prescott (1984) estimated that, on average, people who are onchocercal blind are likely to live another eight years with blindness and then to die 12 years prematurely.[24] This indicates that preventing one case of blindness would on average add another 20 years of productive life, when controlling for other health conditions and aggregating the effects of preventing disability and postponing death. The method used in the analysis represents the effects of blindness and premature death by the complete loss of labor productivity.[25]

23. The incidence level without OCP was assumed to be a weighted average of the incidence levels in the hyperendemic and mesoendemic areas estimated by Prost & Prescott (1984). In other words, the incidence level was assumed to be an equally-weighted average of 0.4% and 0.08%. The incidence level with OCP was assumed to begin a decline from an equally-weighted average of 0.4% and 0.08% in 1975 to a level of 0.03% in 1980 and 0% thereafter. Recent negligible incidence rates also reflect the fact that use of ivermectin—the drug that kills infant worms in the human body thereby preventing the onset of blindness—has been relatively widespread since 1987.

24. Prost and Vaugelade (1981) and Remme (1989, p.21) use a figure of 13 years.

25. See M. Drummond (1989).

Since one case of blindness prevented adds another 20 years of productive life to the individual, the extra labor supply due to OCP is estimated by calculating a moving sum of lives saved over the previous 20 years. The results are

Table 2a. Additional Number of Cases of Blindness Prevented and Productive Laborers Available Due to OCP[a]

Year	*Cases of Blindness Prevented*	*# of Productive Laborers Available*	*Year*	*Cases of Blindness Prevented*	*# of Productive Laborers Available*
1975	0	0	1994	31208	264551
1976	1213	1213	1995	33434	297985
1977	2410	3623	1996	35646	332419
1978	3593	7216	1997	37848	367857
1979	4762	11979	1998	40040	404303
1980	5918	17897	1999	42223	441764
1981	7062	24959	2000	44398	480244
1982	8195	33154	2001	46568	519749
1983	9316	42470	2002	48732	560286
1984	10428	52898	2003	50892	601862
1985	12023	64921	2004	53050	644484
1986	13603	78524	2005	55205	687667
1987	15169	93692	2006	57360	731424
1988	17519	111212	2007	59516	775772
1989	19848	131060	2008	61674	819926
1990	22156	153215	2009	63834	863912
1991	24444	177660	2010	65997	907753
1992	26715	204374	2011	68179	951488
1993	28969	233344	2012	70361	995134

a. The number of laborers available in a given year includes new cases of blindness prevented in that year as well as cases that were prevented in earlier years (up to 20 years ago) since we assume that a person prevented from blindness remains productive in economic terms for 20 years. For example, in 1994 the number of cases of blindness prevented is projected to be 31,208. The corresponding number of additional laborers available for production purposes in that year is the *sum* of the number of new cases of blindness prevented in 1994 as well as the number of new cases of blindness prevented each year in the past for a maximum of 20 years (in this case the period 1976–1994).

Table 2b. Total Additional Number of Cases of Blindness Prevented and Additional Years of Productive Labor Available Due to OCP

Years	Total Cases of Blindness Prevented	Total Number of Additional Years of Productive Labor
1974–1994	264,551	1,707,962
1974–2002	593,440	5,112,569
1974–2012	1,199,508	13,091,991

presented in Table 2a. Table 2b presents the sum of the cases of blindness prevented and the additional years of productive labor available over different time horizons.

Percentage Increase in Labor Force

The percentage increase in the labor force for a given year due to OCP is estimated by dividing the number of increased productive laborers by the rural population in the OCP area. Epidemiological studies show that the average age of those with blindness is between 30 and 40 years old (Remme 1989)—usually the most productive years of one's life. This implies that people prevented from becoming blind will have a good likelihood of participating in production. In addition, the demand for labor will increase as additional agricultural land is freed from the disease. According to the PAG Report, limited and over-cultivated farm land was a major constraint to agricultural production before OCP began operations, and was also a causal factor for out-migration. In most cases, the oncho-freed land provides better farming opportunities than land utilized in areas which were lightly or non-infected before the Program began.

