Economic Benefits of Malaria Control in Ethiopia

Norman Holly
Office of International Health
Department of Health, Education,
and Welfare

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I. INTRODUCTION

In 1955, the World Health Organization (WHO) established among its goals the global eradication of malaria. Their decision was inspired by the eradication achieved in specific temporate regions through deployment of insecticides and drugs available after World War II and by the persuasions of experts dominant in the field of malaria control. It seemed confirmed in the success of several malaria eradication pilot projects in various tropical countries. In Ethiopia, for example, three pilot projects escaped virtually unaffected a 1958 epidemic that brought terrible losses to other parts of the country. By 1960 a campaign was underway throughout malarious regions of the world designed to interrupt transmission by residual spraying of DDT.

The strategy included dividing target countries into a number of attack areas for time-phased resource allocation. Staggering budgets were committed in expectation of long-term benefit accrueing from a brief devastating campaign. Credit financing and grant assistance for a considerable portion of this committment were extended by the Agency for International Development (AID).

It was a risky venture and skepticism was expressed among some malariologists. Nevertheless, it seemed worth attempting partly because of the stakes involved. Malaria is a disease that separates rich countries from poor; and in many poor countries, it was one of the more destructive

diseases. It affected hundreds of millions of people, killing many and debilitating most of the survivors to a low level of work efficiency. It had rendered vast tropical regions unsuitable for economic development (in Ethiopia, for example, those regions below 2,000 metres which for centuries have been the repositories of fertile topsoil washed down periodically from higher altitudes); and thus had deterred additional millions of persons from exploiting their most productive resources. To this extent it affected the welfare of enormous populations and had undoubtedly swayed the course of history. The elimination of this particular disease was regarded as so crucial to human well-being that the temptations was overwhelming to parlay the pilot projects into a massive global strike.

The campaign enjoyed early success. Transmission was interrupted in several countries; but subsequently malaria swept back through many of them, to engulf with additional misery those persons whose natural resistance had diminished in the meantime. In several other countries, the incidence of malaria was reduced but transmission was not interrupted in the areas under attack; so resources could not be reallocated to proximate areas on schedule. Ethiopia was one of those countries unable to interrupt transmission.

Owing to these failures of implementation and subsequent uncertainty regarding the predictability of eventual malaria eradication, several authorities including Gabaldon[1/] and Bruce-Chwatt[2/] urged further analysis of the practical impediments encountered and review of overall strategy.

In 1969 the 22nd World Health Assembly recommended re-examination of the global strategy of malaria eradication, observing inter alia an imperative to broaden the objective from time limited eradication to

eradication of unspecified term involving interim control measures. Accordingly, the Assembly noted a necessity for economic as well as epidemiological justification to antimalaria campaigns for purposes of financial viability and as prerequisite to credit funding.

It was within this context that the U.S. AID Mission to Ethiopia requested an analysis of economic benefit arising out of the malaria eradication effort in that country. The analysis was undertaken during April, 1970, preceeding and augmenting the work of the malaria Strategy Review Team which convened in Addis Ababa during May 1970.

Limitations of Data Compilation

The analysis that follows may be more easily assimilated if viewed in the light of certain factors limiting collection of hard data.

First, the state of the art of health economics analysis is fairly new and has reached a level of sophistication only in developed countries where statistical analysis is relatively precise. In respect of developing countries it must perforce fall back on the more general macro-economic indices. Those customarily employed in estimating health program benefits include contribution of the program to worker productivity increases, changes in wage rates, influence on agricultural development, pre-program disease costs, population growth and migration, changes in land value, improvements in standard of living, changes in foreign investments and in export production costs, increased import of foreign exchange, and similar measures.

Unfortunately, developing countries collect very few statistics from which these indices might be deduced; and to date, no health program promoted in a developing country has established its own economic baseline data from which future benefit calculations might be drawn*. So the investigator is usually left to cope with a few unrelated facts of rather general nature, and with the recollections of persons who might have been involved with the program over its course.

Another difficulty is that of distinguishing benefits that arise out of a particular activity from those attributable to other productive activities. A single endeavor such as malaria control may be a condition necessary to economic development, but it is not a sufficient condition. The same could be said of feeder roads and bridges, dams and irrigation, agricultural extension services, and several other factors. In concert they foster development; but the relative contribution of any one alone is obscure. Furthermore, the contribution of a single factor applied alone is far less than its contribution when applied in concert with others.

Considering these limitations, it was decided to supplement the usual evaluation procedure with case studies of a few specific development projects in Area A (the only area under attack in Ethiopia) to see if a measure could be ascertained of the return from malaria control investment within. For each of the cases selected projections were made of expenditures and returns over the duration of the currently scheduled anti-malaria

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Although baseline studies have been used to demonstrate program effectiveness. cf. Spruyt, Elder, et. al., "Ethiopia's Health Center Program -- It's Impact on Community Health," 5 Ethiopian Medical Journal 1 (July 1967).

program, from which were calculated the net present worth and internal rate of return in respect of anti-malaria investment. The procedure is explained below (p. 20 ff).

Earlier Studies

The literature on economic benefits of malaria eradication (or other public health programs for that matter) is not voluminous.

Two papers in the 1950s, by MacDonald[3/] and Prince[4/] discussed the economic importance of malaria in very general terms.

In 1965 Newman[5/] published a regression analysis of the effect of malaria eradication on population growth in Ceylon and British Guiana. He estimated the increase in post-war population growth attributable to eradication to approximate 60 per cent in Ceylon and 40 per cent in British Guiana. Nevertheless, he felt that eradication should be pressed with "considerable vigor" out of humanitarian reasons and that maximum effort should be applied to economic development for a decade or so following eradication.

Barlow[6/] extended Newman's study in Ceylon with an econometric model quantifying the effect of eradication on population size, labor, capital, and other inputs. He found a short-run positive effect in respect of per capita income, but a long-run negative effect as the demands of larger populations exceeded output (especially social output). The negative outcome might be averted, he suggested, through a combined program of malaria eradication and birth control.

Titmuss and Abel-Smith[7] also attempted to link population growth with malaria eradication in Mauritius.

Newman's estimates of population growth in Ceylon are refuted by Meegama[8] and Frederiksen[9] as biased by inaccurate assumptions. Barlow's model was criticised on presentation to the American Economic Association as understating benefits.[10] The Titmuss/Abel-Smith work is faulted by Frederiksen[11] as improperly grounded and oblivious to inverse correlations between mortality and productivity.

