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AN ECONOMIC ANALYSIS OF THE INTEGRATED MATERNAL AND CHILD NUTRITION PROJECT OF THE GOVERNMENT OF INDIA

A Report Prepared By:
MARTY MAKINEN

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ABBREVIATIONS

ANM	Auxiliary Nurse-Midwife
AWW	Anganwadi Worker
CARE	Cooperative for American Relief to Everywhere
CDPO	Child Development Project Officer
CMR	Child Mortality Rate
CYP	Couple Year of Protection
GOI	Government of India
IMCN	Integrated Maternal and Child Nutrition
IMR	Infant Mortality Rate
IQ	Intelligence Quotient
LFA	Least Favorable Assumption
LHN	Lady Health Visitor
MCH	Maternal and Child Health
MFA	Most Favorable Assumption
MO	Medical Officer
NIN	National Institute of Nutrition
POL	Petrol, Oil, and Lubricant
Rs.	Indian Rupees
s.d.	Standard Deviation
SNP	Special Nutrition Program
SQ	Socialization Quotient
TA/DA	Travel Allowance and Daily Allowance
USAID	United States Agency for International Development

I. INTRODUCTION

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The economic analysis of a project is a step-by-step process. It begins with an examination of the cost-effectiveness of a selected approach which is compared to alternative approaches to attacking a problem. Once the analyst has shown that the preferred approach has been chosen, he must compare it to alternative general approaches. After selecting an alternative, he must identify and evaluate all costs and benefits, both direct and indirect. In this final step, the rate of return of the project can be compared to investments in other, public and private, domains.

This paper begins with a discussion of the cost-effectiveness of alternative interventions to achieve reduced infant and young-child malnutrition, morbidity, and mortality.

Direct nutrition interventions are compared with pure-income transfers, food-price subsidies, and increases in health care services.

In Chapter III, the author examines the cost-effectiveness of the proposed Integrated Maternal and Child Nutrition (IMCN) model and compares it to the current model known as CARE-MCH (Maternal and Child Health). Explicit calculations of the cost of delivering an effective increase in the calorie intake of at-risk children and mothers are presented.

The author, in trying to measure the expected rate of return, discusses the unit of analysis. Because the IMCN project will be phased in and will not have full impact until it has been in operation for several years, the analysis must cover eight years, 1982-1989. Within this period, the costs of the project should stabilize and effectiveness should be determinable.

As part of the analysis, the writer identifies the expected direct and indirect benefits of the project. He attempts to quantify, as best he can, three of the most important benefits, viz., the expected increase in future productivity, the earning-advancement effect of preventing deaths, and savings in food resources. The author shows that these benefits alone should be enough to earn at least a 10 percent return on investment. It is not possible to calculate the exact rate-of-return.

The last step in the economic analysis is to specify how the economic benefits which were identified, but which were not quantified because of a lack of information, can be measured. The author recommends that efforts be made to measure the benefits during the project, not only to determine full economic impact, but also to provide information that may be used generally to plan other health, population, and nutrition interventions.

A series of financial tables is presented in Chapter IV. These tables provide the basic information with which final financial tables can be prepared once the scale of the project has been determined. It is important to note that although real costs are used in the economic analysis, inflation is included in the financial tables. Inflation is added into the calculations in order to plan how the project should be implemented.

II. THE COST-EFFECTIVENESS OF NUTRITION INTERVENTIONS

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In the broadest sense, nutrition interventions such as IMCN must be judged for their cost-effectiveness in achieving the same goals as other possible interventions. The goals are reductions in infant and young-child malnutrition, morbidity, and mortality. The attacks on malnutrition and morbidity, although they themselves have merit, are also a means to reducing mortality. Two alternative strategies are suggested in this paper to reach the goals: provide additional health services and increase income.

With additional health services, additional curative and preventive care can be provided. In curative and preventive programs, morbidity and mortality would be attacked, but malnutrition would not be affected appreciably.[1] A health service system is in place in India. The benefits that would accrue if the system were improved might well outweigh costs, but the impact of any improvement would be marginal only, because the same services would merely be extended to more people. For the severely malnourished, mortality rates are 12 times the normal rate, and for moderately malnourished children between 1 year and 3 years, they are 3 times the normal rate (A. Kielmann, "Weight for Age as an Index of Risk Deaths in Children," Lancet, June 10, 1978). A program which does not attack malnutrition will be curative, and not preventive.

Income programs can attack malnutrition indirectly by raising disposable income and thereby inducing increased spending for food. Alternatively, food prices can be subsidized to increase consumption with current income. The low-calorie income elasticities found in India and elsewhere (M. Selowsky, "The Economic Dimensions of Malnutrition in Young Children," World Bank Staff Working Paper, No. 294, 1978), even among low-income groups, indicate that relatively large increases in income would be necessary to close the calorie gap. Food subsidies have been proposed as a less expensive alternative to pure income transfer to affect nutritional status. A study in Kerala (S.K. Kumar, "Impact of Subsidized Rice on Food Consumption and Nutrition in Kerala," International Food Policy Research Institute, Research Report 5, 1979) showed that food subsidies were between 6 times and 10 times more effective in improving nutritional status than income transfers of the same amount. Efforts to improve infant and young-child child nutrition that include both income transfers and food subsidies involve considerable "wastage," however, because adults and older children, and not the target group, become the beneficiaries of increased food consumption.

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[1] Some illnesses, such as measles, cause weight loss that can begin a case of malnutrition. Rehydration of diarrhea cases can avert nascent malnutrition. Most health services, however, are related only peripherally to nutrition; many are called for only after malnutrition has done its damage.

Food-subsidy programs do not address the problem of intra-family food distribution, because much of the gap in young-child nutrition can be filled through relatively small shifts in the distribution of the family's current resources. Furthermore, subsidy programs are not likely to be sustainable, as was shown in Sri Lanka (G.D. Gavan and I.S. Chandrasekera, "The Impact of Public Foodgrain Distribution on Food Consumption and Welfare in Sri Lanka," International Food Policy Research Institute, Research Report 13, 1978), where, even when the programs were targeted only to low-income groups, they imposed a heavy fiscal burden.

The IMCN program will improve on the cost-effectiveness of the alternative interventions by targeting food supplements only to children who have been judged, on the basis of nutritional criteria, to be in need. The extra inputs to carry out the targeting will be less costly than the food wastage that would occur were these inputs not added (see Chapter III).