The estimates of the percentage increase in the labor force for a given year assume that 100% of the people prevented from becoming blind and 100% of the rural population are in the work force. However, if the number of active persons (in economic terms) in the rural sector were used as the denominator, the percentage increase in the labor force would be greater than the percentage increase in labor force estimated here.[26] Consequently, the labor-related benefits would be larger than those presented here. Offsetting this is the fact that probably not all of those saved from blindness will actually participate in the labor force. Using the rural population instead of the active rural labor force as the denominator for the calculation of the percentage increase in the labor force due to OCP tends to offset the overestimate which would occur if one assumes 100% of those saved from blindness are in the active labor force.[27]

26. Hence, using the rural population as the denominator gives a lower bound to the percentage increase in the labor force. It is estimated that about two-thirds of the rural population is economically active.

Table 3. Labor-Related Benefits
(in 1987 US$ million)

Horizon	*Labor Force Participation Levels*	*Net Present Value @3%*	*Net Present Value @10%*	*ERR*
29 Years	100%	-37	-93	2%
39 Years	100%	293	-58	7%
	85%	192	-77	6%
	70%	90	-95	4%

Output Elasticity of Labor

The percentage increase in output is calculated assuming an output elasticity of labor of 0.66 in OCP countries. This means that a 1% increase in the number of workers will increase output by 0.66%.[28] Output is measured as agricultural value-added at factor cost.[29] To estimate the value of the additional output attributable to the increased labor force, the agricultural value-added is multiplied by the computed percentage increase in output (i.e., labor-related benefits equal 0.66 times the percentage increase in labor times the agricultural value-added). The resulting estimates of labor-related benefits are presented in Table 3.

Results for Labor-Related Benefits

Labor-related benefits are compared with the costs presented in the previous section. The NPV over a 39 year horizon (1974-2012) and an 85% labor force participation level is US$192 million at a discount rate of 3%. The NPV at a 10% discount

27. Table 3 presents an analysis of the sensitivity of the estimates to various assumptions about the participation of the people prevented from blindness in the labor force using a 39 year project horizon.
28. An output elasticity of labor of 0.66 is estimated in a recent study by M. Over, *The Macroeconomic Impact of AIDS in Sub-Saharan Africa*, (the World Bank, 1992), assuming only two factors of production for the rural sector: labor and land.
29. Agriculture value-added (AVA) at factor cost is used since it better reflects the income accrued in the agricultural sector than AVA at market prices which includes other transaction costs, such as indirect taxes. From 1974 to 1990, data used in the analysis was retrieved from the Bank Economic & Social Database (BESD), World Bank. From 1991 onwards, the figures are calculated on the basis of the average annual growth rate over the project horizon.

rate for the same project horizon and labor force participation level is negative. The corresponding ERR is 6%. Table 3 summarizes the NPVs and ERRs corresponding to other labor force participation levels. The NPVs and ERR for a 29 year project horizon are also reported.

Using a longer horizon and a low discount rate generates greater NPVs since the labor-related benefits accrue in the later stages of the program horizon whereas the costs are incurred beginning at inception of the Program. In this respect, it is sensible to use a longer program horizon for a health program such as OCP in order to include the benefits gained from the project in later years.

As mentioned above, the estimated ERR considering only labor-related benefits is 6% over the period 1974-2012, assuming an 85% labor participation level. OCP would be economically justifiable, based upon labor-related benefits alone, if the economic rate of return (the opportunity cost) from alternative projects was less than 6%. Although an ERR of 6% is not necessarily low for a health project, it is always possible that other health projects would have a greater ERR. Thus it is important to extend the analysis to incorporate land-related benefits. This is presented in the next chapter.

3

Land-Related Benefits

Land-related benefits are measured by the incremental output produced from the additional agricultural land available (so-called "new land") as a result of onchocerciasis control.[30] Data on land transactions are not readily available in OCP countries. Data availability is precluded by the lack of property rights that carry monetary values in a commercial sense. Thus we cannot calculate land-related benefits by the direct method of multiplying the area freed by the market price of land. However, it is reasonable to equate land-related benefits with the incremental value of output produced over the program horizon. The contribution of land can then be estimated using the Cobb-Douglas production function as in the previous chapter.