Socio-economic analyses were attempted in several reports of WHO-sponsored malaria strategy review teams during 1967-68. Only one of these (on Thailand) discussed benefits of malaria eradication to any degree, chiefly that associated with increased agricultural cultivation.

At the present time, a household survey is being conducted in eastern Paraguay by Dr. Gladys Conley of the Pan American Health Organization to determine social consequences of the current malaria epidemic there. Some of the information being collected would be useful to an economic study.

II. GENERAL INDICES OF ECONOMIC BENEFIT

Roughly one-fourth of Ethiopia, largely the central regions, reaches heights of 2,000 metres or more. Transmission of the malaria parasite normally does not occur in these higher altitudes.

For centuries much of the population avoided the malarious lowlands, accepting in preference the poorer soils, crowded conditions and under-employment characteristic of the mountains. Some farming and grazing was pursued below 2,000 metres by daily or seasonal migrants from the hills, and by inhabitants able to tolerate chronic infection. Consequently, agricultural productivity remained marginal, and very little venture capital was invested in commercial farming.

Malaria control made the lowlands habitable and encouraged redeployment of labor and capital into these more fertile regions. As new land was brought into cultivation, it increased in value; and as investment stimulated commercial farming the marginal productivity of labor rose. This led to higher wages and greater disposable income; better marketing; possibly cheaper exports and greater export revenues; to more dynamic economic practices and to changed attitudes toward development. These are basic economic indices since 95 per cent of the Ethiopian gross domestic product (GDP) is agricultural.

Effect of malaria Morbidity on Agricultural GDP

One issue still unresolved among development economists is whether social sector investment enhances or deters economic viability in developing

countries. According to the predominant theory viability is attainable only as economic growth outstrips population growth. In stagnant or low-level equilibrium societies this requires massive concentration of resources to construct a productive infrastructure with sufficient thrust to overcome development inertia. Health sector investment is assigned low priority or sometimes regarded as resource misallocation because it stimulates growth of an abundant factor (labor) at the expense of a scarce factor (capital), and because the propensity of labor to save for further investment is thought to be negligible. Therefore, multilateral investment organizations have generally avoided funding health programs other than self-liquidating or infrastructure investments such as sewers and water supply.

Both tenets of this argument seem questionable; namely, that population growth is inversely related to economic growth, and that there is little marginal propensity to save among farmers. It has been shown by some economists -- such as Kuznets, Hagen and Malenbaum -- that economic growth sometimes accompanies population growth, and that a crucial ingredient appears to be endogenous attitudes as much as exogenous capital. It has also been demonstrated in several "low level equilibrium" countries that propensity to save is stimulated when the agents of growth are brought within reach of the farmer (such as high-yield strains, extension services and credit, land reform, co-operative marketing, technical education, etc.)

There is even room to doubt that infrastructure investment in stagnant economies encourages social progress to any significant degree absent the changes which are known to make human investment worthwhile. From this point of view it matters a great deal as to the incentives by which the farmer is motivated, and his ability to exploit them fully.

It is here that the eradication of debilitating communicable diseases assumes significance. A farmer who tolerates periodic reinfection of malaria is nevertheless chronically sick. He works, but not very well. His goal is to achieve what has been done before; he may be physically incapable of adopting more intensive cultivation and multiple cropping. Worse yet, he is probably mentally resistant to learning advanced methods and to undertaking the complex activity characteristic of enterprise, and is likely to remain a subsistence farmer of low expectation. Removing the impairment of malaria therefore accomplishes much more than the restoration of human productivity. It also makes people more receptive to innovation and education, more likely to accumulate saving or undertake deficit financing for investment, more capable of progressing to a higher standard of living.

Malaria has a greater deleterious impact on GDP than many other communicable diseases because its peaks of transmission coincide with planting and harvest seasons when all hands are needed, however temporarily. A most dramatic account of the 1958 epidemic in Ethiopia tells of attack rates reaching 50 to 75 per cent of village populations, of crops laying unattended to be ravaged by animals and of consequent malnutrition added to infirmity and death.[12/] But even in periods of normal morbidity the impact of malaria on work efficiency is readily apparent.[13/]

We tried to compile an estimate of this impact from health officers and plantation managers in commercial farms throughout Ethiopia. The concensus of opinion is that healthy persons outproduce those suffering malaria by 50 per cent. This estimate coincides with an earlier estimate by Smith[14/] in the Philippines.

All of the foregoing refers to untrained tillers of the soil. Malaria gains additional leverage when it hits commercial farms and development projects where some workers have high marginal productivity. Several project managers pointed out that production might be seriously set back if a few key personnel -- such as irrigation controllers and team managers -- were struck simultaneously. Such a prospect was faced by the World Bank in specifying malaria eradication activity as prerequisite to its recent financing of the Wolamo-Sodo agricultural development project in the Rift Valley. Similar stipulation will likely become characteristic of future development financing in malarious regions. Project managers in Area A (which have had eight spray rounds to date) fairly uniformly agree that the projects would be very costly or impossible without malaria control despite the existence of surplus labor nearby.

Migration

So long as they were crowded into the hills, large numbers of farmers remained unemployed and at best managed to subsist. When the risk of malaria was reduced they began to migrate toward the bottomlands to work small-holdings, join commerical farms or undertake mercantile activity in settlements of other newcomers. Extensive sections of Ethiopia have been settled in this fashion since the anti-malaria campaign began, enhancing the marginal productivity of both the migrants and the highland farmers who stayed on.

No data exist to define the extent of this migration. Resettlement from highland to lowland, from overpopulated to underpopulated regions, from

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nomad to farm worker, is reckoned in the hundreds of thousands. This will continue into the future to the extent that Ethiopia is able to absorb additional investment in agricultural development.

