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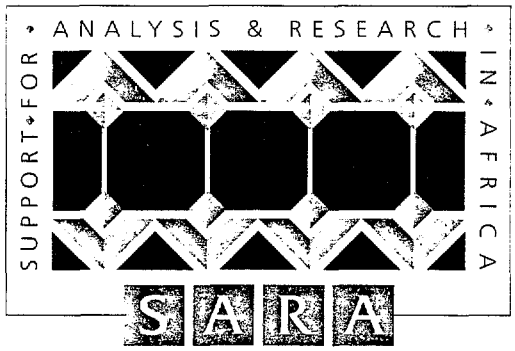

SOUTIEN POUR
L'ANALYSE ET LA RECHERCHE
EN AFRIQUE

Cost-effectiveness of the Nutrition Communication Project in Mali

July 1997

Jay Ross
The Academy for Educational Development

The SARA Project is funded by the U.S. Agency for International Development (AFR/SD/HRD)

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Executive Summary

Malnutrition is an important and largely unrecognized cause of illness and death, particularly among children in developing countries. Over the past few decades, many strategies to curb malnutrition have been tested and proven effective. Less is known about the cost-effectiveness of these various strategies. In these times of limited resources, program funders, planners, and managers need to know which strategies are most effective from both a programmatic and financial perspective.

This report, *Cost-Effectiveness of the Nutrition Communication Project in Mali,* analyzes data from the Nutrition Communication Project (NCP) in Mali, which operated between 1989 and 1995 with funding from the U.S. Agency for International Development and, beginning in 1991, from UNICEF. By examining NCP's work in Mali in detail, the author:

- estimates the financial cost incurred for each child saved from malnutrition or from death caused by malnutrition as a result of project interventions;
- acknowledges the limitations of the analysis, both in terms of determining true economic cost and numbers of children affected;
- offers a methodology that can be adapted for future cost-effectiveness studies of development projects.

NCP was designed to address malnutrition in children under age three through nutrition counseling integrated into existing child survival activities and through complementary communications methods, including radio broadcasts, print media, and village drama. Ten international and domestic private voluntary organizations (PVOs) with established community-based health projects carried out the interventions in communities with a total population of 761,000. NCP's direct objective was to improve nutrition-related behavior, using the assumption that behavioral change in caregivers would lead to improvements in children's nutritional status. An evaluation compared baseline (1990) and post-project (1994) surveys in a total of 24 project and 24 control villages; it indicated a reduction in the prevalence of low weight-for-age and height-for age among children in the project communities.

But at what cost? The study described in this publication provides estimates of the cost-effectiveness of the project in terms of the number of children saved from malnutrition and from death.

Project cost: The researchers used the external financial cost provided through NCP from USAID and UNICEF, a total of $1,094,779. In so doing, however, they acknowledge that this figure does not represent the exact cost of the project. It does

not include the economic value of inputs provided by the PVOs, government agencies, local volunteers, and beneficiaries. Conversely, the approximately $1 million includes funds that did not contribute directly to the outcomes measured in the evaluation. For example, external funds financed school materials on nutrition topics that, although they may well have important long-term effects, probably had no immediate impact on preschoolers' nutritional status in 1994.

Children's lives affected: An estimated 90,026 children under age three live in the project communities. From 1990 to 1994, there was an estimated reduction by 12 percentage points (10,803 children) in the prevalence of low weight-for-age and by 16 percentage points (14,404 children) in low height-for-age. Thus, it costs $101 per child saved from underweight and $76 per child saved from stunting. In looking at death from malnutrition (either as a direct cause of death or a contributor to death by infectious diseases and other causes), an estimated 3,822 children's lives were saved as a result of the project, at a cost of $282 per child.

There are reasons to believe that more children's lives were positively affected as a result of NCP, and of the approximately $1 million spent. For example, the analysis does not include the impact on children who were older than three at the time of the final evaluation but who benefitted from the project as infants. Nor does it include the impact on children yet to be born. To the extent that caregivers change behavior for these younger siblings in the same family, the benefits of the project are expected to continue. In addition, many of the materials and methods developed through the project were used in similar NCP projects in Niger and Burkina Faso and are being adapted for use elsewhere.

These estimates of the cost-effectiveness of the Mali intervention ($101/child removed from malnutrition and $282/child life saved) compare favorably with those from the literature.

The Rationale for Economic Analysis of Nutrition and Child Survival Projects

Worldwide, malnutrition is an important and largely unrecognized cause of illness and death. Poor diets and frequent illness in infancy cause early growth faltering and weakened immunity, lowering resistance to common infections. This process causes more than half of all child deaths in developing countries (Pelletier et al., 1993). Even mild growth faltering doubles the risk of death, relative to normal children. Mild vitamin A deficiency similarly lowers immunity to common infections, turning non-fatal illnesses into fatal ones (Beaton *et al.*, 1993).

Recent analyses suggest that while the prevalence of child malnutrition in the rest of the world has been stable or declining, rates in Africa are increasing (ACC/SCN, 1994). A number of reports on what to do about child malnutrition on the continent have appeared recently (AED, 1995a; Essama, 1995; HHRAA, 1995; Levinson, 1991; Marek, 1993), all of which place some emphasis on the need for cost-effective programs. This is now more appropriate than ever. After several decades of documented nutrition program experience and epidemiological research on the causes of child malnutrition, there is consensus on what strategies are most effective. However, because of the paucity of cost studies, much less is known about the cost-effectiveness of these strategies under different conditions. As resources for nutrition investments become more scarce, planners of large-scale programs will demand the most cost-effective strategies.