The estimate of land-related benefits depends upon the length of the project horizon (the same as those used for labor-related benefits), the amount of "new land", the rate at which it is utilized, the percentage increase in agricultural land due to the new land, the output elasticity of land in the agricultural sector, and the agricultural value-added. Subsequent sections explain the methodology used in estimating each of the aforementioned factors.

30. New land refers to the land freed from onchocerciasis. This land had been abandoned or vacant prior to OCP.

Estimated Total Size of the "New Land"

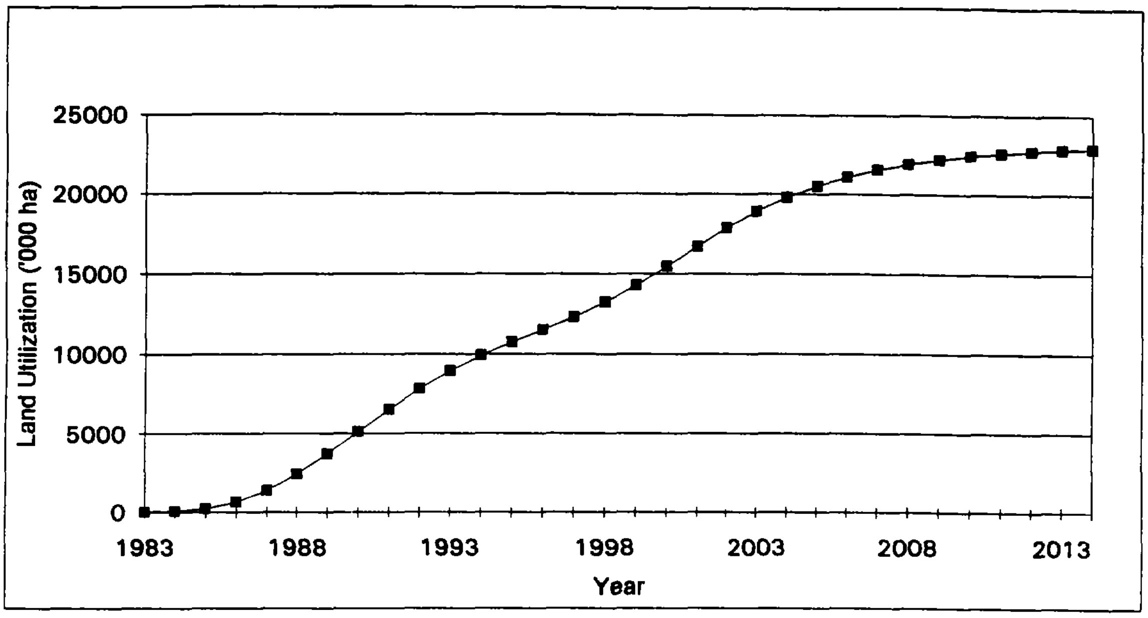
The estimated total size of the "new land" is about 25 million hectares.[31] New land in the extension areas is around 10 million hectares, consisting of 4.9 million hectares in the Southeastern extension plus 5 million hectares in the Western extension area. Intervention in the extension areas started in 1986.

Utilization of the "New Land"

Based on the study by McMillan et al. (1992), this analysis assumes that cultivation of new land starts only after the area is safe from the disease. Once the incidence level has become negligible, utilization of new land begins slowly and then moves faster up to a certain level. In the later stages of the project horizon the pace of land utilization tails off with full cultivation of newly available land. This pattern of land utilization is assumed to follow an S-Curve

31. Source: Table 1, p.15, *Onchocerciasis Control Program: Economic Review Mission (ERM)*, World Bank, October, 1978. ERM estimated "new land" in the original area as 15.4 million hectares after including a reduction for soil quality. Estimates for the southern extension area are based on Table 6: Hectarages of "New Land" Available in the Proposed OCP Extension Area, p.44, ERM, World Bank, October, 1978. Estimates of the western extension area are based on Table 2, Benton & Skinner (1990).