Vast areas previously vacant are now fully farmed and sizeable towns thrive where previously there were none. From Robi to Kembolcha, along the western escarpment of the Awash valley, there are several new towns and few remaining tracts of uncultivated land. Ten years ago, this was empty country, hospitable only to a few farmers sturdy enough to walk daily from the surrounding mountains. Further north into the Alamata Plain, particularly around Kobo-Chercher, and in the Dembia Plain north of Bahar Dar there has been a notable change from acacia pasture land to intensive fixed-land cropping including some 285,000 acres. The city of Bahar Dar itself is largely a product of malaria control. Western Tigre province beyond the main road, formerly remote and uninhabited, now supports a population of 10,000 persons. East of Kembolcha, around Tendaho, some 250,000 acres of previously nomadic brushland is now being planned for cultivation. Nearly all of the development projects running the length of the Awash River depend on continued anti-malaria activity; together they have resettled tens of thousands of persons. (Many of these settlers were formerly nomadic tribesmen). Nazareth, in the upper Awash valley, has blossomed from a rural town into a resort attraction. Nearby Wonji was formerly a malarious marsh serving 30 to 40 graziers; now it has a population of 30,000 and a sugar plantation. The HVA Estate at Metahara, in the middle Awash valley, was founded with the commencement of spraying; it now contains 5,000 persons and will stabilize around 7,500 in the near future. In the Rift valley south of Addis Ababa malaria control has turned Awassa into a prosperous resort.

This is the tenor of the population redistribution and improved land use deriving from malaria control. Although difficult to quantify, it is considerable; and it means better resource utilization, increased production and new receptivity to progress.

Improved resource utilization should be accompanied by increased productivity and higher wages. Wage rate differentials were available from several development projects indicating a doubling of productivity and of wages for both skilled and unskilled labor over the past decade. However, it was not possible to distinguish those differentials attributable to malaria control from those arising out of the mechanization that has occurred simultaneously in some projects.

Land Value Differentials

Increases in land sale price, land rentals, and real estate taxes can indicate the income potential envisioned by entrepreneurs resulting from ecological improvements such as malaria control.

Regrettably no accurate data were available in regard to these indices since an economic market for land does not exist in most of Ethiopia. The northern cantle is largely tied into tribal tenure arrangements which preclude market transactions. Land in the south, in particular all of the land available for development, resides in the Government and is generally reserved for Imperial grants.

Development land is usually leased to concessionnaires for arbitrary fees that do not reflect market value.

Land taxes on commercial ventures may be artificially set to promote or subsidize development, and they are often uncollectable from cash crop farmers and minor entrepreneurs.

Private Income Differentials

Some lowland portions of Area A -- such as the Robi sector and western Tigre -- have been settled spontaneously by subsistence farmers in the wake of the anti-malaria campaign. They offered the attractions of superior fertility, larger individual landholdings, greater cash crop income, and hence improved nutrition and higher living standards. Improvements in living standards can be indicated by income differentials for commodities which a farm family is able to market.

Quantitative data on cash crop income were available for only one region, Shira Awraja in western Tigre Province. This was formerly grazing land inhabited by roughly 500 nomads. The 10,000 farmers and their families who have settled the awraja over the past decade have brought 12,000 to 160,000 hectares into cultivation. They produce 80,000 quintals of sorghum and sesame annually, with a current market value of Eth. $ 2 million. Cash crop income has increased from about Eth. $ 60 per family in 1960 (Eth. $ 100 in good years) to about Eth.$800 in 1970, reducible by inflation averaging 2 to 3 per cent per annum. Part of this income is accounted for by substantial price increases in the dominant crops; but all of it is made possible through the confluence of two activities, the anti-malaria campaign and the construction of feeder roads.

Personal observation and discussions with local inhabitants suggest comparable improvement in living standards resulting from malaria control in the Dembia Plain extending from Shira Awraja to Gondar, along the escarpment from Robi to Kembolcha, and in the valleys between Woldiya and Makele. Except for the early pilot projects in the Dembia Plain and Kobo-Chercher areas, these were unsettled lands ten years ago.

External Payments Contribution

Commercial farms in sectors of Area A previously uninhabitable because of malaria account for a steadily increasing share of commodity exports. During 1969 exports from these farms captured about Eth. $ 36.3 million in foreign exchange.

Commodity	Estimated Value of exports from Area A (Eth. $ 000)
Hides and skins	10,400
Fruits and vegetables	10,400
Coffee	7,650
Oilseed	4,200
Meat	2,240
Sugar	1,100
Live Animals	300
	36,290

Effect on Population Growth

The 1958 malaria epidemic in Ethiopia affected three million persons or more and caused some 150,000 untimely deaths. The 1962 epidemic involved about a half a million persons and resulted in 15,000 to 20,000 untimely deaths. In contrast, no epidemic was evident in the malaria eradication projects concurrently underway at Kobo-Chercher, Akaki, Debra Zeit and Moggio.[12/]

Between 1962 and 1966 an average of 8,000 to 10,000 deaths annually throughout Ethiopia have been attributed to malaria. Following commencement of the malaria eradication program in 1966 the recorded malaria deaths dropped to a level of about 1,000 annually. Area A accounted for most of this reduction in association with independent eradication campaigns in several communities and projects elsewhere.

Disproportionately more malaria deaths occurred among children and young adults than in the elderly population. As might be expected, the subsequent reduction of malaria appears to have been accompanied by greater average life expectancy and an increase in the number of children per mother. This effect has been most notable in development projects where population distributions tend to be unrepresentative of the country at large in emphasizing younger families. Kobo-Chercher, for example, has experienced a post-settlement increase in birth rate estimated at 30 per cent. (The socio-economic impact of such growth may be partially offset by increased productivity among the predominantly working age populations of Kobo-Chercher as well as other development projects.)

The net demographic effect of anti-malaria campaigns is obscure in two aspects: primarily in regard to the uncertain relationship between mass disease control programs generally and population growth, and also in reference to the unresolved debate over concepts and methods employed in correlating malaria and population.

Recent literature suggests that the contribution of mass disease control programs to population growth may have been overrated. Greater causative significance is inreasingly given socio-economic factors like income, nutrition, housing, transportation, water supply, and so on.[15] It is further suggested that a substantial reduction in mortality "is a precursor of, and perhaps a prerequisite for, a reduction in fertility in the course of demographic transition."[16]

All three major studies involving correlation between malaria eradication programs and population growth remain controversial and are alleged to be based on improper assumptions (cf. p. 6 supra.) In paticular, Frederiksen[17] shows that postulations claiming such correlation are not confirmed by events, but that contrarily in Ceylon at least an inverse correlation is evident between nutrient consumption and mortality rates.

It would appear from the overall tone of published discussion on the subject that the impact of malaria control on population growth has not been established, nor has it been distinguished from other influences associated with income and living standards. Given the current state-of-the-art in health economics and the lack of data base in Ethiopia, it seems doubtful that a significant contribution can be made to existing literature short of a trenchant survey directed to this topic.

The scant data available in Ethiopia indicate only that an increase in birth rate has occurred, especially in lowland development projects, as the result of improvement in well-being in which reduction of malaria, improvement in nutrition, greater disposable income, easier transportation and other factors are comingled.