The health and nutrition education components of IMCN will address the issue of intra-family food distribution and lead to improvements in health and sanitary practices that should avert illnesses that catalyze malnutrition. The management of IMCN will be integrated into the health service system so that the complementarities between the two can be used to advantage. Additional malnutrition prevention will be undertaken by IMCN; special attention will be given to mothers of low-birth-weight babies and pregnant women at risk of delivering a low-weight child. These women will be targeted for supplemental feeding to raise the weights of their high-risk children (for a discussion of the mortality risk for low-birth-weight children, see R. Puffer, Report to USAID/New Delhi, 1981). A second group of high-risk children will be targeted also for IMCN. Funds have been provided to develop weaning foods using low-cost, locally-available products (different foods will be developed for different areas). The foods will meet a critical need, because many cases of malnutrition have their genesis at the point of weaning. Once such foods are developed, their use will be promoted in the educational activities devised for IMCN.

In sum, by targeting food supplements, by educating the public to improve intra-family allocations, by integrating maternal and child health into the health services, and by giving special attention to those at high risk, the IMCN program will be made more cost-effective than other alternatives in reducing infant and young-child malnutrition, morbidity, and mortality.

III. A COMPARISON OF COST-EFFECTIVENESS: THE IMCN VERSUS CARE-MCH

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In this chapter, the author compares the cost-effectiveness of IMCN with that of the current CARE-MCH feeding program. To make the comparison, he examines ration cost, the effectiveness of delivery to the at-risk group, the adequacy of the ration in meeting the calorie gap, and the outreach of each program to non-food beneficiaries.

The CARE-MCH ration costs $0.027 per beneficiary per day. The IMCN ration costs $0.071 per beneficiary per day (a weighted average of $0.077 per maternal beneficiary and $0.069 per child beneficiary). The IMCN ration is 2.6 times as costly as the CARE-MCH ration.

In CARE-MCH, the cost of reaching an at-risk food beneficiary is $0.052; in the IMCN program, the cost is $0.071. In the best of CARE's MCH programs, the Special Nutrition Program (SNP), beneficiaries are selected on the basis of age and socioeconomic criteria. A CARE study (Anderson, 1976) found that only 52 percent of those fed were in fact malnourished. The IMCN will choose its child beneficiaries by using three nutritional criteria: weight for age and height, failure to gain weight, and recent illness. Maternal beneficiaries will be chosen on the basis of risk of giving birth to a low-weight child. The mistake of giving rations to those not in need should be minimal in IMCN.

The daily nutritional gap for malnourished children in India is 500 calories. The typical CARE-MCH ration contains 345 calories and is fed 240 days per year. A study of ration leakage found that 47 percent of the food is consumed. The effective daily increase afforded by the CARE ration is 163 calories.

The IMCN ration will be delivered 300 days per year to children and 365 days to maternal beneficiaries. The ration will contain 600 calories. Nutrition education and house visits by the anganwadi worker (AWW) will minimize ration leakage. It is felt that these activities will also contribute to a reduction in the calorie gap by inducing families to feed pregnant and lactating mothers and young children more adequately out of existing resources. The IMCN expects to raise the net daily intake by 400 calories.

The additional nutrition education, the selection of beneficiaries, and the management inputs included in IMCN will cost $0.0205 per beneficiary per day above food costs. The IMCN cost per 100-calorie effective increase is $0.0319, or more than 25 percent more than IMCN. The IMCN will be more likely than CARE-MCH to be able to reduce malnutrition because the size of the ration is large enough to meet the gap and feeding will take place 25 percent more days per year than under CARE-MCH.

Moreover, the IMCN will protect the children who are not direct food beneficiaries. It will monitor each month the health and nutrition status of all children between the ages 0 and 6, including those found to be malnourished in the feeding programs. Those children who need health care will be referred to facilities in the health system. The health and nutrition activities of IMCN are designed to reach the entire community, not just those who receive supplements, and not just children. By providing nutrition supplements and education to pregnant women, babies with higher birth weights will be born; hence, neonatal and infant mortality will be lowered, and the incidence of early malnutrition will decline as well.

The concept of an anganwadi mother-and-child center will encourage mothers and children to make better use of existing health services. More pregnant women will take advantage of tetanus toxoid vaccinations, and iron and folic acid supplements, as well as the services of trained dais (midwives). Similarly, it is expected that child-vaccination coverage will increase as the anganwadis are established. None of these kinds of outcomes could be anticipated if, as in CARE-MCH, only food supplements were provided.

The IMCN expects to achieve significant reductions in the incidence of malnutrition and mortality among infants and young children. It is expected that the incidence of severe malnutrition will be reduced by 50 percent, and moderate malnutrition by 25 percent, within three years of program operation at any given site. For a typical block of 100,000 population, the number of severely malnourished should fall from 3,400 to 1,700, and the number of moderately malnourished from 4,800 to 3,600.

The risk of mortality is 12 times the normal rate for the severely malnourished child and 3 times the normal rate for the moderately malnourished (Kielmann, 1978). By reducing the incidence of malnutrition and by supplementing persons who are malnourished, the current rate for young-child mortality--approximately 30 (calculated by R. Puffer with data from the Registrar General)--will be reduced to less than 20. The efforts to raise birth weights, ensure healthy births, and improve the adequacy of breast milk are expected to result in a reduction in the infant mortality rate from 125 to 95 in IMCN areas. Table III-1 and Figure III-1 show the expected results after three years of IMCN operation in a typical block. It is expected that 265 infant and young-child deaths will be averted annually in each block. No such impact on mortality has ever been demonstrated in the CARE-MCH program.

Calculation of Economic Benefits

Much of the benefit or cost to any project that affects mortality and morbidity is not quantifiable in economic terms, because lives saved

