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Until relatively recently the paramount concerns of nutritionists and policy makers in that field seem to have been exclusively of a scientific nature. Humanitarian concern has been the overriding basis for application of their work and must not be neglected. However, many have begun to realize that economic questions should also be of primary importance. We intend to show how economics can be integrated with nutritional science to assist in the development of needed policies.

The link between economics and nutrition has roots in the past but the interconnection has been largely neglected for two centuries. Malthus' interpretation of the relationship between population growth and food production was found wanting because of technological changes which he did not and could not foresee. He predicted that while population would grow geometrically, output would grow only arithmetically, and cyclic famines would occur. While Malthus was incorrect for the industrial nations, his predictions still hold to a lesser extent for less developed, densely populated countries such as India and Brazil.

Economics involves the study of how men choose to employ scarce resources. Resources have alternate uses in production and consumption. There are a myriad of ways in which a society's resources can be allocated. Each different pattern of allocating resources provides a different level of welfare or well-being to the society. This welfare is composed of the positive and negative contributions to the economy from a pattern of allocation. There are two aspects to most questions of allocation--efficiency and equity. Efficiency involves the most <u>productive</u> use of scarce resources. Equity relates to the <u>justness</u> or <u>fairness</u> of the distribution of these resources. Economic analysis assists in understanding the tradeoffs between efficiency and equity. For example, allocating funds for a new factory to increase output might be more

productive than providing food supplementation to workers in a less expensive facility while spending the same total funds. This is illustrative of the efficiency aspect of economic analysis. Total productivity may even be lower but society's desire for good health for its citizens may outweigh efficiency considerations so the food program would be implemented on equity grounds. The greatest output is not necessarily best for society when judgments of fairness are included in an analysis.

If a society's resources were not limited, there would be little need for an economics of nutrition. Unlimited resources could then be devoted toward the elimination of malnutrition. It is obvious that scarcity of resources exists. In fact, most developed and underdeveloped countries cannot provide the most basic social services to all of its citizens. One cannot expect developing countries to design nutrition programs to completely end malnutrition while there are so many other pressing demands on funds.

Given this scarcity of resources, allocation of funds must be made between numerous programs. Nutritionists and economists together must help establish the priorities between food and other types of programs. Cost-benefit analysis providing a thorough examination of the efficiency question is one basic approach toward establishing priorities. This technique enables the analyst to determine the relative benefits from a given set of expenditures for a variety of programs. However, cost-benefit analysis cannot answer all the questions as it can not deal with many nonquantifiable areas. Effects of nutrition on mental health and skeletal structure are two areas where quantification is impossible. Other aspects are difficult to quantify accurately.

In the past, the application of nutrition has been exclusively related to humanitarian concerns, those which are

included in what we have labeled equity. On the efficiency side also, nutrition is a significant economic input. An exclusive concern for equity probably has led to insufficient investment on food programs. The realization that investments in health through nutrition provide economic benefits, as do investments in plants, equipment, education, technology, should lead to greater investment in nutrition programs and research.

Economic questions of efficiency are frequently operationalized through the use of cost-benefit analysis. As applied to the public sector, this analysis is basically a means by which one compares the benefits to society of a program to the costs incurred. The benefits or costs may occur at the same point in time or over the same of different time spans.

Of key importance to food program analysis is that this technique explicitly considers the time stream of benefits and costs. One should note that a program with large benefits in the future (preschool feeding) may be less valuable to a society than one with small benefits in the short run (factory lunch program).

Cost-benefit techniques and other aspects of economic analysis can lead to an understanding of the implications on a nation's economy of various nutritional programs. This understanding is important in establishing priorities for nutrition research.[2]

This study focuses on types of economic benefits associated with nutritional improvement. Nutrition is but one of a number of potential inputs incorporated in the health spectrum. The output of these health inputs is reflected in morbidity, mortality, life expectancy, etc. The factors affecting health can be grouped into four areas: demographic (e.g., age, race, place of residence and population density), socio-cultural and economic (e.g., occupation, nutrition, housing and education),

environmental (e.g., general sanitation and air and water pollution) and medical (e.g., physicians, hospitals, nurses and medical research).[3] There is a large number of interactions between and within each group. The output of the health programs can influence, in turn, the inputs.