Unfortunately, in most efforts to date, the nutrition impact of programs has been poorly documented. The reasons for this have varied. In most cases evaluation is simply not given high priority in the budgets and work plans of implementing agencies, which give greater priority to the short-term maximization of project impact, even though that impact may never be adequately measured. When evaluation of the nutritional impact of a program does receive priority, there is rarely sufficient attention paid to documenting the cost of achieving that impact. And if cost data are documented, it is usually done in a way that prevents a detailed analysis of the full economic costs of a program, including the hidden costs—of volunteer labor, time taken by beneficiaries, or local resources contributed, for example. Even the financial costs to the implementing agency are rarely disaggregated into the costs of research and development, startup, and expansion. This kind of disaggregation is necessary because it provides a basis for comparing the cost-effectiveness of different strategies at different stages in program development. Decision-makers need to know whether precious funds for nutrition improvement should be spent expanding an existing program, adapting another to their situation or developing a new one from scratch. They need to know what aspects of each type of program are most expensive, how these costs can be reduced, and what sacrifices in effectiveness are in-

volved. In short, they need to know what strategies are most cost-effective under different conditions.

This report cannot respond fully to this need because the information at our disposal also suffers from inadequacies in the documentation of nutritional impact, our ability to attribute the impact to the intervention with complete confidence, and the fully disaggregated economic accounting of program costs. However, this exercise is useful in extracting some lessons from the record, about the cost-effectiveness of the program reviewed here and the need for better documentation for the purposes of cost-effectiveness analysis.

The Nutrition Communication Project in West Africa

The nutrition program reviewed here was implemented under the Nutrition Communication Project (NCP), a USAID-funded project undertaken by the Academy for Educational Development (AED) between 1987 and 1995. NCP's broad mandate was to use social marketing strategies to improve child nutrition, primarily in response to requests for technical assistance in these areas from USAID missions overseas. In 1988, planning began for NCP to provide training and technical assistance to the ministries of health in Mali, Niger, and Burkina Faso. Although all of the projects that took shape in the three countries were designed to improve child nutrition using social marketing, there were some marked differences that reflected the different needs, priorities, institutional environments, and available resources and that included differences in objectives and outcome measures. The Mali program has been chosen for this analysis because it is the largest of the three country programs and has the most comprehensive impact evaluation.

Mali Nutrition Communication Project: Background and Description

Mali is one of the poorest countries in the world with a GNP of $250 per capita and an infant mortality rate of 170 per 1000 live births (UNICEF, 1996). Child malnutrition is a major cause of death and disability, with 31 percent of preschool children suffering from underweight (falling more than two standard deviations below the median weight-for-age). Young children are particularly susceptible to malnutrition due to poor feeding practices and a high prevalence of diarrhea, respiratory infections, and malaria.

The Mali Nutrition Communication Project described here was designed to address the problem of malnutrition by building nutrition counseling into existing child survival activities in selected communities and by introducing a mix of complementary communications methods, including radio broadcasts, print media, and village drama.

The Mali Nutrition Communication Project was implemented between 1989 and 1995 by the Mali Ministry of Health (MOH) with technical assistance from AED. A unique feature of the project is that it was implemented through ten international and domestic private voluntary organizations (PVOs) that had already established community-based health projects focused on child survival, forming a ready-made institutional structure for the newer nutrition communication efforts. This allowed the project to begin and expand quickly and to weather the political and administrative changes that occurred during the project period.[1]

From October 1990 through March 1995, the Nutrition Communication Project assisted the Government of Mali and ten PVOs in community-based nutrition education with the following components: health worker and primary teacher training, radio dramas and spots, and development of print media. Formative research had shown that introduction of weaning foods was late (at nearly one year), and that feeding during and after illness was inadequate. Messages about food selection and infant feeding were developed to address these problems, and a wide array of communications materials were developed to support a multi-channel communications strategy.

The NCP in Mali was implemented in three phases:

1) Program Development (1989–1991). In this phase, ethnographic research and quantitative surveys were used in three PVO sites to define the behavioral and nutritional objectives of the program, to identify a set of appropriate messages, and to devise an appropriate communications strategy. This formative research suggested a set of key behaviors that were crucial to nutrition improvement.

2) Expansion (1991–1993). In the expansion phase the project grew to include a total of ten PVOs (Table 1), three government ministries, and an additional donor (UNICEF). Project teams from each PVO were trained in the use of individual counseling to communicate messages related to the key behaviors identified in the first phase.

3) Consolidation (1993–1995). In this phase of the project the counseling activities were continued and reinforced by the introduction of a number of new communications methods: radio broadcasts, literacy training, and child-to-child activities.

[1] These changes included the replacement of the Nutrition Services as the Ministry of Health's lead agency in the project by a newly created nutrition agency in 1990 and the transition from military rule to a democratic government in 1992.