III. DETERMINANTS OF MALARIA CONTROL INVESTMENT: CASE STUDIES

According to the revised strategy recommended for malaria control in Ethiopia,[18/] agricultural development projects should receive priority for resource allocation as the program expands from Area A. We should therefore ascertain whether or not the marginal gain can be expected to exceed marginal outlay for malaria control in a micro-economic situation. This determination is possible if time and risk factors associated with investment are taken into account.

Several techniques are available for calculating the marginal efficiency of capital investment generally. Two of these techniques, expressing net present worth and internal rate of return, are adaptable to allocations for malaria control as an investment sector associated with a development project. They have been applied to five agricultural development projects in the Awash valley and to a holiday resort in the lower Rift valley. The results are shown in Table 1.

Net Present Worth of Future Returns

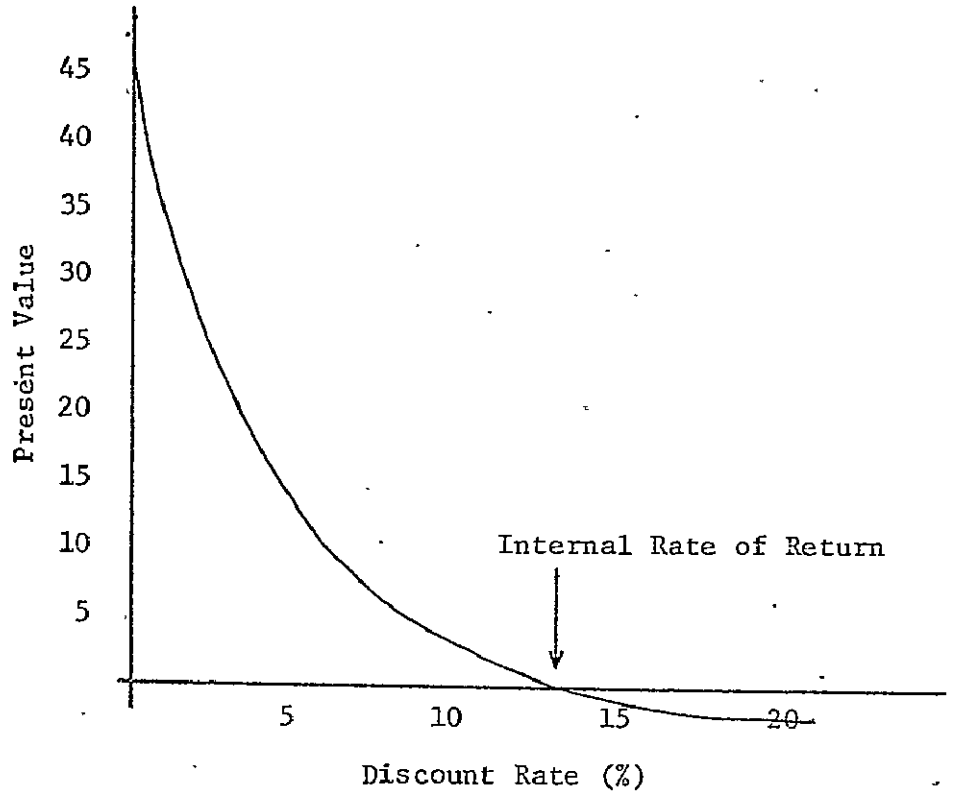
Net present worth is calculated by projecting estimated income and expenditures over the anticipated life of an investment, deriving algebraically the net cash flows generated in each year, and discounting them back to the present by means of factors associated with the estimated opportunity cost of capital. The net benefits thus discounted are then added algebraically to arrive at net present worth. Any investment yielding a net present worth

that exceeds the cost of the investment is advantageous. (For Ethiopia the opportunity cost of capital was reckoned at 10 per cent).

Difficulties are encountered when the proposed investment is taken to be a development sector, such as malaria control. Since it is impossible to distinguish the contribution of anti-malaria expenditure from the contribution of other investment sectors, the net present worth of the anti-malaria investment must be regarded as directly dependent upon the net present worth of total project investment. This may be inaccurate in a real situation; some possible errors of this approach are discussed below (cf. p. 22 infra.)

Internal Rate of Return

The internal rate of return is the rate of interest that equates discounted returns and discounted costs; or, restated, which reduces to zero a series of net cash flows over the assumed life of a project. Graphically, if the curve of present values of net returns is plotted against an axis of ordinates of present values and an axis of abscissas of discount rates, the internal rate of return is shown by the intersection between the curve and the axis of abscissas.



In mathematical terms the internal rate of return is the solution value of r in the equation

$$\sum_{t=0}^{t=n} \frac{E_t - C_t}{(1 + r)^t} = 0$$

where E is the revenue differential, C is the social cost, and n represents anticipated investment life. When converted for the factor of malaria eradication (assuming the original timetable), n would equal 15. For purposes of the present report n for malaria control is linked to the development project, and is varied somewhat according to availability of data -- an unavoidable procedure requiring some subjective judgements and introducing some error.

An investment showing an internal rate of return higher than the opportunity cost of capital (10 per cent in Ethiopia) is worthwhile in absolute terms. In relative terms, investments should be favored in order of highest internal rate of return until such time as it becomes reduced to the level of the next highest, and so on. This procedure outweighs other criteria (for example, employment maximization) as a stimulus to economic growth.

TABLE 1

NET PRESENT WORTH AND INTERNAL RATE OF RETURN OF MALARIC CONTROL INVESTMENT IN SIX ETHIOPIAN DEVELOPMENT PROJECTS

Project	Approx. Malaria Control Investment (Eth. $ 000)	Net Present Worth @10% opportunity cost (Eth. $ 000)	Internal Rate of Return (Per Cent)
Nura Era - Aware Melka	8	6.85	46
Melka Sedi - Amibara	3	2.58	20
Kesem - Kebena	2	6.20	> 100
Assayita	30	111.60	> 100
Tibila	5	-1.08	< 10
Bellevue du Lac Resort	0.2	2.96	> 100

Notes on the Validity of these Calculations

There has been a tendency in past evaluations to attribute to a single development factor all of the net benefit realized in a project it makes possible, and also to neglect netting out intermediate inputs transferred from other uses. This has resulted in overstatement of benefit to the factor being evaluated, grossly on occasion. An attempt was made here to bypass the former dilemma by prorating development project net benefit among all input factors before determining net present worth and internal rate of return for the malaria control factor. The latter dilemma could not be avoided because of total lack of information regarding alternate uses of labor and capital in Ethiopia. (Most of the agricultural growth enabled through malaria control employes labor whose alternate use is felt to be negligible.) The transfer cost of capital cannot be determined, although it is likely to be low relative to productivity when employed in formerly malarious areas.