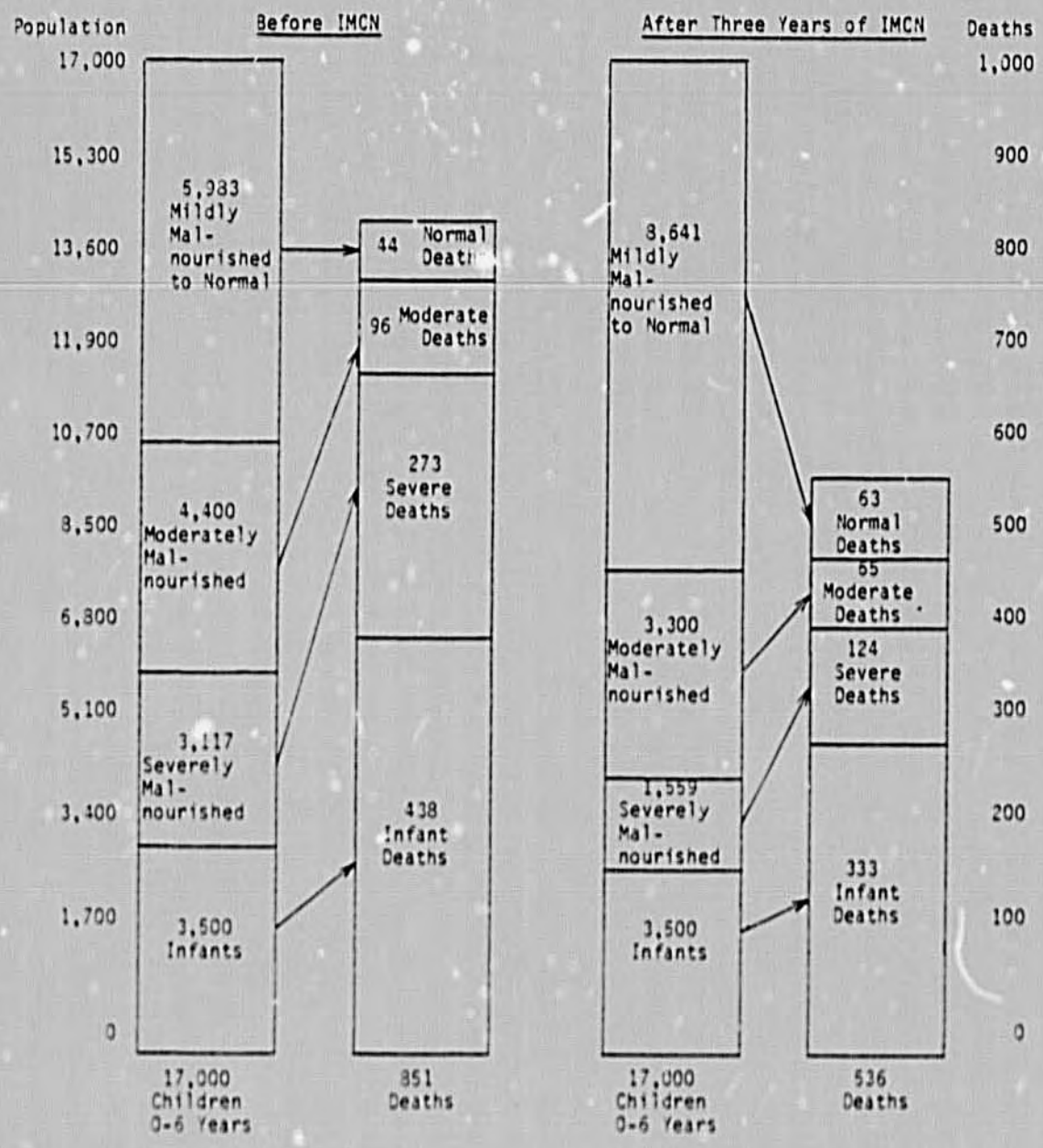
Table III-1

EXPECTED RESULTS OF IMCN ON MALNUTRITION AND MORTALITY IN ONE BLOCK

Population	Before IMCN	After 3 Years of IMCN
Infants	3,500	3,500
Severely Malnourished	3,117	1,559
Moderately Malnourished	4,400	3,300
Mildly Malnourished to Normal	5,983	8,641
TOTAL	17,000	17,000
Deaths		
Infant	438	333
Severely Malnourished	273	124
Moderately Malnourished	96	65
Mildly Malnourished to Normal	44	63
TOTAL	851	586

Figure 1

EXPECTED RESULTS OF IMCN ON MALNUTRITION AND MORTALITY IN ONE BLOCK



or lost and illnesses caused or averted have significant, pure, utility effects. Thus, such a project should not be judged on purely economic grounds. The calculation of expected net economic benefits only gives an indication of the total net benefit to the project.

With this caveat in mind, the author was able to quantify certain economic benefits of the IMCN project. Others could not be quantified because of a lack of information. To all the economic benefits, both quantified and not quantified, it was necessary to add the pure utility gains of young-child deaths prevented and illnesses averted.

The author quantified, or tried to quantify, the expected gain in productivity, the reduction in child mortality, and the value of improved educational performance. The methods he used to quantify the consequences to the population, potential resource savings, mothers' time, general health, and maternal depletion are discussed below.

The unit of analysis is three Indian development blocks of 100,000 population. Three blocks instead of one block are used, because the project will be phased in over four years. The first year will be devoted to preparation; in each successive year, one-third of the final total number of blocks will become operational. The time horizon is extended beyond the final year of the project for three reasons. One, the results of the nutrition intervention will not be fully realized until the project has been in operation for three years; all the project blocks will not have their full effect until two years after the USAID has terminated its financial support. Two, it is expected that the Government of India (GOI) will continue the program after the USAID's commitment expires. Three, the expected improvement in nutritional status will lessen the amount of required food to a steady amount only after all the blocks are operating in their fourth year.

The research and development expenditures and other fixed costs of the program are assigned pro rata to the three-block unit.

Each block consists of 100 villages of 1,000 persons. There are 170 children between 0 and 6 and 30 pregnant women in the average village at a given moment. The crude birth rate is 40. The ex ante infant mortality rate is 125; the mortality rate for those between 1 and 6 years is 30.6. It is expected that 20 percent of the children are severely malnourished and 28 percent are moderately malnourished. In a typical village, in the 0-3 age group, there would be 24 severely malnourished and 33 moderately malnourished persons. In the 4-6 age group, there would be 10 severely malnourished and 15 moderately malnourished children.

The project will provide a daily supplementary food ration, valued at $0.077, to an average (per village) of 10 pregnant and lactating women who are determined to be at risk of giving birth to a low-weight baby or having a low-birth-weight baby. All severely malnourished children and the worst one-third of the children who are moderately malnourished will receive a ration valued at $0.069 for 300 days per year.

After three years of operation, it is expected that through its prevention efforts the project will have reduced the incidence of severe malnutrition by one-half and that of moderate malnutrition by one-fourth. The project expects to be able to rehabilitate 60 percent of the remaining cases of malnutrition. Eighteen percent of the severely malnourished will be brought to normal; 42 percent will be improved to moderate malnourishment. Sixty percent of the moderates will become normal. In addition, the improvements in mothers' status are expected to reduce the infant mortality rate from 125 to 95. The mortality rate for children between 1 and 6 will be reduced from 30.6 to 20.0.

Table III-2 shows the annual costs and results of implementing the project in a three-block unit. The reader should note that the numbers of malnutrition cases and the number of deaths averted reach a maximum beginning in 1987, when the third phased-in block has been operational for three years. Costs stabilize in 1988, when the number of beneficiaries of the supplement levels off.