It is worthwhile noting that malnutrition is probably the most significant health problem throughout the world. Malnutrition, broadly defined as an inadequate intake and utilization of various nutrients and/or calories such as to significantly impair one's mental and physical performance, is estimated to afflict more than 30% of the population of less developed countries.[4] Its impact is most severe on the young, of whom 20-80% are malnourished.[5]

Although the problem is of massive dimensions, most efforts toward developing nutritional programs have been small scale or of a temporary nature because of some emergency.

A. Nutrition as an Economic Input

Improved nutrition has largely been viewed in a humanitarian context. In economics, it is termed a merit want, i.e., there is a considerable desire within any society to ensure that no one is starving. Although in general it is difficult to quantify the benefits to the adequately nourished, these benefits must still be considered in any sensible analysis of food programs. The gains in efficiency can be quantified more easily. In this section we will deal with these.

Numerous benefits may come from the change in nutritional status of individuals or populations. Much of the available information which demonstrates the effect of elimination of malnutrition has been summarized for this discussion.[6] Benefits to economic efficiency from improved nutrition can be considered in ten categories. These categories and a brief discussion are presented below. It should be noted that although all these relationships between the various categories

such as physical and mental performance are quite clear, many of the specific interrelationships are not understood completely. Furthermore, most relationships have not been examined for their effects on large populations. These relationships are mainly based on small studies and inferences drawn from laboratory and clinical findings.

1. Physical performance: Improved nutrition should increase the capacity for prolonged physical work, raise the productivity of workers, and increase the motivation to work. Caloric requirements for work are one of the three major requirements that must be satisfied by the energy produced from food. The other two are basal metabolism to keep up the life processes and growth requirements for children, adolescents, and expectant mothers. There is a close correlation between adequacy of work calories and work productivity. If the work calories are below the required amount for the activity being undertaken, two things will happen. First, the body will adapt somewhat to this lower food intake by avoiding effort. Second, the body will lose weight.[7] The economic studies in this area leave much doubt of the actual significance of improved nutrition.

2. Mental performance: Improved nutrition improves learning, through what is believed to be structural changes in the brain, prevents an interruption of cognitive development, and increases the ability to concentrate and work. There are three reasons for this relationship. First, severe malnutrition increases the incidence of permanent brain damage among children aged 0-3.[8] If the undernutrition occurs after the age of 3 years, there will probably be no permanent damage. This question of permanent retardation remains open as many factors are still unknown.

Second, malnourished children, even if they have not suffered brain damage, may suffer retarded cognitive development. The apathy of nutritional deprivation (especially anemia and

protein deficiency) results in poorly developed inter-sensory integrative performance. Often the result of this apathy and listlessness is questionable. But, Dr. Joaquin Cravioto sees these aspects of the infant's behavior leading to a progressive withdrawal from the environment. The inactive child does not utilize the stimuli around him. This leads to a delay in the conditioning of the effective production of conditioned reflexes. "Evidence already exists that the lag in the development of certain varieties of inter-sensory integration have a high correlation with backwardness in learning to read. . ." [and] "can interfere with the second primary educational skill--learning to write."[9]

Third, children aged 6-18 can not utilize fully the potential to concentrate on work displayed by the well-nourished children of the same background. Hungry children are unable to concentrate, have poor judgment, are irritable, moody, and unable to sustain mental application. Controlled studies done in Asia, Africa, and the U.S. have shown that increased food intake produces changes in mental performance.[10]

3. Morbidity: Improved nutrition results in higher resistance to disease and lowers the severity of that disease. Poor nutrition can lead to a greater incidence of bacterial, viral, richettsial, and protozoal infections. Some of the mechanisms of the synergism are interference with antibody response, alternation of tissue integrity, interference with non-specific protective substances, non-specific destruction of bacterial toxins, and nutritional alteration of endocrine balance.[11]

In less developed countries, among the pre-school children protein-calorie disorders and iron deficiencies seem to be the most serious.