Table 1. Project PVO partners, geographical areas and populations served by the Mali NCP

PVO Partner	Geographical Area	Total Population Served
CARE	Macina circle, Ségou Region	56,000
Save the Children	Kolondieba and Zantiebougou Districts	150,000
Africare	Dioro, Ségou Region	92,500
World Vision	Koutiala district	100,000
Centre D'Appui Nutritionnel et Economique aux Femmes (CANEF)	southern Sikasso Region	127,500
Aide à l'Enfance Canada-Mali (AEC)	Koulikoro	50,000
Association d'Entréaide et Pour le Développement (AED)	Ségou Region	50,000
Plan International	Koulikoro	50,000
Programme Intégré de Developpement de Bafoulabé (PIDEB)	Kayes Region	50,000
Association d'Aide et d'Appui aux Groupement Ruraux et Urbains (3AG)	Koulikoro Region	35,000
Total		761,000

Some aspects of the Mali program raise important issues and challenges for the study of cost-effectiveness. Specifically, a) the wide involvement of so many institutions with different levels and kinds of inputs, financial and otherwise, make a complete cost accounting virtually impossible; b) the wide variety of activities undertaken by NCP make it difficult to distinguish program activities—and associated costs—from activities and costs that, although incurred, may not have been directly relevant to the program or specifically to the measured outcomes; and c) the benefits of the project extend beyond the limited geographic area of its implementation and, in time, beyond the project's final evaluation. Each of these problems is discussed in greater detail next.

First, the true economic costs of a program such as this should include, in theory, the economic value of all the inputs provided by the PVOs, government agencies, local volunteers, and beneficiaries. However, in this retrospective analysis we do not have enough information to estimate these costs. The approach taken here, therefore, is to relate effectiveness only to the external financial cost provided through NCP, from USAID and UNICEF. We might assume these to underestimate the true economic cost of the program. However, an argument can also be made that the marginal cost to the PVOs of adding nutrition communications to the existing child survival activities was quite small. The PVOs did not add staff or acquire extra materials, vehicles, or space for these activities. Instead, their costs were mostly the opportunity costs of alternative uses of the staff time taken to attend training sessions and implement the communications activities. The argument made here is that the actual opportunity costs are small (and possibly negative) because the communications skills acquired and the nutrition objectives pursued would have crossover advantages for other aspects of child survival programs, significantly enhancing rather than detracting from even non-nutritional objectives such as reduced morbidity and greater survival.

Second, the wide variety of activities undertaken by NCP make it difficult to distinguish relevant from non-relevant costs. For example, project funds were spent on the development of a primary school teachers' guide and on teacher training workshops, efforts with important long-term effects but probably without any immediate impact on preschoolers' nutritional status. Although it is theoretically possible to estimate the marginal cost of this activity and to subtract it from the total, this is not easy because the financial accounting was not done in a way that makes this kind of disaggregation feasible. There were many such activities in the mix that, while cost-effective in the long term, are unlikely to have had any measurable impact on preschooler nutritional status by the project's completion.

Finally, because materials and strategies developed under this project were used in other areas within Mali, and adapted for other countries in West Africa and elsewhere in the world, the geographic scope of the impact of this project is not limited to the target population. To the degree that the benefits of the project have been felt outside the project area, an estimate of cost-effectiveness that assumes geographical limitation underestimates total benefits. Similarly, because the benefits of this project are expected to extend long beyond the actual project period, a single post-project evaluation entirely misses much of the program's long-term impact.

Project Impact

Assessing the impact of the Mali NCP or the degree to which the project achieved its overall objectives of "improving the nutrition status of women and young children" (AED, 1995b), requires measurements of nutritional status. The project's *direct* objective, however, and the mechanism by which the improvement in status was to be achieved, was an improvement in behavior, suggesting that behavioral change should be the appropriate measure of effectiveness.

There are good reasons for measuring both status and behavior. The measurement of nutritional status is needed because a) it offers objective verification of improvements in feeding behavior that are difficult to measure; b) evidence is needed, not only that program activities result in behavior change, but also that these changes resulted in improved status; and c) although the specific behaviors recommended in programs are often situation-dependent and cannot be directly compared (in cost-effectiveness studies, for example), anthropometry offers a set of internationally standardized indicators that are functionally relevant and that can be compared across widely different cultures, intervention strategies, and target behaviors. On the other hand, when behavior change is the direct objective of the program, it is necessary to prove to donors and policy-makers that behavior actually did change. Any changes observed in status can then plausibly be attributed to the behavior change program.

The evaluation of the Mali NCP was planned as a quasi-experimental case-control study, with baseline (1990) and post-project (1994) surveys that examined nutrition knowledge, practices and status in eight project (case) villages and eight matched comparison (control) villages in each of three districts, giving a total of 24 project and 24 control villages. The evaluation was not a true experimental design because the allocation of treatment was not random and treatment status could not be hidden from the beneficiaries or investigators. If implemented according to plan, how-

ever, the design's ability to compare outcomes over time for project and control villages could offer a powerful test of the effectiveness of the intervention.

The use of quasi-experimental designs in nutrition program evaluation has been challenged on the grounds that conditions virtually never permit valid attribution of cause because such designs are virtually never implemented according to plan (Schön *et al.*, 1984). Common problems include exposure of comparison villages to project benefits, poorly standardized or lapsed treatments in project villages, confounding changes in conditions over time, and failure to observe the original sampling design during surveys. It is also rarely appreciated that the unit of analysis for village-level interventions is the village rather than the individual child or household. As a result, sample sizes needed to make statistical statements about the effects of interventions are often grossly underestimated. Although impeccably designed in many ways, the Mali NCP evaluation suffered from all of these problems, thus preventing a definitive statistical probability statement attributing a change in nutritional status to the program.