A. Direct Benefits

The IMCN will feed a 600-calorie food ration to all severely malnourished and to the worst one-third of moderately malnourished children between 0 and 6 for 300 days each year. In an average covered block, this is expected to amount to 3,400 severe cases and 1,600 moderate cases. In addition, those mothers determined to be at risk of delivering a low-birth-weight baby will be fed a daily ration of 600 calories throughout the last two trimesters of pregnancy and the first six months of lactation. There will be approximately 1,000 maternal food-supplement beneficiaries per block. The remaining 12,000 better-nourished children in each block will benefit from the monthly monitoring of their nutritional status, from the health and nutrition education imparted to their mothers through the anganwadi worker (village nutrition worker) and the auxiliary nurse-midwife (ANM), and from periodic vaccinations and deworming. All mothers will benefit from the health and nutrition messages and from the services of the trained dai.

B. Indirect Benefits

By stimulating improvements in the quality and reach of the health service system, the project is expected to have an impact on the health and nutritional status of the community at large. As knowledge is acquired about the availability of health services, as diets improve, and as sanitation, hygiene, and health practices improve, general morbidity should begin to decline. The reduction in morbidity will mean an increase in labor supply per capita, because fewer working days will be lost to

Table III-2

COSTS AND EXPECTED RESULTS OF IMCN
IMPLEMENTED IN THREE BLOCKS

Fiscal Year	Food Supplement Beneficiaries	Costs ($000) Non-Food	Food	Total	Cases of Malnutrition Averted	Deaths Averted
1982	0	79.4	0.0	79.4	0	0
1983	6,000	134.0	131.6	265.6	384	88
1984	11,298	285.7	248.7	534.4	1,152	265
1985	15,895	198.5	351.2	549.7	2,304	530
1986	13,792	174.0	307.7	481.7	3,072	707
1987	12,391	174.0	278.7	452.7	3,456	795
1988	11,690	174.0	264.2	438.2	3,456	795
1989	11,690	174.0	264.2	438.2	3,456	795

illness and premature death, and an increase in effective labor supply, because debility caused by illness and nutritional deficiency will be reduced.

It can be expected that, as increased numbers of young children survive, the population will be positively influenced to accept family planning. In this way, the cost per couple year of protection (CYP) will be decreased. There may be other benefits as well, for it is believed that improved nutritional status at an early age has a significant impact on a person's capability to reach genetic-ability potential and to profit from education.

The IMCN project will demonstrate that there is a more effective use for the food now used in other programs. Furthermore, it will become a resource for other programs, because as the program progresses and as malnutrition is reduced, food requirements should diminish and food should be freed for use elsewhere. The program also will show the social profitability of investment in young-child nutrition. As it does so, additional investments in this domain by the Indian Government and other donors will become more likely.

The project will enable the GOI to realize a savings in the resources that are obligated at this time to health and education. The process of developing in a child the productive capacity of an adult, that is, human capital, may be seen as a function of several factors, including health, education, and nutrition. The optimal combination of these inputs obtains where their marginal productivities per dollar spent are equal. Currently, much is spent in India on health and educational inputs into child development; little is spent on nutrition. It is felt that additional investment in nutrition is likely to have higher marginal productivity than additional investments in health and education. Indeed, it may be that more efficient spending would obtain if more resources were targeted to nutrition and fewer to health and education. In other words, to develop human capital to the current level, total spending on health, education, and nutrition would have to be less than that which is spent now for health and education alone.

There is evidence that the three inputs are not perfect substitutes for one another. Studies on the effect of education on IQ, cited by Selowsky and Taylor ("The Economics of Malnourished Children: A Study of Disinvestment in Human Capital," 1971), show that, at most, education can recover half of the IQ potential that is lost because of early childhood malnutrition. Morbidity and mortality rates that exceed normal levels are associated with undernourishment, which requires spending on curative health--spending that would not be necessary if malnutrition were prevented. The excess morbidity has an additional cost: time lost by mothers who must care for their sick children.

The excess mortality, in addition to its effects on population, wastes the resources spent on child development and depletes mothers'

strength. All the resources devoted to rearing children who die prematurely, including food, time for child care, health services, and the costs of mothers' pregnancies, are lost. Each birth may cause mothers to suffer loss of working power, both at the time of the birth and in the future, and make later births more difficult.

C. Increases in Productivity

It is difficult to calculate how much productivity will increase because the nutritional status of young children has been improved. It is known that malnutrition causes a loss of potential physical and mental ability. Physical and mental ability, in addition to environmental stimulation, health, education, and the availability of capital, determine productivity. Thus, the prevention of malnutrition can have some positive effect on future productivity. It has been shown that the timely rehabilitation of malnourished children can restore much physical and mental potential.

The value of a gain in productivity can be calculated as the current value of increased output attributable to improvement in nutrition. To find the value, one must know the value of output in the absence of the nutritional intervention, the secular growth rate of productivity, the expected working lifetime, and the amount of increase in capacity that may be attributed to the intervention. Symbolically, the formula for each case of malnutrition avoided would be:

$$P.V. = \sum_{t+s-a}^{n-a} (y'_t - y_t)\left[\frac{1+g}{1+r}\right]^t \qquad (1)$$

where,

P.V. = present value of the productivity increase attributable to the nutrition intervention;

t = time in years; a is the age of the child at the time of the intervention, s is the age when one enters the workforce, and n is the age of retirement;

y'_t = the expected value of earnings in year t of an individual who is well nourished in childhood;

y_t = the expected value of earnings in year t of an individual who is malnourished in childhood;

g = expected secular rate of productivity growth; and

r = rate of discount.

The difference in expected earnings of individuals who were well and poorly nourished in childhood may be expressed as a proportional increase in ability (α):

$$y'_t = y_t(1 + \alpha). \qquad (2)$$

Substituting (2) into (1), the result would be:

$$P.V. = \sum_{t = s - a}^{n - a} \alpha\, y_t \left(\frac{1 + g}{1 + r}\right)^t . \qquad (3)$$

The working lifetime in India, accounting for the probability of death, is approximately 43 years--from age 12 to age 55.

A discount rate of 10 percent is used.

A variety of values is plausible for values α, g, and y_t. The IMCN project will be implemented in the rural and tribal areas in India where expected future employment can accurately be approximated as that of a landless agricultural worker. Thus, y_t would take on the value of the annual wage of such a worker. This approach was used in the World Bank's Tamil Nadu Nutrition Project (World Bank, 1980). Annual earnings were calculated as Rs.1,300 ($162.50), using a daily wage of Rs.5 for the equivalent of 260 working days. A more optimistic assumption is that the expected earnings can be approximated by the per capita income of India, Rs.1,520 ($190).[1] As was assumed by the World Bank, it is expected that 10 percent of children will not reach age 12.