Prorating development project net benefit has the effect of linking internal rate of return for malaria control investment to internal rate of return for the entire enterprise. Consequently a smaller malaria control benefit may be indicated in projects where considerable capital expenditure is devoted to measures that reduce malaria incidence, and a larger net benefit where higher incidence is incurred through employer negligence. This possibility should be considered in reviewing the calculations above.

Furthermore, the benefits shown may be overstated to the extent of hidden social costs (communication networks, dams, roads) and productivity increases arising out of improved agricultural methods. They may be

understated to the extent of stimulated secondary development, improved human and livestock nutrition, reduction in contractor costs for social investments as a result of reduced malaria, and the degree to which development otherwise enabled through malaria control is constrained by drags on productivity (such as lack of credit, inefficient marketing methods, poor water distribution, etc.).

IV. COST OF CONTROLLING MALARIA

Under the Present Program

That protion of Area A which is sprayed comprises 470,000 km^2 and a population of 4,763,157.

During the three years FY 1967 through FY 1969 the average total cost of residual spraying for vector control was Eth. $ 2.02 (U.S. $ 0.81) per person or Eth. $ 20.45 (U.S. $ 8.18) per square kilometer. The population average rather than the area average is used for purposes of projection.

The bulk cost of chloroquine is Eth. $10.18 (U.S. $ 4.07) per 1,000 tablets, enough to protect more than 9 persons annually at a steady rate of two tablets weekly. The maximum cost of prophylaxis is therefore Eth. $ 1.06 (U.S. $ 0.43) per patient year. This does not include distribution and overhead, which varies considerably according to circumstances. (Chloroquine prophalaxis is generally regarded as supplementary to spraying when feasible; spraying is preferred as a control measure for greater reliability).

As recommended in the SRT Report [18/]

The 1970 malaria Strategy Review Team for Ethiopia presumed continuance of the current funding level on the basis of estimated malaria control input requirements, debt capacity of the Imperial Ethiopian Government and conversations with the IEG Deputy Minister of Finance. The Team then recommended strategic modifications designed to trade off program economies

for expanded operations and research without jeopardizing the degree of control already achieved in Area A. These modifications would:

1. Reduce present expenditure by:	Anticipated financial impact:
a. Integrating the Malaria Eradication Service and basic (Provincial) health services.	Improved cost effectiveness undetermined but reckoned at 1/3 present expenditure for activities and operations integrated.
b. Reducing spraying to one round annually where transmission is "minimal" or absent during dry season.	Contingent on MES delineation of appropriate sectors and definition of "minimal".
c. Continuing components of surveillance other than case detection only in "limited" areas.	Contingent on MES delineation of "limited" areas.
2. Assume new obligations for:	
a. Conducting "intensive antimalaria activities" in development projects beyond Area A.	Few development projects currently planned or active outside Area A; depends largely on plans in future.
b. Adding 2 surveillance agents to each health station.	Approx. Eth. $30,000 now to Eth. $240,000 as planned health stations are established.
c. Establishing a transmission research site.	Expense unknown but should be relatively small.
d. Training and orienting MES staff in surveillance and control for programs integrated; providing adequate statistical assistance; training microscopists.	Relatively small addition to current training cost.
e. Collecting baseline data for economic evaluation in new attack sectors.	Salaries for 2 or 3 statisticians for Area B.

Continuance of current funding levels for categorical disease programs to be integrated with malaria eradication was also presumed. Considering current projections for agricultural development it seems likely that the revised strategy for Area A will release sufficient funds and material to commence attack in development projects outside Area A within the scheduled budget as need arises.

It should be recognized that integration for all practical purposes implies absorbtion of existing basic health services by the MES in veiw of the preponderance of MES manpower, resources and logistics; and therefore, it may cause a shift in future allocation of health service resources favoring regions lying below 2,000 metres altitude.

V. OTHER SOCIO-ECONOMIC CONSIDERATIONS

The economic benefits described above are indicative of the potential return from continued investment in malaria control assuming proper management of the resources it makes accessible. At present this potential is attenuated by customs tending to counteract effective control (or even facilitate parasite transmission) and by usage serving to reduce the value of the released resources. The practices described below are judged to diminish justification for continued investment until corrected.

Induced Malaria Hazards in Development Projects

Inattention on the part of development concessionaires and lack of Government regulation hinder malaria control and cause considerable waste of Malaria Eradication Service expenditures.

Agricultural concessionaires realize immense returns from their ventures, ranging from 30 per cent to well over 100 per cent per annum of total capitalization.

Most concessionaires contribute nothing toward malaria control, regarding it to be the sole responsibility of the Malaria Eradication Service by virtue of taxation. They indulge in practices which promote vector breeding such as haphazard construction and poor management of irrigation canals, improper disposal of waste water and lack of elementary sanitation. (Poorly controlled irrigation has contributed to two recent malaria epidemics at the Nura-Era and Abadir farms). They attract large

numbers of non-immune and infected migrant laborers to these vector reservoirs, but employ no screening procedures. According to one report,[19]

> Experience has shown that the farm staff are not interested in anti-malaria measures ... until the inevitable epidemic occurs. These epidemics not only affect the farm areas and their immediate vicinities, but the dispersion of seasonal labor leads to a wide dissemination of malaria throughout the neighboring provinces, jeopardizing the progress that the Malaria Eradication Service has made.

On the other hand, most concessionaires rely on MES control activities to provide a surplus labor pool from which unskilled persons are hired as day-laborers at Eth. $1.00 to Eth. $ 1.25. No housing, sanitation or health facility is provided. Workers taking sick are replaced from the pool and left to care for themselves.

In that region of the Middle Awash experiencing most rapid development (Melka Sadi - Melka Warer - Amibara) there is only one health station manned by a dresser, with minimal stocks and facilities. Farm settlement health facilities are limited to aspirin and chloroquine; but chloroquine is in such short supply that it is often black marketed at several times cost even among workers who normally resist prophalaxis. (Black markets in chloroquine are common elsewhere in Ethiopia; in Arba Minch it is sold privately for Eth. $ 3 to Eth. $ 5 per patient year, against a wholesale cost of Eth. $1.06).