Figure 1. Utilization of New Land in the OCP Area



Note: The above figure exhibits two S-curves of "new land" utilization for the original and extension areas.

pattern[32] (See Figure 1). According to an epidemiological study done by OCP, there is evidence that after eight years of vector control the incidence of onchocerciasis was negligible with no danger of disease transmission. The land in the original area is expected to be largely utilized by 2003 and in the extension areas by 2014. Figure 1 and Table 4 present details of the

32. The S-curve function can be written as $\log y_t - \log y_{t-1} = a(\log y^* - \log y_{t-1})$, where t = time, y_t = the area settled at time t, and y^* = the final land area settled. Intuitively, the left hand side represents the proportionate rate of change of land utilization, which is assumed to depend on fraction 'a' of the proportionate gap between land settlement at time t and the final level of land settled, y^*. The smaller the amount of land settled at time t-1, the greater the proportionate gap of land to be ultimately settled, and the faster the current proportionate rate of growth of land settlement at time t. Finally, as land settlement nears its target value, y^*, the fewer the opportunities for further new settlement, and the proportionate rate of increase of land settlement tails off as all land becomes settled. In this study a simulated S-curve response was generated by assuming an initial value y_0 of 10 thousand hectares and 7 thousand hectares, for the original area and the extension areas respectively, 'a' the catch-up rate was assumed equal to 0.25, and y^* represented the final hectarage of settled land: for the original OCP area this took a value of 1.3437 million hectares and 10,000 million hectares. The results are tabulated in Table 4 and graphed in Figure 1.

Table 4. Utilization of New Land Available and Total Agricultural Land in OCP Countries
('000 ha for a given year)

Year	Utilization of New Land Available	Agricultural Land	Year	Utilization of New Land Available	Agricultural Land
1975		172137	1995	10739	163334
1976		171713	1996	11497	162907
1977		171289	1997	12285	162481
1978		170867	1998	13208	162056
1979		170445	1999	14285	161632
1980		169923	2000	15473	161210
1981		169403	2001	16694	160789
1982		168885	2002	17866	160368
1983	10	168368	2003	18929	159949
1984	61	167853	2004	19776	159531
1985	234	167464	2005	20491	159114
1986	644	167077	2006	21078	158698
1987	1376	166690	2007	21548	158283
1988	2432	166304	2008	21919	157869
1989	3728	165919	2009	22208	157457
1990	5137	165485	2010	22431	157045
1991	6533	165053	2011	22602	156635
1992	7824	164621	2012	22732	156225
1993	8956	164191	2013	22831	155817
1994	9919	163762	2014	22906	155409

Note: All the figures on land presented above are rounded.

S-Curve pattern assumed for the utilization of new land.[33]

Percentage Increase in Agricultural Land and Output Elasticity of Land

The percentage increase in agricultural land for a given year is calculated by dividing the additional new land available by total agricultural land.[34] The percentage increase in output is estimated using the same methodology used for calculating the labor-related benefits. The output elasticity of land is multiplied by the percentage increase in agricultural land. This implies that a 1% increase in agricultural land will increase agricultural output by 0.33% as this analysis assumes constant returns to scale and that there are only two factors of production. Based on the data given it seems that total agricultural land has been slowly decreasing over recent years in OCP countries. Possible causes would include desertification or an increase in urban land taken away from agricultural uses, both representing important challenges facing West African countries. The additional land freed as a result of OCP is increasingly vital to agricultural production as population pressures mount and the demand for food increases. The additional output gained with the extra agricultural land equals the computed percentage increase of output multiplied by existing output as measured by agricultural value-added (i.e., land-related benefits equal 0.33 times the percentage increase in land times the agriculture value-added).