The Bank assigned no value to the activities of women who are not involved in market labor; hence, for them, any gain in productivity is valueless. This is a serious error to make when trying to measure the social value of an intervention. Because market labor is available to women (the Bank says that 15 percent of women would be so employed), it is implicit that, when women choose not to work in the market, the marginal value of their wage employment is lower than that of their alternative activities. Therefore, increases in women's productivity that are attributable to nutrition intervention are counted here.

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[1] Per capita income is calculated by dividing national income by the total population, including children, old people, and others not in the workforce. Thus, if per capita income were the base, the target population would be well into the lower-income part of the Indian economy.

As a final consideration of y_t, it is assumed that 10 percent of those who reach working age will be unemployed.

The pessimistic assumption about g, the secular growth rate of agricultural productivity, is that g will be zero. That is, declining land-labor ratios will overwhelm any increases because of improved technology and physical and human capital. An optimistic assumption is that productivity will grow at 3 percent, the historic post-independence rate of growth of the Indian economy as a whole.

The following parametric values (see Table III-3) are used to calculate the current value of the earnings of an unskilled, landless worker:

$$
\begin{aligned}
y_t &= \text{Rs.}1{,}300 - 1{,}520 \\
g &= 0.00 = 0.03 \\
r &= 0.10 \\
n &= 55 \\
a &= 2 \\
s &= 12.
\end{aligned}
$$

The results show that the current value of the expected future earnings of the targeted beneficiaries of IMCN would range from $561, under the least favorable assumption (LFA), to $1,269, under the most favorable assumption (MFA).

Because the value of the productivity increase is unknown, the next step is to solve for the α value that would allow project costs to be covered. The reader should note that this procedure will produce a 10 percent return on investment, because a 10 percent rate of discount is used.

The cost per malnutrition case averted (see Table III-4) will be high in the early years of the project, then decline to a stable level after six years, when all blocks have been in operation for three years. After 1987, the cost per case averted will be stable at $127. To meet this cost and to earn a 10 percent return on investment, the avoidance of malnutrition will have to raise output by 10.0 percent under the MFA and by 22.6 percent under the LFA. To cover all the costs of the project through 1989 (they will average $187 per case averted), those who avoid malnutrition will have to increase their productivity by 14.7 percent under the MFA and by 33.3 percent under the LFA. These rates are needed to justify the project on productivity growth alone.

There is no direct evidence of what one can expect as an increase in productivity; therefore, one must determine whether increases of 10.0 percent to 33.3 percent are within the order of magnitude that reasonably may be expected. The National Institute of Nutrition (NIN), in Hyderabad, India

Table III-3

PRESENT VALUE OF FUTURE EARNINGS
OF AN UNSKILLED, LANDLESS WORKER
(In $)

Secular Productivity Increase (%)	Base Annual Earnings Rs. 1,300	Base Annual Earnings Rs. 1,520
0	$ 561	$ 655
3	1,085	1,269

Table III-4

IMCN COST PER MALNUTRITION CASE AVOIDED

Fiscal Year	Cost Per Case Avoided	Cumulative Cost Per Case Avoided
1982	NA	NA
1983	$692	$898
1984	464	573
1985	239	372
1986	157	276
1987	131	228
1988	127	203
1989	127	187

(NIN, Annual Report, 1980), found a significant (but unspecified) difference in wages paid to day laborers that was based on physical size. Adult size is an indication of childhood nutrition. In the NIN study, size was used implicitly by employers as an indicator of productivity. In this way, childhood nutritional status was linked to adult productivity.

Kalra, et al. (A. Kalra, et al., "The Impact of Malnutrition on Intelligence," Indian Pediatrics, February 17, 1980, p. 109-116) found that the IQ-SQ* scores of malnourished children between the ages of 1 and 12 differed from those of a control group by 30.4 points. The Kalra study showed that 57 percent of the malnourished group would be classified as mentally retarded, but that only 1 percent of the control group would be so classified. The investigators observed also that the degree of malnutrition is positively related to the degree of retardation.

Srikantia and Yogananda Sastri (S.Y. Srikantia and C. Yogananda Sastri, "Observations on Malnutrition and Mental Development," National Institute of Nutrition) have criticized studies such as Kalra's, contending that control is not maintained for the influence of mothers' attitudes and intelligence on mental development. Cravioto has tested for the effect (J. Cravioto, "Intersensory Development as a Function of Age, Stimulation and Antecedents of Severe Malnutrition," Symposium on Nutrition and Functional Performance, Proceedings of the Nutrition Society of India, No. 22, 1978). He has found that the negative relation between kinesthetic and visual competence (which affects reading ability) and malnutrition remains even when home stimulation is controlled.

In a review of studies of childhood malnutrition and mental development, Clugston (Y.A. Clugston, "The Effect of Malnutrition on Brain Growth and Intellectual Development," Tropical Doctor, January 11, 1981, p. 32-38) found that, in deprived communities, the malnourished show persistent significant differences in cognitive functions, attention span, ability to concentrate, and motivations into late childhood when compared to the well-nourished.

None of the studies cited above makes the link between childhood malnutrition--hence, ability--and later adult productivity. Selowsky has used the results of such studies, in addition to those of studies showing the predictive power of childhood ability on adult ability, to calculate the future value of increases in childhood ability (M. Selowsky, "Nutrition, Health, and Education: The Economic Significance of Complementarities at Early Ages," Report Presented at the Sixth World Congress of the International Economic Association, Mexico City, 1980). Selowsky has shown that a one standard deviation (s.d.) increase in childhood ability would increase by 0.65 the lifetime earnings of persons with low educational attainment. A two s.d. increase would improve earnings 1.32

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* Intelligence Quotient-Socialization Quotient.

times. Selowsky also has shown that persons with greater ability will seek more education, which further improves earnings. Accounting for both the pure-ability effect and the induced education-effect, a one s.d. increase in ability would imply a 2.32-fold improvement in lifetime earnings; a two s.d. increase would imply a 5.63-fold increase.

Thus, the increases in earnings needed to exact a 10 percent return on the IMCN investment are well within these ranges, provided that improvements in ability of one s.d. to two s.d. can be expected.