One problem in the evaluation concerned the actual measurement of project and comparison villages. Of the original 24 project and 24 comparison villages only eight project and four comparison villages were measured in 1990 and 1994. The results for these villages, shown in Figure 1, provide a quantitative estimate of the

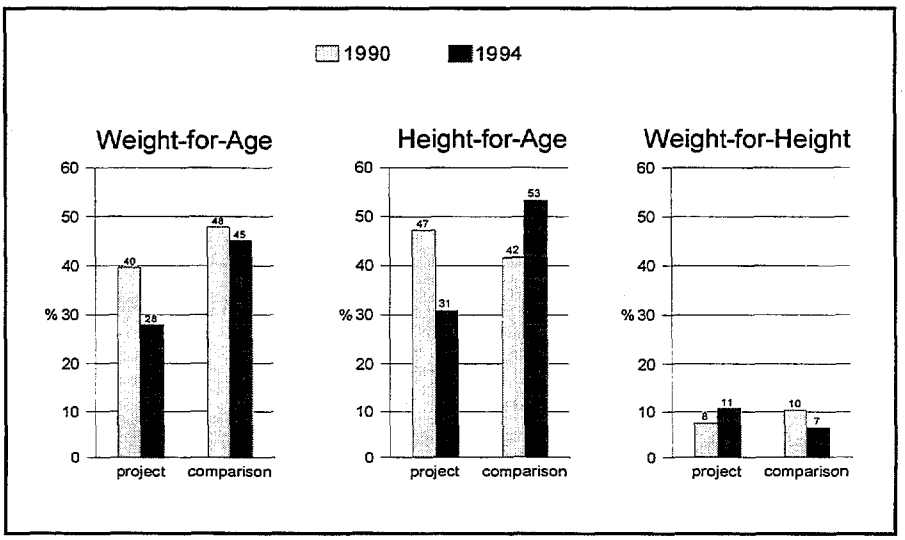

Figure 1. Malnutrition rates in 1990 and 1994 in project and comparison villages. Differences between 1990 and 1994 are statistically significant only for the improvement in weight-for-age and height-for-age in project villages.

impact of the program on the prevalence of low weight-for-age, height-for-age, and weight-for-height.[2] In project villages there was a reduction in the prevalence of low weight-for-age in children under 36 months of age from 40 percent to 28 percent, while the prevalence in non-project (comparison) villages remained constant. The improvement in weight-for-age appears largely due to an improvement in linear growth, since parallel changes occur in the prevalence of low height-for-age (47% to 31%), but not of low weight-for-height.

Although these results are large and in the expected direction, deviations from the original evaluation design preclude a definitive statistical probability statement that attributes improvements in nutritional status to the program. The challenge here is to present other evidence suggesting that this interpretation is plausible. To do this, the evaluators used a cross-sectional analysis of the post-project survey data. If nutrition practices and status are related to the duration of NCP activities in the village and to the NCP messages actually recalled by the mother, it is easier to argue that the changes observed are attributable to the intervention. Evaluators were thus able to build a different kind of argument based on *plausibility* rather than on statistical *probability* (Fishman and Golaz, 1996). The plausibility argument establishes that a) the project was well-designed and successfully implemented; b) there was a measurable change in nutrition knowledge, behavior, and status in project villages; and c) these changes are not easily explained in any other way. We examine the evidence for each of these statements in turn.

The project was well-designed and successfully implemented. The Mali NCP used a theory-based approach and state-of-the-art techniques to reach a well-defined target audience, delivering precisely the information and advice needed to improve infant feeding practices using a multi-channel behavior change communication strategy. This strategy was based on a period of formative ethnographic research undertaken in the project area and was guided by current theories on how to achieve behavioral change most effectively through communication.[3] A series of five storybook

[2]These measures of child nutritional status are standardized against a reference population of healthy children. Weight-for-age provides a comparison of a child's weight with the weight of an average healthy child of the same age. Similarly, height-for-age and weight-for-height provided a comparison of height and weight with expected height and weight based on healthy children of the same age and height, respectively. These measures are usually expressed in standard deviation units (z-scores); a z-score less than -2 (more than 2 standard deviations below the median for healthy children) is taken to indicate malnutrition.

[3]Through USAID's various health communication efforts (HealthCom, AIDSCOM, NCP, SOMARC; and the Child Survival Action Program) the "applied behavior change" or ABC approach has been developed, perfected; and broadly applied to achieve sustainable change in individual health behavior. This approach emerged from practical application of "social cognitive learning theory" (Bandura, 1995) and the "theory of reasoned action" (Fishbein and Middlestadt, 1995) among others (Smith and Elder, 1996).

flip charts, a set of counseling cards, and live drama were used to model appropriate nutrition behaviors. Later, these were reinforced using short radio spots and weekly broadcasts of a serialized drama. Much effort and many resources were put into training village-level health workers in a specially designed five-step counseling approach using the storybook flip charts and counseling cards. These activities were implemented in the context of existing child survival programs that had already achieved a degree of community participation and confidence. The evidence discussed below establishes not only that these activities took place, also but that they were effective in changing nutrition knowledge and behavior.