In 1969 a WHO advisory committee concluded that with continued absence of early health consultation and preventive measures, "the entire (Awash) river basin is likely to be so overrun with parasitic and other environmental diseases that the development of the valley would be an expensive proposition of very questionable feasibility."[20]

Of all the agricultural projects visited in malarious areas only the HVA Estates at Wonji and Metahara appear to have invested substantially in the control of malaria (as well as other communicable diseases). The effect of development policy on health may be seen in the contrast between HVA Estates and other Awash Valley projects lying only a few kilometers distant.

	HVA Estates	Nearby Developments
Workforce:	High percentage permanent	High percentage migrant
Migrant housing:	Sprayed concrete	Mud plaster tukuls
Sanitation:	Potable water; septic tanks complete next year	None
Sick care:	Free to workers; professional staff; preventive emphasis	None (except Public Health dresser)
Health facility:	Two hospitals	None
Pharmaceuticals:	Adequate and gratis	Scarce; incomplete prophalaxis
Malaria caseload:	Estimated at 2% to 4% from hospital records; low on day visited	Estimated at 30% recent sample showed 25%; high on day visited

Several witnesses before the Strategy Review Team recommended legislation compelling developers to participate in or underwrite malaria control activity in their concessions. Legislation exists[21/] granting the Minister of Public Health authority to enforce against the occupant of any premises specific measures in aid of malaria eradication. However, some witnesses doubted that the authority was adequate; and in any event, it has never been invoked.

The World Health Organization (EMRO) have recommended strict enforcement of anti-malaria activity in the Awash Valley[22/] including:

> Full responsibility upon the Awash Valley Authority for prevention and control of malaria until assumed by the Ministry of Public Health.
>
> Clauses in concessionaire contracts requiring anti-mosquito measures on surface waterworks including de-weeding, water level management and flushing of canals, all under MES supervision; approval by MES of all dams, diversions, irrigation and other surface waterworks; improved health facilities, complete co-operation with MES malaria control activity and prompt treatment of malaria cases among workers (outside the valley if necessary).
>
> Screening of all employees and applicants for employment, and successful treatment of all malarious applicants prior to employment.
>
> Recruitment of seasonal labor from malaria-free areas.

The Awash Valley Authority support these recommendations.

It is felt that such regulations can be effective only through specific legislation including the sanction of lease termination for unsatisfactory compliance. In addition standards for sanitation and worker welfare should be established for control of communicable disease which are applicable to all development projects.

Possible Net Economic Detriment through Malaria Control

The major justification advanced for the anti-malaria campaign, in addition to humanitarian objectives, was the bringing of new land into cultivation. But it may equally accelerate present trends that bring new land into destruction by permitting uncontrolled development.

The land available for settlement comprises a unique national asset comprising more thatn 500,000 km^2. The traditional and principal disposition of this land has been Imperial grants, formalized through a series of Land Grant Orders dating from the end of the Italian occupation. At least 40,000 km^2 have already been granted in this fashion (but only sparingly to landless Ethiopians). Orders currently being implemented entitle all serving members of the armed forces, civil service, body guard and police to a freehold of 40 hectares. There are also special grants to patriots, honored citizens and others, often of considerable size, at the discretion of His Imperial Majesty. Development is not a condition of freehold title, and the majority of recipients do not have the experience or desire to work their grants into production.

Most of the grant land being farmed is worked by tenants, sharecroppers, lease-graziers and concessionaires who often operate under retrogressive landlord-tenant relationship and frequently cultivate in destructive fashion. Concessions and leaseholds especially generate incentive to maximize short term gain and to ignore soil conservation. As a result land is cleared to the ultimate in country already characterized by want of trees, plowed vertically on slopes and to edges of ravines, depleted of humus and devoid of buffer strips and crop rotation. Subsistence farmers too cultivate and graze excessively and perpetuate depletion through land tenure traditions.*

---

*Reversing depletion among subsistence farmers may be argued to be more important than among concessionaires since any overall agricultural growth rate of, say, 3 per cent could be achieved by increasing output by 10 per cent in the subsistence sector as against a 25 per cent increase required of the commercial sector.

There is vast evidence of sheet erosion and hardpan in all agricultural regions, and large areas are irreversibly destroyed by gullies reaching down to bedrock. Once started these gullies can cut at the rate of five to ten metres a year, as in the Debre Berhan - Debre Sina section of Arussi province, in the valleys from Asella to Sagure, in western Tigre and elsewhere.

The topsoil of Ethiopia is washing down the Nile and silting the savannah where the Awash terminates. In another decade, there will be five families to today's four (at an estimated 2.2 per cent population growth); but many awrajas will hold less cultivable land. Lacking soil conservation, the effect of malaria control may be to hasten hard core poverty. It is felt that the Ministry of Public Health should initiate a dynamic program of inter-Ministry coordination for controlled economic development in regions under malaria control activity in order to avert this impending and irreversible disaster.

During 1969 the Ministry of Land Reform were urged to adopt a policy of planned, self-contained, owner-occupied settlement; range improvement and cooperative farming; careful selection of settlers; prohibition against subletting and sanction of expulsion; and board control through a proposed Central Agricultural Project Development Authority.[23/] No action has been taken by this Ministry as yet.

It is in the interest of the Malaria Eradication Service and its funding authorities to press for immediate implementation of planned and well administered agricultural settlement and development. Without it, the funds and energy devoted to malaria control may instead subsidize more rapid depletion of Ethiopia's major economic resource.

VI. ADDENDA

Need for Baseline Studies

Interviews were held with His Excellency, Ato Habtu Eshete, Director, Central Statistical Office, and Ato Matmewos Tegueneh, Director of Statistics in the Ministry of Agriculture. These interviews and exhaustive inquiries into all other data sources demonstrate the almost total absence of data which might be useful for measuring the economic impact of anti-malaria activity. Except in respect of the commercial farm case studies, the few data available were estimates drawn largely from memory and cannot be described as reliable.

Baseline data collection for future economic evaluation is not now contemplated by any official body. Provision should be made for collection if another evaluation is contemplated and if greater accuracy is desired.

There are two areas of Ethiopia where accurate and useful baseline information might be found. In view of the present MES schedule there are probably the only areas that will yield reliable data within the present decade.