When it has reached full maturity, the IMCN will make a net improvement of 593 severe and 559 moderate cases of malnutrition to mildly malnourished or normal children in each block each year. Colombian children suffering from moderate malnutrition showed a one s.d. improvement in I.Q. following their enrollment in programs that provided food supplements, health care, and preschool education. The IMCN is expected to produce the same results (H. McKay, et al., "Improving Cognitive Ability in Chronically Deprived Children," Science, April 1978). A study of severely malnourished children (below 70 percent of normal) in Chile has shown that rehabilitation will result in a two s.d. gain (M. Selowsky and L. Taylor, "The Economics of Malnourished Children: An Example of Disinvestment in Human Capital," Economic Development and Cultural Change, October 1973). Thus, it appears that the IMCN will generate the increases in productivity that will be needed to earn at least a 10 percent return.

Reduction in Child Mortality

Two kinds of economic benefits may be calculated for the reduction in child mortality: the current value of advanced earnings and the savings of wasted resources. The advanced-earnings benefit assumes a desire for a specific number of children in a family; that is, if one person dies, (s)he will be replaced by an additional birth. If a death is prevented, the need to have an additional child is eliminated, and the earnings stream of the surviving child is advanced by the number of years between his or her birth and the time at which the replacement is born. The present value of the advancement is calculated as the benefit.

The formula for this benefit is:

$$P.V. = \sum_{t=s-d}^{s-d+a} y_t\left(\frac{1+g}{1+r}\right)^t - \sum_{t=n-d}^{n-d+a} y_t\left(\frac{1+g}{1+r}\right)^t \quad (4),$$

where d is the age of the child when death is averted. Four years are taken as the period of earnings advancement. The definitions of the other symbols are the same as those for the formula on page 13.

The IMCN project expects to reduce both the infant mortality rate (IMR) and the young-child mortality rate (CMR). Each requires a different value for d in the equation described above. Most infant deaths occur early in life (see Ruth Puffer, Report to USAID/New Delhi, 1981); thus, d carries the assigned value of zero for the reduction in IMR. For the reduction in CMR, d is assumed to be two years.

Using the same parameters as those for productivity, the advanced earnings benefit of a prevented infant death is calculated to be $295 under the MFA and $178 under the LFA. For each young-child death averted, the earnings-advancement benefit ranges from $214 under the LFA to $337 under the MFA.

The IMCN project expects to reduce the IMR from 125 to 95 and the CMR from 30.6 to 20.0 The value of the earnings advancement resulting from implementation of IMCN in the three-block unit is shown in Table III-5.

As Table III-5 shows, the earnings-advancement benefit accounts for between 36 percent and 58 percent of costs. Over the eight years, from 1982 to 1988, this benefit would be between 24 percent and 39 percent of total costs.

Premature death causes two kinds of resource waste: spending on child maintenance (i.e., expenditures for food and clothing until the time of death) and maternal costs. Maternal costs include loss of productive time because of pregnancy, loss of time for child care, and loss of strength and vitality with each successive pregnancy. It is not possible at this time to estimate the value of maternal costs. Information is needed on the amount of time diverted from other activities in pregnancy and during child care, as well as on the productivity costs of additional pregnancies (these would include not only reductions in women's physical productivity, but also increased risks in future pregnancies, both for the mother and the child). The time diverted would be evaluated as the marginal value of alternative activities (this probably would be the wage rate for unskilled labor adjusted for the probability of employment). These avoided costs would be part of the benefit to reduction in mortality.

The child-maintenance costs of early death can be determined. The deaths averted by IMCN will occur early, and almost no spending will be lost on clothing. Therefore, this evaluation of child-maintenance costs will include only food losses. Most infant deaths occur in the immediate neonatal period (R. Puffer, Report to USAID/New Delhi, 1981), which means that the average lifespan of a child who dies in infancy is 77 days.[1] Daily consumption is estimated to be 600 calories; hence, 46,200 calories per death are lost.

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[1] Calculated from a study of IMR data in rural North Arcot; data are presented in R. Puffer, Report to USAID/New Delhi, 1981.

Table III-5

EARNING-ADVANCEMENT BENEFIT FROM IMCN
IMPLEMENTED IN THREE BLOCKS

Fiscal Year	Deaths Averted		($000s) Value of Earnings Advancement	
	Infant	Young Child	LFA	MFA
1982	0	0	$ 0.0	$ 0.0
1983	40	48	17.6	28.0
1984	120	145	52.4	84.3
1985	240	290	104.8	168.5
1986	320	387	139.8	224.8
1987	360	435	157.2	252.8
1988	360	435	157.2	252.8
1989	360	435	157.2	252.8

Young-child deaths occur at an average age of two years. Mortality rates are higher among the malnourished. The daily intake of calories by persons in this group is estimated to be 600 calories per day for the first year of life, and only 700 calories per day after weaning. The loss per young-child death is, therefore, 474,500 calories.

These are losses of low-cost calories of locally-produced foods. At current market prices, assuming a mix of 75 percent cereal and 25 percent pulse in the diet, the cost of 600 calories is $0.234; the cost of 700 calories is $0.273. The calculations must be adjusted for losses in converting the food eaten by mothers into breast milk. The efficiency of conversion has been found to be 90 percent for calories, and between 50 percent and 60 percent for protein (J.E. Rohde, "Mother Milk and the Indonesian Economy," The Indian Journal of Pediatrics, Vol. 48); the overall rate is approximately 67 percent. Thus, the cost of 600 calories of breast milk is $0.348. The food loss per infant death is $26.78; the cost per young-child death is $226.67. The food-savings benefit of IMCN is shown in Table III-6.

Other Benefits

Other economic benefits from the IMCN cannot be quantified ex ante. However, many benefits can be measured during the project if appropriate steps are taken to monitor the project's effects. Certain information will be needed to measure these benefits. By measuring the economic benefits of the nutrition intervention, one can obtain information on the benefits that may be expected from other interventions as well. This information can then be used in planning to ensure more efficient use of scarce resources.

The benefits to IMCN which cannot be quantified are effects on population, resource savings, loss of mothers' time, and general consequences to health. The IMCN project expects to reduce significantly infant and young-child mortality. In the short term, a reduction in mortality will have the effect of increasing population growth. If families have children to reach a targeted family size, however, there will be a compensating decrease in future fertility (provided that methods to control fertility are available).