Exposure to NCP messages was measured by asking participants in the 1994 survey whether they had experienced certain components of the intervention. In project villages, 30 percent of the men and 45 percent of the women recalled at least one project intervention, compared with 6 percent of men and 18 percent of women in comparison villages. These results confirm that the project had significant reach within project areas and that non-project (comparison) communities were also exposed. To the extent that comparison villages were exposed to the NCP interventions, the apparent benefits of the project (in these comparative analyses) underestimate the actual benefits.

There was a measurable change in nutrition knowledge, behavior, and status in project villages. The evidence for improvement in child nutritional status has already been presented in Figure 1. Nutrition knowledge was assessed with questionnaires applied during the baseline survey, in 1990 and again in 1994. The precise content of messages was unknown at the time of the baseline survey so many of the more detailed questions that were used in 1994 were not asked in the earlier survey. Nevertheless, the 1994 survey included many of the items from the 1990 instrument that were considered relevant, such as general questions on exclusive breastfeeding and timely introduction of complementary foods. Figure 2 (on the following page) shows the results of comparisons between 1990 and 1994 for project and comparison villages for a number of relevant feeding behaviors targeted by the project. Although improvements were evident for most behaviors in comparison villages (likely due to cross-treatment), greater improvements for all behaviors were seen in project villages where, for example, the proportion of mothers giving breastmilk as the newborn's first food and withholding water until after four months more than doubled. There were also significant increases in the proportion of women reporting appropriate complementary feeding behaviors.

These changes are not easily explained in any other way. The original evaluation design matched comparison villages with project villages to ensure comparability. However, since this design was not followed precisely, it is possible that factors other

than the intervention might account for the improvements observed.[4] Here we examine two possible confounders of the relationship: socioeconomic status and age.

Socioeconomic Status. If economic conditions during the project period improved more in the project villages than in the comparison villages, this might provide an alternative explanation for the observed differences shown in Figures 1 and 2. Two lines of evidence suggested that this was not the case. First, evaluators looked for a relationship between weight-for-age and ownership of a radio or bicycle in 1990 and in 1994. Although bicycle and radio ownership were twice as great in project villages, neither was significantly related to weight-for-age in 1990 or 1994. This suggests that wealth alone is not a significant predictor of nutritional status in this context, an observation consistent with greater acknowledgment of the role of inadequate infant feeding practices, independent of household level food availability as

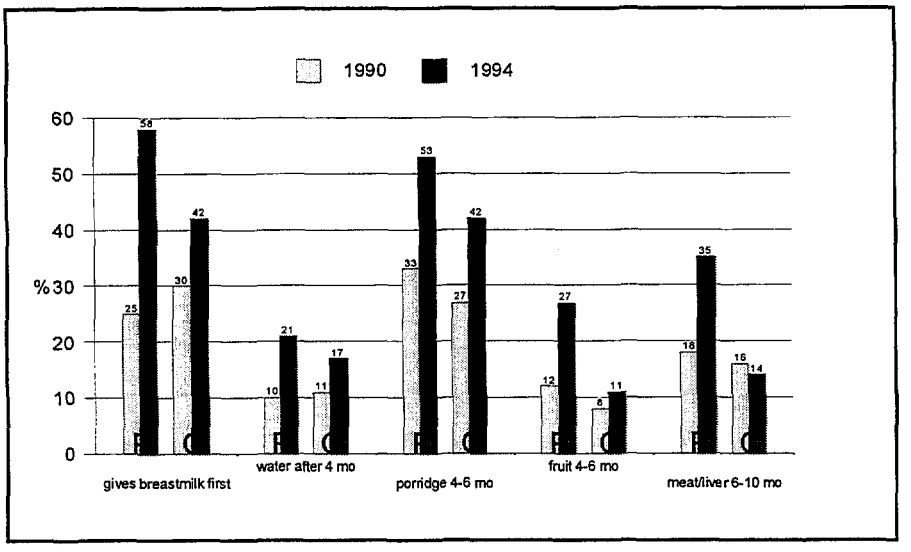

Figure 2. Percent of sample reporting appropriate infant feeding practices in project (P) and comparison (C) villages in 1990 and 1994 (Fishman and Golaz, 1996).

[4]Although there were 24 project villages and 24 control villages selected in the original evaluation design, one district (16 villages) was dropped from the project when the NGO overseeing these activities ceased operations in 1993, and in another district all "comparison" villages were eventually included in the project, thus limiting the contribution that these villages could make to the evaluation. These circumstances, together with budget cuts that reduced the number of villages that could be resurveyed, and decisions made by the post-project survey team to exclude other sites, meant that only eight of the original project villages and four of the comparison villages were actually measured in the post-project survey. Furthermore, all four comparison villages came from a single district, and most (75 percent) of the project villages came from another. Statistical comparisons, which assume random allocation of treatment, are thus rendered meaningless. There is also potential for confounding of project effects with geographic ones, particularly since a) the district with the majority of project villages and no comparison villages was significantly wealthier, both in 1990 and in 1994, and b) significant improvements in economic welfare occurring throughout southern Mali between 1992 and 1994 may have been felt more in one district than another.

a determinant of child nutrition (Engle, 1995). Second, when the sample was divided at the median wealth score, and the effect of the project was examined within wealth strata, the effect of NCP remains strong. Thus, we still see an effect of the project when wealth is held relatively constant (Fishman and Golaz, 1996).