The Wolamo Project is located near the town of Sodo in the Rift Valley, south of Addis Ababa. It involves an agricultural development scheme funded by the World Bank and a resettlement scheme. A school and health center exist, and provision is made for land planning, soil conservation, roads, extension services, central marketing and agricultural credit. Settlement and cropping of the lowland savannah, as well as the type and value of produce, depend on effective malaria control or eradication. Spraying

of DDT will commence within the next two or three months; therefore baseline survey is of immediate importance.

Area B, lying west from Addis Ababa toward the Sudan, includes some of the richest soil in the country. It is the source of most of Ethiopia's coffee and tea production, and has excellent potential for all of the more valuable crops. Realization of this potential depends largely on anti-malaria activity and feeder road construction. MES reconnaissance has been completed and the first round of spraying may commence within a year. This is the only large area available for baseline study within the forseeable future.

On recommendation of the United States Ambassador approaches were made to the MES and the Peace Corps Ethiopia office of commence baseline data collection, but both were unreceptive. Additional approaches might be made to the World Bank and other international financing institutions in regard to specific development projects like the Wolamo Agricultural Development Unit.

Sample Calculations of Net Present Worth and Internal Rate of Return (Vide § IV)

See following pages.

NURA ERA -- AWARA MELKA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	Incremental Gross Revenue	Capital Investment	Current Operating Costs	MES Cost of Malaria Eradication	Total Net Benefit
1966				-	-
1967	1494	841	1050	8	-405
1968	1992	281	1400	8	303
1969	2900	1878	2136	8	-1122
1970	2960	500	2186	8	266
1971	3035	90	2241	8	696
1972	3035	--	2241	8	786
1973	3035	--	2241	8	786
1974	3035	--	2241	8	786
1975	3035	--	2241	8	786
1976	3035	1162	2241	8	-376
1977	3035	920	2241	8	-134
1978	3035	500	2241	8	286
1979	3035	--	2241	8	786
1980	3035	--	2241	8	786

NURA ERA -- AWARA MELKA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	ME Net * Benefit	PWF at 10%	Net Present Worth at 10%
1966			
1967	-1.71	.909	-1.55
1968	1.44	.826	1.19
1969	-2.23	.751	-1.67
1970	0.79	.683	0.54
1971	2.38	.620	1.48
1972	2.80	.564	1.58
1973	2.80	.513	1.44
1974	2.80	.466	1.30
1975	2.80	.424	1.19
1976	-0.88	.385	-0.34
1977	-0.34	.350	-0.12
1978	0.83	.318	0.26
1979	2.80	.289	0.81
1980	2.80	.263	0.74
			6.85

* Pro rata portion of total net benefit distributed over investment costs.

NURA ERA -- AWARA MELKA

INTERNAL RATE OF RETURN CALCULATION

Year	ME Net* Benefit	PWF at 45%	Net Present Worth at 45%	PWF at 50%	Net Present Worth at 50%
1966	-	-	-	-	-
1967	-1.71	.689	-1.18	.666	-1.14
1968	1.44	.475	0.68	.444	0.64
1969	-2.23	.328	-0.73	.296	-0.66
1970	0.79	.226	0.18	.197	0.16
1971	2.38	.156	0.37	.131	0.31
1972	2.80	.107	0.30	.087	0.24
1973	2.80	.074	0.21	.058	0.16
1974	2.80	.051	0.14	.039	0.11
1975	2.80	.035	0.10	.026	0.07
1976	-0.88	.024	-0.02	.017	-0.01
			+0.05		-0.12

Internal rate of return (interpolated) = $45\% + 5\% \left(\frac{5}{5 + 12}\right)$

$= 46\%$

* Pro rata portion of total net benefit distributed over investment costs.

MELKA SEDI -- AMIBARA

NET BENEFIT CALCULATION (Eth. $ Thoúsand)

Year	Incremental Gross Revenue	Capital Investment	Current Operating Costs	MES Cost of Malaria Eradication	Total Net Benefit
1966					
1967					
1968	210	630	150	3	-573
1969	405	580	303	3	-481
1970	702	238	507	3	- 46
1971	1474	455	897	3	119
1972	1474	--	897	3	574
1973	1474	--	897	3	574
1974	1474	--	897	3	574
1975	1474	--	897	3	574
1976	1474	600	897	3	- 26
1977	1474	475	897	3	99
1978	1474	280	897	3	294
1979	1474	--	897	3	574
1980	1474	--	897	3	574

MELKA SEDI -- AMIBARA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	ME Net* Benefit	PWF at 10 PC	Net Present Worth at 10 PC
1966			
1967			
1968	-2.20	.909	-2.00
1969	-1.63	.826	-1.35
1970	0.18	.751	0.14
1971	0.26	.683	0.18
1972	1.91	.620	1.18
1973	1.91	.564	1.08
1974	1.91	.513	0.98
1975	1.91	.466	0.89
1976	-0.05	.424	-0.02
1977	0.22	.385	0.08
1978	0.75	.350	0.26
1979	1.91	.318	0.61
1980	1.91	.289	0.55
			2.58

*Pro rata portion of total net benefit distributed over investment costs.

MELKA SEDI -- AMIBARA

INTERNAL RATE OF RETURN CALCULATION

Year	ME Net* Benefit	PWF at 19 PC	Net Present Worth at 19 PC	PWF at 20 PC	Net Present Worth at 20 PC
1966					
1967					
1968	-2.92	.840	-2.45	.833	-2.43
1969	-2.17	.706	-1.53	.694	-1.51
1970	-0.25	.593	-0.15	.578	-0.14
1971	0.35	.498	0.17	.482	0.17
1972	2.55	.419	1.07	.401	1.02
1973	2.55	.352	0.90	.334	0.85
1974	2.55	.295	0.75	.279	0.71
1975	2.55	.248	0.63	.232	0.59
1976	-0.07	.208	-0.01	.193	-0.01
1977	0.29	.175	0.05	.161	0.05
1978	1.00	.147	0.15	.134	0.13
1979	2.55	.124	0.32	.112	0.28
1980	2.55	.104	0.27	.093	0.24
			0.17		-0.06

Internal rate of return (interpolated) = $19\% + 1\% \left(\frac{17}{17+6}\right)$

$= 19.7\%$

* Pro rata portion of total net benefit distributed over investment costs.