Improving nutrition and reducing morbidity would lead to greater attendance at both school and work. There are two aspects to the morbidity question. One is disability. That is, the people unable to work, and the other is debility or lowered productivity because of the sickness. Only disability is considered under the classification of morbidity. The issue of debility is covered under the first two categories, mental and physical performance. Numerous studies have shown how this relationship between nutrition and morbidity will result in lower morbidity rates when malnutrition is eliminated or when the individual receives better nutrition although his nutritional status might categorize him as being malnourished.[12]

4. Mortality: Improved nutrition decreases fetal, infant, child, and certain types of maternal mortality significantly. Malnutrition directly increases the mortality rate for women and indirectly for infants 0-1 and directly for infants after they are weaned. During pregnancy the fetus drains the mother of many nutrients which in malnourished mothers leads to a higher incidence of maternal mortality. Also, maternal mortality is a major cause of immaturity and prematurity, both frequently recurring factors in infant deaths.[13] (Between 1/2 and 3/4 of all children who die in the first four weeks of life) are premature.[14]

Numerous studies have validated this relationship between improved nutrition, especially increased iron and protein, and reduced mortality in less industrialized countries, but few conclusive studies have been completed in the western industrialized countries.[15] In less developed countries often the cause of death is usually some interaction between malnutrition, parasitic load, and infectious disease.[16] The interaction between malnutrition and infectious disease

exists simultaneously. Malnutrition worsens the infectious disease and increases the likelihood of fatality. At the same time, infection intensifies malnutrition and will often lead to further disorders. This constellation includes nutrition, parasitic diseases and health problems such as diarrhea.

Most people have great difficulty in placing an economic value on life. Perhaps because of the nature of economics as the dismal science, economists appear to have less difficulty than most. We have tried to follow one noted economicst's reasoning: "What I tried to do," said T. C. Schelling about his paper, "was to avoid the two traditional approaches to saving lives or reducing mortality statistics. One approach is that life is priceless and the other is that life is worthless."[17]

Lowering the death rate due to malnutrition might exacerbate the problems associated with other diseases. Since more sick children will live but remain debilitated, the death rates will rise from measles, hookworm and other diseases which a healthy child can withstand.

5. Structural development: Improved nutrition will increase the height and weight of an individual, may reduce fragile bones among the aged, and will increase trainability of muscles. There is little question that a malnourished child will grow at a slower rate than the well-nourished child, and also if the child is malnourished at a very early age, he will probably never attain the same physical size as a well-nourished child. The same relationship is thought to hold for the head size of the individual.[18] The relationship between height and nutrition is very sensitive in a long term. Studies have shown that famines or economic crises of war can lead to decline in the height of children as happened in Moscow in World War II, during a famine in the Middle Ages in

Iceland, and after a famine in the 1880's in Italy.[19] Little can be said about the direct economic impact of shorter height, or smaller size.[20] Kraut and Muller cite several studies to show a reduction in the Vitamin C supply will reduce muscle trainability and an increase in the protein supply will increase muscle strength.[21]

6. Mental health: Better nutrition will lower the number of behavioral disorders such as irritability, restlessness, and anxiety of many age groups. Malnutrition is believed to cause some behavioral disorders. Changes in behavior are the most difficult relationships to quantify and also the most difficult to unravel from their many complex interrelations with other factors.[22]

7. Fertility decline: An unverified hypothesis is that improving nutrition will lead to a reduction in the birthrate. One of the reasons for this is believed to be the close link between birthrates and death rates in developing countries. Thus, lowering the infant mortality rate would lead ultimately to a lowering of the birthrate.[22.5] Some have argued that large families are characteristic of less developed countries because parents anticipate security in their old age from support provided by offspring. Thus, a decline in infant mortality will mean that fewer births within a family could lead to the same number of progeny reaching maturity. Critics of this viewpoint stress the tremendous lag required for the birthrate to adjust and note also that adequate birth control will be required. Additionally, well fed females will mature faster; consequently, in industrialized countries, the age of menarche (onset of menstruation) has declined several years over the past several centuries.[23] Better nutrition is felt to be the prime factor in this decline. Less developed countries could also be affected by an earlier onset of menarche.