Models of household fertility-behavior hold that, to reach a given targeted family size, more births than are necessary occur when child mortality is high. Families will be trying rationally to ensure coverage of the risk that children may not survive. Under the same hypothesis, as the chances of survival improve, fertility decreases, and this reduction more than compensates for the decline in mortality. Information on fertility rates before the project, during phase-in, and while the project is in full operation should be gathered to determine whether a social

Table III-6

FOOD-SAVINGS BENEFIT FROM IMCN
IMPLEMENTED IN THREE BLOCKS

Fiscal Year	Deaths Averted		($000s)
	Infant	Young Child	Value of Food Saved
1982	0	0	0.0
1983	40	48	12.0
1984	120	145	36.1
1985	240	290	72.2
1986	320	387	96.3
1987	360	435	108.2
1988	360	435	108.2
1989	360	435	108.2

cost should be charged against the project because it is promoting population growth or whether credit should be given to the project because it is reducing population growth. In addition, the amount of time required for households to perceive the reduction in child mortality and to modify their behavior accordingly should be measured.

A corollary is that the decrease in household demand for fertility as the risk of survival improves should lead to changing demand for contraceptives. One would expect not only that demand for contraceptives (or acceptance of family planning) would increase, but that the mix of contraceptive methods also would change. That is, increased assurance of child survival will allow households to have children less frequently and still reach the desired family size. The use of contraceptives that permit greater spacing between births should increase relatively faster than use of methods such as sterilization, which often are used only when the target size has been achieved or surpassed.

Increased spacing will have additional positive impact on child health. Improvement in nutritional status may be self-reinforcing. Improved nutrition lowers mortality, which increases acceptance of family planning, which improves child health and nutrition. In this way, mortality is further reduced. In these ideal circumstances, the payoff of investment in nutrition is high indeed.

With information on this process, the benefit to be attributed to the nutrition intervention can be measured, and the need for other, complementary, interventions, such as the promotion and availability of contraceptive devices, can be determined. The degree of complementarity among nutrition, health, population, and other inputs also will become evident.

The second non-quantifiable benefit is resource-savings. Population considerations comprise one area where possible resource-savings can be realized with IMCN. Without nutrition intervention, child-mortality rates remain high. Malnutrition affects the future productivity of children. One reason that households demand children is to ensure that parents will have support in old age. If mortality and malnutrition are high, the population is reluctant to reduce fertility, because the parents' chances of having surviving productive children to support them in old age are lowered. If the government wishes to promote family planning in this kind of environment, it must be prepared to make expensive persuasive efforts. If the resources are spent to reduce child mortality and malnutrition, fewer resources will have to be spent on persuasion, because the problems which cause household resistance to persuasion will be ameliorated.

Similarly, the resources now spent on health may be saved. With improvements in the nutritional status of children and improvements in sanitary practices, children will be less susceptible to disease, disease will be less likely to spread, and the consequences of disease will be

less severe. Areas covered by IMCN should experience reductions in child morbidity and case-fatalities. Reduced morbidity produces economic benefits from reduced time for child care and decreases in the expenditures of households (usually by mothers) and the formal health care system. It also may reduce spending on disease prevention (e.g., well-nourished children are less likely to die from measles; therefore, measles vaccination may be given lower priority). Morbidity and case-fatality studies should be done, as well as studies on time and money expended because of illness.

It is expected that the general health of the community will improve when the IMCN is in place. The nutrition messages aimed at mothers and children will reach some adult males, with the result that the health of men will improve, too. As the health of children is improved, the number of infectious persons in the population will be reduced, and the transmission of general diseases will decline. With better sanitary conditions, the incidence of disease will be lowered. Finally, as the community becomes more aware of the health care system, it will seek earlier cures, and more effort will be made to prevent illness. Any observable general decline in morbidity between IMCN and control (non-IMCN) areas should be calculated as the value of days of work saved and time for care and expenditures avoided. Any additional spending on health care that is occasioned by the increased use of the medical system must be netted out of this benefit.

Conclusions

In addition to the humanitarian benefits from reductions in morbidity, mortality, and malnutrition, the IMCN offers many economic benefits. Those that have been quantified are the benefits in future productivity, advanced earnings, and food-savings. Not enough information is available at this time to quantify the additional economic benefits of increased acceptance of family planning, resource-savings in health care, savings of mothers' time and strength, and the health benefits to the community at large. (The methods to calculate these benefits during the project were described briefly in this chapter.)

The magnitude of the benefit of future productivity is unknown. An increase in productivity that is between 10 percent and 33 percent would justify IMCN on economic grounds alone. If the benefits of advanced earnings and food-savings are included, the required increase in productivity is reduced by 8 percent to 25 percent. This kind of productivity-increase is well within the range that may be expected. Thus, one can conclude that IMCN probably will earn much more than a 10 percent return on investment.

IV. FINANCIAL ANALYSIS

IV. FINANCIAL ANALYSIS

Tables IV-1 through IV-4 give a detailed breakdown of the costs of the agreed-on technical package for IMCN. Agreement has not been reached on the scale of the project; therefore, it is not possible to put together a definitive budget at this time. However, the Cost Worksheet (see page 34) and Table IV-6, which breaks out the marginal costs of phasing-in three blocks, should be useful in setting a budget once the scale of the project is determined.

When using Table IV-6 to put together the final budget, Item 4 under GOI, "Salaries," must be divided, as was agreed, between the GOI and the USAID. Also, the state's and the GOI's administrative costs (Table IV-3) and the non-start-up, non-recurring costs (Table IV-4) must be included.

Table IV-7 shows the evolution of food needs of a three-block unit. Maximum food needs occur in the third year of operation (1985). Thereafter, they decline, as the incidence of malnutrition declines, until they reach a constant level (1988 and beyond). This should occur when all the blocks are in their fourth year of operation.

Table IV-5 has been included so that the costs of upgrading health services will be available if it is decided that the IMCN will be implemented in non-upgraded areas. Current plans call for all IMCN blocks to go into upgraded districts; thus, costs listed in Table IV-5 are not included in any of the budgets.

Table IV-1

BLOCK START-UP COSTS

	$000	Rs.000
1. Management		
a. District HQ (18 Blocks/District)		
1. Vehicle ($9,100)	0.51	4.04
2. Furniture and Equipment (Rs.7,200)	0.05	0.40
b. Block HQ		
1. Vehicles (Jeep, Trailer, Mopeds, Bicycles)	10.28	82.24
2. Furniture and Equipment	0.90	7.20
2. Equipment at Villages (100)		
a. Scales (Rs.328 + 10% Reserve)	4.51	36.08
b. Birth Weight Scales (Rs.16)	0.20	1.60
c. Weight and Height Charts (Rs.27)	0.34	2.70
d. Arm Tapes (Rs.1) (4/Center)	0.05	0.40
e. Growth Charts (Rs.0.30)(200/Center)	0.75	6.00
f. Nutrition Education Materials (Rs.280)	3.50	28.00
g. General Equipment (Rs.506)	6.33	50.60
h. Play Equipment (Rs.270)	3.38	27.00
3. Training		
a. AWWs (Rs.900)	11.25	90.00
b. Dais (Rs.300)	3.75	30.00
c. ANMs (Rs.687)	1.72	13.74
d. Mukhyasevikas (Rs.2,260)	1.41	11.30
e. CDPO (Rs.2,600)	0.33	2.60
4. Weaning Food Development (Rs.4/Kg)	5.00	40.00
TOTAL	54.26	433.90