New land began to be utilized in 1983 when the first year of land-related benefits materialized. In other words, this is after eight years of OCP intervention in the original area. Land-related benefits, take time to accrue, but these benefits then start to grow quickly. A recent study by the World Bank also indicates that an important driving force behind growth in agricultural production, particularly in the Sahel countries, has been the cultivation of new land in previously oncho-endemic areas.[35]

Results of Land-Related Benefits

The NPVs over a 39 year project horizon (1974-2012) and 85% land utilization range between US$3,154 million and US$380 million at discount rates of 3% and 10%, respectively. The estimated ERR corresponding to a 39 year project horizon and 85% land utilization is 18%. Table 5 summarizes the NPVs and ERRs for different land utilization levels. The NPVs and ERRs for a 29 year project horizon are also reported.

It should be noted that this new land is likely to be more productive than existing land. This is because the new land would have lain fallow for quite some time and therefore will tend to be more fertile.[36] The recovered land should also have better access to water because onchocerciasis was most prevalent near rivers where the vector (blackfly) laid its eggs. This implies that, at least for the first few years of cultivation, actual land-related benefits should be greater than ours.[37]

Overall, the assessment of land-related benefits shows that, using the Cobb-Douglas production function and its assumption of constant elasticity of output with respect to factor inputs, the additional output gained with new land is substantial. As the use of new technologies and fertilizer increases along with improved exten-

33. In order to examine the sensitivity of land-related benefits to the proportion of land utilization, this analysis includes three different assumptions for the long-run level of land utilization: 70%, 85%, and 100% respectively. Results under the assumption of 100% land utilization are presented in detail in Table 4 and Figure 1. The results with different levels of land utilization are presented in Table 5.

34. Source: FAO Yearbook: Production, Vol.44, 1990. For the years 1974, 1979, 1984, & 1989 actual data are used for the total agricultural land; the estimates for the interval years and for 1990 onwards are interpolated using an estimated average growth rate (g). The take-up of "new" land is interpolated using an S-Curve pattern. Agricultural land refers to the total land area including arable land, land for permanent crops, permanent pasture, and forest and woodland, less other land including urban land and desert.

35. Source: Agricultural Growth in the Sahel - Performance of the 80s and Long-Term Implications, Unpublished Article, World Bank, 1992.

36. Land degradation will negatively affect the long-run land-related benefits; however, this study only considers cultivation over the 39 year horizon from 1974 to 2012. Therefore, unless drastic land degradation occurs during the next 15 years, the land-related benefits of the analysis will not be substantially reduced. At the same time technological advancement, the availability of more skilled labor, and the use of fertilizer may increase the productivity of land in the future. For simplicity, this analysis does not consider all of these inter-linked and to some extent offsetting factors.

37. In terms of present value, the benefits accruing in the early years of the project horizon have greater weights than those in the later years of the project. Therefore, the possible positive revisions to the land-related benefits due to more productive new land should be greater than the possible negative revisions in the land-related benefits due to land degradation, when measured in net present value terms.

Table 5. Land-Related Benefits
(1987 US$ million)

Horizon	Net Present Value @3%	@10%	ERR
100% land utilization			
29 Years	1523	240	17%
39 Years	3755	473	19%
85% land utilization			
29 Years	1254	181	16%
39 Years	3154	380	18%
70% land utilization			
29 Years	980	121	14%
39 Years	2548	285	17%

sion programs in these countries, the contribution of new land to agricultural productivity is likely to increase.

Total Benefits (Labor and Land-Related)

The NPV of the labor and land-related benefits together, assuming 85% labor force participation and 85% land utilization over a 39 year project horizon falls within the range of US$3,729 million to US$485 million in 1987 constant dollars at discount rates of 3% and 10%, respectively. The corresponding ERR is 20%. Table 6 summarizes the NPVs and ERRs for different levels of labor participation and land utilization, and for a 29 year project horizon as well.