Age. Nutritional status generally declines between 6 and 24 months, then levels off in the case of height-for-age or recovers slightly in the case of weight-for-age. Any differences in the age profile of the sample between pre- and post-project surveys may therefore influence the observed prevalence of malnutrition, independently of project effects. In the 1990 survey children 6–24 months old were oversampled because the project was expected to have the greatest impact on children of this age. In 1994, on the other hand, virtually all children under 36 months were sampled so that the average age in the later sample is greater. Because of the usual decline in nutritional status with age, we would expect this slightly older sample to have lower mean nutritional status in 1994 than in 1990. There is some evidence that this was true for height-for-age in comparison villages, but this difference is not statistically significant. However, children in project villages, contrary to expectation based solely on the age distribution of the sample, had *better* nutritional status than the younger children in 1990. Age differences are therefore unlikely to explain the improvement.

An important argument in favor of a causal relationship is an increase in the response to the intervention with greater exposure to it. Evidence for this "dose-response" relationship comes from the 1994 survey results. So far, we have used the post-project survey results from the same villages measured in the pre-project survey. We will now look at additional information obtained in 1994 from villages not surveyed in 1990, permitting cross-sectional comparisons of villages and individuals with different degrees of exposure to the intervention. In the 1994 survey ten villages from each of three districts were sampled. These villages were categorized according to the lengths of time each participated in the project and the time elapsed since participation at the time of the post-project survey, as follows. **High**: A minimum of one year and actively engaged at the time of the post-project survey. **Medium**: Participation for more than six months but less than one year, or, for one year or more but not active for the past two years. **Low**: No deliberate participation but possible inadvertent exposure. The number of men, women, and children surveyed in each exposure category is given in Table 2.

Table 2. Group sample sizes for cross-sectional survey in 1994.

Exposure Category	Group: Men	Women	Children (<36 months)
High	169	337	388
Medium	92	187	227
Low	93	188	230
Total	354	712	845

This categorization is confirmed by the survey results, in terms of the number of NCP components (excluding radio) that men and women could remember and in terms of the percentage who could recall at least one intervention. These results, shown in Table 3, show a clear trend toward greater recollection of NCP components with increasing exposure. Even in villages that did not officially participate in NCP activities, 11 percent of men and 21 percent of women could recall at least one component, testimony to the extensive reach of the project beyond participating villages. Results not presented here show similar dose effects for recollection of particular channels and even particular counseling card images (Fishman and Golaz, 1996).

Table 3. Recollection of program components by men and women in different exposure categories.

	Mean Number of Components Recalled		% Recalling at Least 1 Component	
Exposure Category	Men	Women	Men	Women
High	1.34	2.06	33.7	56.1
Medium	0.79	0.66	18.5	30.5
Low	0.31	0.43	10.8	20.7

The impact of this exposure on behavior was investigated by asking about actual infant feeding practices. Results for each exposure category are compared in Figure 3. In villages with greater exposure to NCP messages, mothers were more likely to feed breastmilk as the first food, to wait until after four months before introducing water, and to feed certain complementary foods recommended by the program. All of these behaviors are considered conducive to lower morbidity and better infant growth.

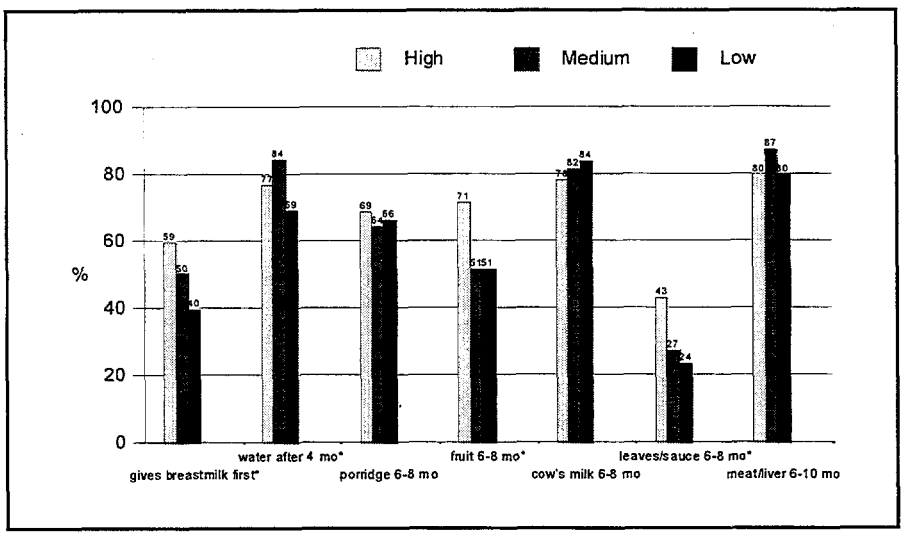

Figure 3. Percent of sample reporting appropriate infant feeding practices in high-, medium-, and low-exposure villages. Items with asterisks indicate statistically significant differences ($p<0.05$).

To summarize the results of these evaluations, the pre- and post-project surveys suggest that in project villages, NCP activities were responsible for a reduction in the prevalence of low weight-for-age from 40 percent to 28 percent and in stunting from 47 percent to 31 percent. Although there were differences in the age profile of the sample at each point, this is unlikely to explain the improvements because nutritional status generally declines with age and the later sample is older. There were also improvements in general economic conditions over the interval of the program, but these have no apparent impact on nutrition in non-NCP villages, and cross-sectional analyses reveal no relationship between economic factors and child nutrition in this population. The causal link between NCP activities and improvements in nutrition is even more plausible considering the strong technical design and effective implementation of the program. This is further supported by evidence from the 1994 cross-sectional survey of improvements in infant feeding behavior could be expected to result in the observed improvements in nutritional status, and by the strong association observed between these reported behaviors and actual program exposure.