In these countries a decline in the woman's age of menarche from about 16 to 13 could lead to an increase in fertility because age-specific fertility years peak much earlier in the Third World than they do in western countries.

Other reasons for increased fertility would come with a decline in stillbirths, and a decline in short periods of sterility or even in permanent sterility caused by diseases such as malaria, measles, and yellow fever.

8. External effects; Benefits of improved nutrition accrue not only to the individuals who would be fed. Considerable gains would accrue to individuals other than the target population of the nutrition program. There are two aspects to this. The first is related to the larger question of income distribution. People who are hungry, one might hypothesize, will be more likely to steal to obtain food. There is a considerable cost involved in preventing such crime and similar social pathologies.

The second and more meaningful aspect is that the malnourished have a greater tendency to transmit communicable diseases and parasites (TB and hookworm). Adequate nutrition will help to break the chain of many infections. The total benefits will be far greater than those received by the recipient of the food program. The methods for evaluating these benefits are controversial. One cannot ignore the numerous other non-quantifiable benefits such as increased political participation and social integration.

9. Intergeneration effects: There will be many benefits accruing to later generations. The effects of better health will benefit future generations in at least three ways:

a. The children of healthy parents will be healthier and better motivated.
b. Healthier mothers will have an easier time raising their children.
c. Children of the better educated will be better educated through informal education which the children receive at home.[24]

These inter-generational financial gains have been estimated for the U.S. to be at least 14% of this generation's financial gains. Popkin's analysis assumed they were 10% of the total economic benefits received from better mental and physical performance and lower morbidity and mortality rates.

10. Associated benefits.

The reduction of the number of malnourished will result in a decline in the demand for medical services to treat them and hence lower medical expenditures. Part of the savings for lower medical costs accrue to the individual and part to society which subsidizes these costs. It is frequently the case that health services for the treatment of the malnourished are so scarce that there will be few benefits accruing from a reduction in their treatment and rehabilitation. Possibly more significant is the reduction in expenditures by the poor on burials. This is the logical consequence of lowered mortality.

B. Benefit Analysis

If the larger society responds in the same way as the smaller samples upon which some of the previous section's relationships were based, mathematical projections could be used to indicate nationwide response.[25] The policy maker faces the prospect that any national nutritional program would be costly. He must consider, of course, the reverse side of the issue as well: What benefits does a nation forego in not taking action against hunger and malnutrition? The analysis of the benefits pointed out above are the subject of this section. We consider below several concepts which must be appreciated before we deal with some applications of this procedure.

1. Public versus private: In evaluating the benefits of a program, the public agency assessing the programs should include the public gains, the private benefits received by the target population and also the relevant external benefits received by the nontarget populations.[26] The calculation of the benefits to the public sector is independent of its ability to capture these benefits. This is unlike a private business which is only interested in the benefits which it can capture and bases its investment decisions upon these benefits and its private costs.

2. Utilization of increased capacity:

a) There exists the probability that this increased mental and physical capacity cannot be utilized.

One might argue along traditional economic development lines that the benefits from increasing the nutritional status of the populationwill not be reflected in increased national product. This argument has been made for overpopulated countries and is associated with the theory of surplus labor. Its basic idea is that some populations are so dense, and have so little tillable land, that additional workers could do nothing. An addition to or removal from any farm of even one worker will not change the total output. First, this theory has weighty opponents in the economics field. It has nowhere been proven. Second, it ignores structural breakthroughs that might occur. One example is an increased mental and physical awareness might enhance the ability of people to deal with a changing environment. This would be exhibited by farmers adopting new techniques more readily. The questionable assumptions relating to the capturing of economic benefits will be discussed later.

b) One should not expect that improved nutrition will solve the poverty problem and change the distribution of income in less developed countries. People will still function in the same labor markets. Who receives the benefits and the question of income distribution must be a constant consideration.