In general, in order to evaluate projects, a reasonable discount rate would be between 8% and 12%. However, as stated above, it has been argued in the literature that the appropriate discount rate for health projects should be lower than that for non-social sector projects due to a higher proportion of non-quantifiable benefits accruing to society at large. At the same time, the discount rate should be lower for long gestating projects and, in particular, those that involve an inter-generational transfer of benefits so that the time value of the benefits does not apply to the same set of beneficiaries over the life of the project. The lower discount rate helps account for the fact that the time value of benefits shifts as those benefits begin to accrue to a new generation. In this respect, using 10% as the benchmark discount rate is on the high end for a long-gestating social sector project. Hence, the fact that OCP enjoys an ERR of 20% underscores the highly cost-effective nature of the Program.

Table 6. Total Benefits of OCP
(1987 US$ million)

			29 Years	39 Years
100% Labor Force Participation & Land Utilization:				
	NPV:	*discount rates*		
		@ 3%	1869	4430
		@ 10%	329	597
	ERR		20%	21%
85% Labor Force Participation & Land Utilization:				
	NPV:	*discount rates*		
		@ 3%	1548	3729
		@ 10%	257	485
	ERR		18%	20%
70% Labor Force Participation & Land Utilization:				
	NPV:	*discount rates*		
		@ 3%	1222	3022
		@ 10%	184	372
	ERR		16%	18%

CFA Franc Devaluation and Inflation

The costs of OCP in nominal terms have been adjusted to reflect the January 1994 devaluation of the CFA franc (43% of OCP expenditures are denominated in CFA francs). In converting the nominal costs into 1987 US dollars, it was assumed that the average deflator (used as an indicator of the price level) grows at a rate of 2.5% per year after 1992. This assumption is relaxed since inflation is expected to accelerate in the CFA franc zone countries following the devaluation.[38] The sensitivity of the ERR of the total (labor and land-related) benefits to various rates of inflation was examined. The impact of a one-time increase in the rate of growth of the CFA franc-denominated portion of the average deflator was analyzed.[39] We tested several assumptions, ranging from 15% through 75%, over one, two, and three year periods, respectively. (Actual inflation during the six months immediately following the devaluation was in fact below 35% in most CFA countries.) It was determined that the ERRs were invariant to inflationary developments that could affect the costs of OCP in real terms. The primary reason for the lack of sensitivity is due to discounting. In present value terms, changes in the benefits accruing in the later stages of the project (in this case in the period 1994-96) have a minimal impact on the ERR calculations.

38. One of the reasons for higher expected inflation levels is the increase in the price of imports as a result of the devaluation. An additional impact of the devaluation would be to make agricultural exports internationally more competitive. Projected increases in the growth rate of agricultural output after 1994 do not significantly impact the cost-benefit analysis since any changes in the net benefits accruing in later years of the project are highly discounted due to the long time horizon of OCP.

39. See Table 1. The average deflators were calculated as a weighted average of regional deflators based upon the currency shares of OCP expenditures.

Conclusions

This cost-benefit analysis suggests that land-related benefits are greater than labor-related benefits in net present value (NPV) terms. These results stem from several factors. First, conservative estimates of population size and the low annual population growth rate in rural areas reduce the labor-related benefits. Second, the analysis does not quantify other associated benefits, such as the reduction of other onchocerciasis-related symptoms (debilitation and disability), and the reduction of lost production time by other family members when providing care. Another factor not included in the analysis is that the Program increases the probability of better parental care for children on whom the future productivity of labor will depend. However, despite the conservative nature of the assumptions and the exclusion of non-economic or otherwise non-quantifiable benefits, the program appears to be economically justifiable, based upon labor-related benefits alone.

The standard discount rate used to evaluate World Bank financed projects in the productive sectors (excluding social sector projects such as health and education) is 10%. In other words, the annual rate of return earned with an investment should be about 10% or more in terms of achieving an efficient allocation of Bank resources in the productive sectors. At a 10% discount rate, the NPV for a 39 year project horizon is US$485 million in 1987 US dollars assuming 85% labor participation and land utilization. The corresponding ERR for OCP is 20% under these moderate assumptions—a very respectable rate of return for any project, regardless of sector. The cost of protecting each person in the 11 country OCP area is an estimated US$0.57 per annum in 1987 constant dollars.