Costs

The financial cost of the Mali NCP was $874,779 to USAID and $220,000 to UNICEF for a total cost of $1,094,779.

Ideally, cost studies should be undertaken concurrently with the program they are evaluating. This permits ongoing disaggregation of project expenditures in a way that facilitates distinctions between different kinds of financial expenditures and between financial and other economic costs of the program. These distinctions are valuable for policy purposes because a) not all of the total costs of a program may be relevant for every application or for every outcome of interest, and b) often more than just the financial costs should be included.

Relevant Costs. The financial costs of the Mali program may include those for activities that have little direct bearing on the effectiveness indicator chosen here. Such cost may be seen as superfluous to the program for the purpose of determining cost-effectiveness and perhaps should be subtracted from the total. For example, before the intervention part of the program began, 20 country visits were made by international consultants (for reconnaissance, planning, ethnographic research, program development, baseline surveillance, and training). Although not *all* of these visits *fully* focused on the development of this program[5], or on those aspects of the program that could be considered to have a direct impact on child growth, it is impossible to identify superfluous activities and estimate their marginal costs. Other activities that may be considered partly superfluous include a vitamin A survey, the development of literacy materials with nutrition messages, development and application of a training module for primary school teachers, and a vitamin A "knowledge, attitudes, and practices" survey. This is a problem even for concurrent cost studies, but is particularly difficult for retrospective ones such as this for which financial records and activity reports do not permit the necessary disaggregation.

The second problem with retrospective cost studies is that, while institutional financial accounting systems are designed to monitor *financial* costs, there are often economic costs that never enter the implementing agency's accounting ledgers.[6] In the case of the Mali NCP program these include the resources used by the NGOs to have their staff participate in program training, implementation, and evaluation, as well as the opportunity costs of participation by the beneficiaries themselves.

[5]For example, some visits were made for planning a vitamin A program with the Ministry of Health which was canceled mid-way in the design phase.

[6]Financial costs include all money spent to implement the intervention. Economic costs more accurately reflect the full cost of the intervention because they include the opportunity costs of financial and non-financial resources used.

The approach taken here is to use the total financial costs to USAID and UNICEF as the cost of the program. Subtraction of non-relevant costs would require a number of arbitrary decisions about the relevance of particular activities. Even once these were identified, the cost data are not disaggregated to a degree that would permit the costs of these activities to be estimated without a number of additional arbitrary decisions. We should emphasize that inclusion of the cost of non-relevant activities will cause further underestimation of the cost-effectiveness of the program.

Cost-effectiveness

For our purposes, two outcome measures are proposed for estimating cost-effectiveness: 1) children saved from malnutrition and 2) child lives saved as a result.

Children saved from malnutrition. The estimated total population covered by NCP activities in Mali was 761,000 (Table 1). Using the current demographic profile for the country (UN, 1994), approximately 11.83 percent of this population, or 90,026 children is under age three. Given the reduction by 12 percentage points in the prevalence of low weight-for-age, and by 16 points in low height-for-age, the number of *current* cases of malnutrition prevented or cured is therefore 90,026 x 12 percent = 10,803 (underweight) and 90,026 x 16 percent = 14,404 (stunting). The cost per child saved from underweight is therefore $1,094,779/10,803 = $101. Similarly the cost per child saved from stunting is $1,094,779/14,404 = $76. This underestimates the true impact of the program on malnutrition because it does not include the impact on children in previous years who have aged beyond the current under 36-month cohort. Nor does it include any enduring impact of improved behavior on children yet to be born. The number of children missed by these estimates is potentially greater than the number included. These issues are addressed in greater detail in the discussion.

Child lives saved. It is possible to estimate the number of child lives saved due to the reduction in underweight using the methods and relative risk estimates derived by Pelletier *et al.* (1994). The additional assumptions used in these calculations are that a) the prevalence of underweight was reduced from 39.6 percent in 1990 to 27.9 percent in 1994; b) this reduction occurred in a linear fashion between 1990 and 1994; c) the baseline child mortality rate of 214/1000 live births reported for the country as a whole (UNICEF, 1996) applies for the region served by NCP; and d) the prevalence of malnutrition in children under 36 months applies to the entire under-five population. The last assumption is necessary to use the under-five mortality rates to compute the number of lives saved. Since most under-five mortality occurs in children under 36 months, and since weight-for-age prevalence changes very little after about 24 months, this assumption is unlikely to bias the calculations presented here.

Cost-effectiveness

The prevalence of mild, moderate, and severe malnutrition in 1990 and 1994, converted to the percent-of-median system using the formulas given by Pelletier *et al.* (1994), is given in Table 4. Assuming that the relative risk of mortality due to mild, moderate, and severe malnutrition is 2.5, 4.6, and 8.4, respectively, the proportion of child mortality attributable to malnutrition in 1990 was 53.2 percent, with mild and moderate malnutrition alone accounting for 41.4 percent of child mortality.[7] The reductions in malnutrition between 1990 and 1994 (seen in Table 4) that we attribute to the NCP program would result in an overall reduction in nutrition-related mortality over this period by 18.4 percent with a reduction by 35.6 percent in the final year of the program. In absolute terms, if nutrition prevalence remained at the 1990 level, there would have been an estimated 39,700 child deaths in the NCP area, 21,100 of which would have been due to malnutrition and its interaction with infectious disease. The improvements in nutrition over the five years from 1990 through 1994 saved an estimated 3,822 child lives, at a cost per life saved of $282 ($1,094,779/3,882). This calculation does not include any benefits of the program beyond the final evaluation. To the extent that behavioral changes were sustained for the current cohort of children and for any children yet to be born, this calculation underestimates the total number of child lives saved due to the program.