KESEM - KEBENA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	Incremental Gross Revenue	Capital Investment	Current Operating Costs	Cost of Malaria Eradication	Total Net Benefit
1966					
1967	292	252	116	2	- 78
1968	378	48	168	2	160
1969	403	160	224	2	17
1970	489	56	276	2	155
1971	575	48	328	2	199
1972	661	48	380	2	231
1973	747	48	432	2	265
1974	833	48	484	2	309
1975	919	48	536	2	333
1976	950	48	555	2	345
1977	950	48	555	2	345
1978	950	48	555	2	345
1979	950	48	555	2	345
1980	950	48	555	2	345

KESEM -- KEBENA

INTERNAL RATE OF RETURN CALCULATION

Year	ME Net* Benefit	PWF at 10 PC	Net Present Worth at 10 PC	PWF at 100 PC	Net Present Worth at 100 PC
1966					
1967	-0.42	.909	-0.38	.500	-0.21
1968	1.47	.826	1.21	.250	0.37
1969	0.09	.751	0.07	.125	0.01
1970	0.93	.683	0.64	.062	0.06
1971	1.05	.620	0.65	.031	0.03
1972	1.07	.564	0.60	.015	0.02
1973	1.10	.513	0.56	.007	0.01
1974	1.16	.466	0.54	.003	
1975	1.14	.424	0.48	.001	
1976	1.14	.385	0.44		
1977	1.14	.350	0.40		
1978	1.14	.318	0.36		
1979	1.14	.289	0.33		
1980	1.14	.263	0.30		
			6.20		+0.29

Internal rate of return = >100%

*Pro rata portion of total net benefit distributed over investment costs.

ASSAYITA (SMALL PRODUCERS)

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	Incremental Gross Revenue	Capital Investment	Current Operating Costs	MES Cost of Malaria Eradication	Total Net Benefit
1966					
1967	4475	1820	2730	30	-105
1968	6393	780	3400	30	2183
1969	7103	130	4095	30	2848
1970	7813	137	4300	30	3346
1971	7917	143	4515	30	3229
1972	8021	151	4741	30	3099
1973	8125	158	4978	30	2959
1974	8229	166	5227	30	2806
1975	8333	175	5488	30	2640
1976	8540	140	5630	30	2740
1977	8600	90	5700	30	2780
1978	8600	--	5700	30	2870
1979	8600	--	5700	30	2870
1980	8600	--	5700	30	2870

ASSAYITA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	ME Net* Benefit	PWF at 10 PC	Net Present Worth at 10 PC	PWF at 100 PC	Net Present Worth at 100 PC
1966					
1967	-0.69	.909	-0.63	.500	-0.35
1968	15.55	.826	12.85	.250	3.89
1969	20.08	.751	15.08	.125	2.51
1970	22.47	.683	15.35	.062	1.39
1971	20.66	.620	12.81	.031	0.64
1972	18.89	.564	10.65	.015	0.28
1973	17.18	.513	8.81	.007	0.12
1974	15.52	.466	7.23	.003	0.05
1975	13.91	.424	5.90	.001	0.01
1976	14.17	.385	5.46	--	
1977	14.33	.350	5.02		
1978	15.03	.318	4.78		
1979	15.03	.289	4.34		
1980	15.03	.263	3.95		
			111.60		+8.54

Internal rate of return = > 100%

*Pro rata portion of total net benefit distributed over investment costs.

TIBILA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	Incremental Gross Revenue	Capital Investment	Current Operating Costs	Cost of Malaria Eradication	Total Net Benefit
1966	-0-	-0-	-0-		
1967	188	166	182	5	-164
1968	250	55	242	5	- 51
1969	670	222	612	5	-168
1970	1120	416	892	5	-192
1971	1176	43	937	5	192
1972	1294	90	1031	5	169
1973	1488	149	1186	5	149
1974	1786	228	1423	5	131
1975	2233	342	1779	5	108
1976	2440	150	2040	5	246
1977	2600	70	2190	5	336
1978	2680	310	2240	5	126
1979	2740	380	2180	5	176
1980	2800	120	1940	5	736

TIBILA

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	ME Net* Benefit	PWF at 10 PC	Net Present Worth at 10 PC	PWF at PC	Net Present Worth at PC
1966					
1967	-1.86	.909	-1.69		
1968	-0.67	.826	-0.55		
1969	-0.80	.751	-0.60		
1970	-0.58	.683	-0.40		
1971	0.78	.620	0.48		
1972	0.60	.564	0.34		
1973	0.44	.513	0.23		
1974	0.31	.466	0.14		
1975	0.20	.424	0.08		
1976	0.44	.385	0.17		
1977	0.59	.350	0.21		
1978	0.19	.318	0.06		
1979	0.27	.289	0.08		
1980	1.42	.263	0.37		
			-1.08		

Internal rate of return = <10%

*Pro rata portion of total net benefit distributed over investment costs.

BELLEVUE DU LAC RESORT

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	Incremental Gross Revenue	Capital Investment	Current Operating Costs	Cost of Malaria Eradication	Total Net Benefit
1966					
1967					
1968	158	210	36	0.2	- 88
1969	188	23	36	0.2	129
1970	210	--	56	0.2	154
1971	235	--	55	0.2	180
1972	250	--	55	0.2	195
1973	250	210	55	0.2	- 15
1974	250	23	55	0.2	172
1975	250	--	55	0.2	195
1976	250	--	55	0.2	195
1977	250	--	55	0.2	195
1978	250	210	55	0.2	- 15
1979	250	23	55	0.2	172
1980	250	--	55	0.2	195

BELLEVUE DU LAC RESORT

NET BENEFIT CALCULATION (Eth. $ Thousand)

Year	ME Net* Benefit	PWF at 10 PC	Net Present Worth at 10 PC	PWF at 100 PC	Net Present Worth at 100 PC
1966					
1967					
1968	-0.07	.909	-0.06	.500	-0.04
1969	0.44	.826	0.36	.250	0.11
1970	0.55	.751	0.41	.125	0.07
1971	0.65	.683	0.44	.062	0.04
1972	0.71	.620	0.44	.031	0.02
1973	-0.11	.564	-0.06	.015	--
1974	0.44	.513	0.23	.007	--
1975	0.71	.466	0.33	.003	--
1976	0.71	.424	0.30	.001	--
1977	0.71	.385	0.27	--	
1978	-0.14	.350	-0.05		
1979	0.44	.318	0.14		
1980	0.71	.289	0.21		
			2.96		+0.20

Internal rate of return = >100%

*Pro rata portion of total net benefit distributed over investment costs.

FOOTNOTES

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21/ Negarit Gazeta Order No. 6, February 28, 1959 (Ethiopian Calendar).

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