It should be noted that using our methodology biases the benefits against projects in low-income countries because the valuation of a productive life is estimated as the per capita income foregone. Similarly, since our estimates rely on measures of per capita income in the rural sector, which are lower than per capita GDP, our methodology also assumes low per capita benefits from saving people from blindness. Therefore, the benefits calculated here should be seen as a conservative, if not lower bound, estimate of the actual magnitude of benefits resulting from OCP. Nevertheless, the analysis presented here generates distinctly positive net present values for OCP. The results of this cost-benefit analysis consistently conclude that the Onchocerciasis Control Program has been and remains a highly productive program in economic terms.

References

Benton, Bruce and Elizabeth Skinner, "Cost-benefits of Onchocerciasis Control," *Acta Leidensia*, Vol. 59/No. 1 and 2, p. 405-411, 1990.

———, "Taming the Lion's Stare," *Bank's World*, Vol. 11/No. 5, May 1992, p. 8-10.

Berg, Elliot, *Some Rural Development and Health Sector Implications of Oncho Control*, World Bank (processed), August, 1984.

Birch, Stephen and Cam Donaldson, "Applications of Cost-benefit Analysis to Health Care: Departures from Welfare Economic Theory," *Journal of Health Economics*, 6:211-225, September 1987.

Brent, Robert, *Project Appraisal for Developing Countries*, New York University Press, 1990.

Drummond, M. F., "Output Measurement for Resource Allocation Decisions in Health Care," *Oxford Review of Economic Policy*, Vol.5, P. 59-74, Spring 1989.

Food and Agriculture Organization of the United Nations (FAO), *FAO Production Yearbook 1990*, FAO, Vol. 44, 1990.

———, *FAO Production Yearbook 1972*, FAO, Vol. 26, 1972.

Gagg, J. van der, William B. Neenan and Theodore Tsukahara, *Economics of Health Care*, Praeger, 1982.

Garrin, Guy, *Economic Evaluation of Health Care in Developing Countries: Theory and Applications*, St. Martin's Press, 1984.

Griffin, Charles C., *Health Care in Asia: A Comparative Study of Cost and Financing*, World Bank, 1992.

———, *User Charges for Health Care in Principle and Practice*, World Bank, 1988.

Hammer, Jeffrey S., "The Economics of Malaria Control", *Research Observer*, Vol.8/No.1, World Bank, 1993.

Hunting Technical Services Limited, *Socio-economic Development Studies in the Onchocerciasis Control Program Area*, Hunting Technical Services Limited, 1988.

Institute for Development Anthropology (IDA), *Land Settlement Review: Settlement Experience and Development Strategies in the Onchocerciasis Control Program Areas of West Africa*, IDA, 1990

Jacoby, Hanan G., *Shadow Wages and Peasant Family Labor Supply: An Econometric Application to the Peruvian Sierra*, Living Standards Measurement Study (LSMS), Working Paper No.73, World Bank, 1990.

Jayne, Thomas S., John C. Day and Harold E. Dregne, *Technology and Agricultural Productivity in the Sahel*, United States Department of Agriculture, 1989.

Joint Program Committee, *Context for the Fourth Financial Phase (1992-1997): Bringing the Program to a Successful Conclusion (JPC 12.10)*, OCP, 1991.

———, *CSA Report on Mechanisms for Promoting Socioeconomic Development in Onchocerciasis Control Zones (JPC 7.8)*, OCP, 1986.

———, *Plan of Operations for the Third Financial Phase (1986-1991) (JPC 6.6)*, OCP, September, 1985.

Kohli, Kedar N., *Economic Analysis of Investment Projects: A Practical Approach*, Hong Kong: Oxford University Press, 1993.

Kuyvenhoven, Arie and L. B. M. Mennes, *Guidelines for Project Appraisal: Introduction to the Principles of Financial, Economic, and Social Cost-benefit Analysis for Developing Countries*, Hague: Government Printing Office, 1985

Lee, Kenneth and Anne Mills, *The Economics of Health in Developing Countries*, Oxford University Press, 1983.

Levi, Yair, *A Land Settlement in West Africa: A Literature Review*, unpublished article.