Table 4. Prevalence (% of children) with low weight-for-age using the z-score and % of median systems. Percent of median prevalence are computed using formulas given by Pelletier *et al.* (1994).

W/A category	1990	1994
z-score <-2	39.6	27.9
<60% of median	3.4	1.3
60–69% of median	12.3	7.3
70–79% of median	29.4	24.8
<80% of median	45.1	33.4

[7]The percentage of a condition due to a risk factor is known in epidemiology as the "etiologic fraction" or "population attributable risk" (PAR), which is calculated here using formulas provided by Pelletier *et al.* (1994) after Kleinbaum *et al.* (1982).

The cost-effectiveness of the Mali intervention compares favorably with that of nutrition programs reviewed by Horton (1992), who reports the cost per death averted was $1,482 for the Tamil Nadu supplementary feeding program and $1,522 for vitamin A capsule distribution in Bangladesh.

Discussion

We have argued that the cost-effectiveness estimates presented here are plausible. However, due to problems with the design and implementation of the evaluation, we cannot, in principle, derive statistical confidence limits on these estimates. Our confidence in these estimates is thus not derived from statistical theory but from ancillary corroborating information from the cross-sectional survey. Also, because of possible selection biases that may have reduced the comparability of project and control villages in the final sample, and because of the different age profiles of the pre- and post-project samples, there is a real possibility of confounding by socioeconomic status and child age. However, as discussed earlier, the lack of correlation between economic indices at the household level and reponse to the intervention suggests that such economic factors are not important. Differences in the age profile between 1990 and 1994 are unlikely to threaten the validity of the results reported here because the 1994 sample is older on average and, in the absence of a project effect, would have appeared worse off rather than better.

There are reasons to believe that the cost-effectiveness estimates reported above underestimate the true cost-effectiveness of the project. First, at the time of the final evaluation, the population included children over the age of three who, although exposed to the intervention, are not included as beneficiaries here. Since field activities ran in some villages from the beginning of 1991, children of an age most likely to benefit from the program at this time (6–18 months) might be five years old by the time of the post-project survey in December 1994. Any nutritional benefits to these older children would not have been detected in the evaluation. A cohort-component method to estimate the number of children to have benefited would more accurately capture the true benefits of the project.[8]

[8] Using a cohort-component approach we assume that a) the reductions in malnutrition are linear over the period of the program; b) the new children "saved" from malnutrition in a given year are all children of weaning age (6–18 months); and c) once a child is "saved" from underweight or stunting, he or she continues to maintain this well-nourished status throughout childhood. This is unlikely to be true for every child but is probably true on average so that the prevalence of malnutrition remains at the improved level. Choosing a one-year age interval is merely a computational convenience. Calculations show that the cohort-component method results in estimates of children saved from malnutrition over the five years from 1990 to 1994 are 38 percent greater than by simply multiplying the 11.7 percent reduction in prevalence by the 0- to 36-month-old population in 1994.

Second, subsequent cohorts (children yet to be born at the time of the 1994 survey) are also expected to benefit from the NCP intervention, to the extent that the improvements in infant feeding behaviors are sustained. In fact, sustainability of the improvements was enhanced by investing heavily in health worker and teacher training, thus increasing institutional capacity for behavior change. The expected benefits to subsequent cohorts of children, also unmeasured here, are expected to be substantial. For these reasons, this assessment of only the current benefits to the current population of children under three underestimates the value of the program.

Finally, the NCP materials and methods have benefits that were, and continue to be, felt far beyond the geographic boundaries of the project area. These materials were used at the time in similar NCP projects in Niger and Burkina Faso and are still being adapted for use in other countries within West Africa and in other regions.

Conclusions

Cost-effectiveness studies are best begun early in the design phase of a program to ensure an adequate accounting of financial and other economic costs from the outset. For the purposes of cost-effectiveness analysis, it is particularly important that the opportunity costs of non-financial inputs (such as volunteer labor or donations of resources from other agencies) be identified, shadow-priced, and appropriately recorded. It is also wise to disaggregate costs according to whether they are used to design and develop the program, begin implementation of the program in a new area, or continue implementation of an existing program. Disaggregation along these lines allows the cost-effectiveness of each stage of the program to be considered independently by decision-makers. The NCP financial accounting systems, while adequate for most administrative purposes, did not include non-financial costs and did not disaggregate by stage of implementation or in a way that permits identification of costs that are not relevant to a particular outcome.

Bearing these caveats in mind, gross estimates of the cost-effectiveness of the Mali intervention suggest that it cost $101/child removed from malnutrition and $282/child life saved. These estimates compare favorably with those from the literature. This project can be expected to have impact beyond its immediate target populations and implementation periods. Because these geographic and temporal spillover benefits cannot be measured, the cost-effectiveness of these programs is underestimated.

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