Table IV-2

BLOCK RECURRING COSTS

	$000	Rs.000
1. Non-Food		
a. Medicines (Oralyte, Deworming) (Rs.68/Center)	0.85	6.80
b. Government Administration		
1. District Cell (18 Blocks)	0.61	4.91
2. Block Cell	9.00	72.00
3. POL	3.13	25.00
c. Village Workers' Honoraria		
1. AWWs (Rs.150/Month)	22.50	180.00
2. Dais (Rs.50/Month)	7.50	60.00
d. Growth Charts and Stationery	0.39	3.14
e. Monitoring and Evaluation	1.25	10.00
f. Training (10% Turnover/Year)	1.30	10.41
g. Processing Mothers' Tonic (50p/Kg)	2.85	22.81
TOTAL	49.38	395.07

Table IV-3

ANNUAL ADMINISTRATIVE COSTS

		$000	Rs.000
1.	GOI		
	a. Special Officer (Rs.2,000/Month)	3.00	24.00
	b. 2 Assistants (Rs.1,000/Month)	3.00	24.00
	c. Stenographer-Typist (Rs.600/Month)	0.90	7.20
	d. TA/DA (Rs.800/Month)	1.20	9.60
	e. Driver (Rs.600/Month)	0.90	7.20
	f. POL	3.13	25.00
	Subtotal	12.13	97.00
2.	State		
	a. Special Officer (Rs.1,500/Month)	2.25	18.00
	b. 2 Assistants (Rs.800/Month)	2.40	19.20
	c. TA/DA (Rs.620/Month)	0.93	7.44
	d. Stenographer-Typist (Rs.600/Month)	0.75	6.00
	e. Peon (Rs.350/Month)	0.53	4.20
	Subtotal	6.86	54.84
3.	District		
	a. Special Officer (Rs.1,200/Month)	1.80	14.40
	b. Assistant (Rs.600/Month)	0.90	7.20
	c. TA/DA (Rs.360/Month)	0.54	4.32
	d. Stenographer-Typist (Rs.500/Month)	0.75	6.00
	e. Peon (Rs.350/Month)	0.53	4.20
	f. Driver (Rs.600/Month)	0.90	7.20
	g. POL	3.13	25.00
	h. Contingency (Rs.20,000)	2.50	20.00
	Subtotal	11.04	88.32
4.	Block		
	a. CDPO (Rs.833/Month)	1.25	10.00
	b. Assistant (Rs.300/Month)	0.45	3.60
	c. Stenographer-Typist (Rs.250/Month)	0.38	3.00
	d. Peon (Rs.350/Month)	0.53	4.20
	e. 5 Mukhyasevikas (Rs.400/Month)	3.00	24.00
	f. Driver (Rs.600/Month)	0.90	7.20
	g. Contingency (Rs.20,000)	2.50	20.00
	TOTAL	9.00	72.00

Table IV-4

NON-START-UP, NON-RECURRING COSTS, USAID

Fiscal Year	$000	Rs.000
1982	1,200	9,600
1983	900	7,200
1984	750	6,000
1985	900	7,200
TOTAL	3,750	30,000

Table IV-5

HEALTH COSTS PER BLOCK

	$000	Rs.000
1. Recurring		
a. Staff		
1. M.O. (Rs.12,000)	1.50	12.00
2. 2 LHVs (Rs.5,000)	1.25	10.00
3. 8 ANMs (Rs.3,600)	3.60	28.80
4. Attendants and Contingencies (Rs.900/ANM)	0.90	7.20
b. Other Expenses		
1. Medicines	2.81	22.50
2. Rent	0.63	5.00
TOTAL	10.69	85.50

Table IV-6

BUDGET FOR PHASING IN A THREE-BLOCK UNIT
(In $)

	1982	1983	1984	1985	LOP
GOI					
1. Vehicles	10,790	10,790	10,790	0	32,370
Inflation	1,079	2,266	3,571	0	6,916
2. Medicines	0	850	1,700	2,550	5,100
Inflation	0	179	563	1,183	1,925
3. POL	0	3,125	6,250	9,375	18,750
Inflation	0	656	2,069	4,351	7,076
4. Salaries	0	39,610	79,220	118,830	237,660
Inflation	0	8,318	26,222	55,149	89,689
USAID					
1. Block Start-Up	38,450	43,450	43,450	5,000	130,350
Inflation	3,845	9,125	14,382	2,320	29,672
2. Block Recurring	0	5,795	11,590	17,385	34,770
Inflation	0	1,217	3,836	8,068	13,121

Table IV-7

FOOD NEEDS FOR PHASING-IN A THREE-BLOCK UNIT

Food Beneficiaries	1982	1983	1984	1985	1986	1987	1988
Maternal	0	1,000	2,000	3,000	3,000	3,000	3,000
Child	0	5,000	9,300	12,900	10,800	9,400	8,700
TOTAL	0	6,000	11,300	15,900	13,800	12,400	11,700
Cost ($000)	0	132	249	351	308	279	264

COST WORKSHEET

		$000	Rs.000
Table IV-1	Block Start-Up Costs		
	GOI		
	Vehicles (t-1)	10.79	86.28
	USAID		
	Furniture, Equipment, Training (t-1)	38.45	307.62
	Weaning Food (t)	5.00	40.00
Table IV-2	Block Recurring Costs		
	GOI		
	Medicines	0.85	6.80
	POL	3.30	26.43
	Salaries		
	Administration	9.44	75.52
	Service	30.00	240.00
		43.59	348.75
	USAID	5.79	46.36
Table IV-3	Annual Administrative Costs		
	GOI (Center + 5 State Cells)		
	Salaries	43.30	346.44
	POL	3.13	25.00
Table IV-4	Non-Start-Up, Non-Recurring Costs		
	USAID		
	1982	1,200.00	9,600.00
	1983	900.00	7,200.00
	1984	750.00	6,000.00
	1985	900.00	7,200.00
		3,750.00	30,000.00
Table IV-5	Health Costs Per Block		
	GOI		
	Salaries	7.25	58.00
	Medicines	2.81	22.50
	Rent	0.63	5.00
		10.69	85.50

October 5, 1981