Little, Ian, Malcolm David and James A. Mirrlees, *Project Appraisal and Planning for Developing Countries*, London: Heinemann Educational Books, 1974.

———, Maurice FitzGerald Scott, *Using Shadow Prices*, London: Heinemann Educational Books, 1976.

Lob-Levyt, Julian, "Compassion, Economics, Politics...What are the Motives behind Health Sector Aid?," *Health Policy and Planning*, 5:82-87, March 1990.

McMillan, Della E., Thomas Painter and Thayer Scudder, *Settlement and Development in the River Blindness Control Zone*, Technical Paper No. 192, World Bank, 1992.

Mills, Anne, *The Economics and Finance of the Health Sector*, Ministry of Health and Management Science for Health, 1984.

———, Lucy Gilson, *Health Economics for Developing Countries: A Survival Kit*, Evaluation and Planning Centre for Health Care, London School of Hygiene and Tropical Medicine, 1988.

Musgrove, Philip, "Is Polio Eradication in the Americas Economically Justified?," *PAHO Bulletin 22(1)*, Washington, D.C.: Pan American Health Organization, 1988.

———, "Cost-Benefit Analysis of a Regional System for Vaccination against Pneumonia, Meningitis Type B, and Typhoid Fever," *Bulletin of PAHO 26(2)*, Pan American Health Organization, 1992.

Noronha, R., *Land Tenure in Sub-Saharan Africa*, ed. by Maunder, A., the Twentieth International Conference of Agricultural Economists in 1988, 1990.

OCP, *Onchocerciasis Control in the Volta River Basin Area*, Onchocerciasis Control Program (OCP), 1973.

———, *Plan of Operations for the Third Financial Phase (1986-1991)*, OCP, September 1985.

Over, Mead A., *Economics for Health Sector Analysis: Concepts and Cases*, World Bank, 1991.

———, *The Macroeconomic Impact of AIDS in Sub-Saharan Africa*, World Bank, 1992.

Pearce, David W., ed., *The MIT Dictionary of Modern Economics 4th Edition*, Cambridge, Massachusetts: The MIT Press, 1994.

Prescott, Nicholas and Jeremy Warford, "Economic Appraisal of the Health Sector," *The Economics of Health in Developing Countries*, ed. by K. Lee and A. Mills, Oxford University Press, 1983.

Prost, A. and Nicholas Prescott, "Cost-effectiveness of Blindness Prevention by the Onchocerciasis Control Program in Upper Volta," *Bulletin of the World Health Organization*, 65(5) 1984, p. 795-802.

Remme, Jan Hendrik Frederik, *The Epidemiology and Control of Onchocerciasis in West Africa*, The Netherlands: Reprocentrum De Heij, 1989.

Savadogo, Kimseyinga, *Analysis of Off-farm Income*, University of Ouagadougou, unpublished article.

Scandizzo, Pasquale L., *Agricultural Growth and Factor Productivity in Developing Countries*, FAO, 1984.

Scott, Maurice FitzGerald, J. D. MacArthur and David M. G. Newbery, *Project Appraisal in Practice: The Little-Mirrlees Method Applied in Kenya*, London: Heinemann Educational Books, 1976.

Takemi Symposium on International Health, *Health, Nutrition, and Economic Crises: Approaches to Policy in the Third World*, Harvard University of Public Health, 1986.

UNDP, *Human Development Report 1994*, New York: Oxford University Press, 1994.

Warner, Kenneth E, 1947 and Bryan R. Luce, *Cost-benefit and Cost-effectiveness Analysis in Health Care: Principles, Practice, and Potential*, Ann Arbor, Michigan, Health Administration Press, 1982.

World Bank, *Social Indicators of Development 1991-92*, Baltimore: Johns Hopkins University Press, 1992.

———, *Agricultural Growth in the Sahel-Performance of the 80s and Long-Term Implications*, Unpublished Article, 1992

Younger, S. and Jean-Baptiste Zongo, "West Africa: The Onchocerciasis Control Program", *Successful Development in Africa*, World Bank, 1989.

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