For example, in the study which one of the writers did on the U.S., he considered the poor to be in a different labor market from the nonpoor, and he assumed that labor market structures would not be changed by improved nutrition.[27] Thus, while the poor would continue to receive low wages, many would receive somewhat higher wages from increased productivity and others would become employable.

3. Valuation of Benefits

One class of benefits is termed real in that it increases the productive capacity of a society. We will discuss one case where real benefits have been evaluated.

In Popkin's study of the elimination of malnutrition among the poor in the U.S., he found that economic benefits would come about because poor children would be capable of a 10-30% higher mental achievement. This would result in both a 10-30% higher performance in each grade, and a 10-30% reduction in number of grades repeated by these same children. This causative relation between the higher achievement and the improved nutritional status is based upon a detailed analysis of clinical nutrition literature and discussions with many nutritionists. The relationship upon which this analysis is based was discussed in general terms above (Section A).[28]

There are 3.3 million malnourished children living in poverty. The total gain in higher mental performance in lifetime earnings is $.6-$19.2 billion, mainly in higher achievement. The pertinent economic benefits from higher mental performance is calculated by using the lifetime income differential between high school dropouts and high school graduates.[29] There are two basic assumptions which justify this: First, gains in yearly achievement have the same implications for future earnings as do gains in knowledge resulting from more years of schooling. Second, short-term

gains in educational achievement can be retained over time. Some children with better nutrition will attend school for an extra year while others will gain in achievement. The extra year in school and the gain in yearly achievement will be assumed to have the same impact on a person's earnings potential. Among malnourished children 0-5 and 6-18, 10-30% higher achievement will be gained by eliminating malnutrition. Income differential between high school dropouts and high school graduates is fairly representative of what additional schooling (or an increase in achievement) is worth.[30]

Also, there will be a 10-30% reduction in the rate of grades repeated by these same children. The results were obtained by taking the number of malnourished children 6-17 (the school population) and multiplying this by the respective failure rates to determine the number of children who fail at least one year of school. The percentage reduction of this rate was then applied and finally the current income for 18 year olds was used to determine economic benefits. It is assumed that the reduction of the failure rates means that those children who will no longer repeat a grade will now receive income at least one year sooner and thus income at age 18 was used. The range of benefits from reduced failure would be between 123 and 369 million dollars.

In a more recent evaluation of milk programs for pre-school children in Chile, Selowsky provided an important addition to the state of the art. He assumed changes in intellectual status of the malnourished children from the milk program would bring their status to that of the control group and that this improvement, in turn, would place them in the category of employed (not unemployed) laborers. This program would provide a rate of return of 19-25%.[30.5]

For physical performance, the calculation is simple. It is the change in productivity times the number of workers plus the newly employable workers times their average productivity. One way to measure the increased productivity of salaried

workers is to examine changes in the wage rates of the target population. For many reasons this is downward biased as workers would not capture all of the benefits of their increased productivity. Thus it would be more useful to study actual changes in output. A study of changes in actual output will be the best approach for other sectors such as agriculture.

The calculation of benefits from mortality is slightly more complicated. The way this is done in America is to assume that a life lost is a significant economic loss to society, in the sense that the individual would be able to produce a given amount of income for the rest of his lifetime. The present value of that income is calculated and taken as the economic benefit of eliminating malnutrition.

The questions of productivity and of employment and unemployment obscures this relationship for many less developed countries. There is another form of analysis which might give a lower bound to the amount of benefits available to a society from reducing malnutrition. The proportion of natural resources consumed by people who die without making any contribution to national income can be determined. This can be termed the what-is-put-in approach. It was originally noted by Ghosh for India and later explored by Hansen and Andreano.[31] There is a huge waste of natural resources which takes place because of premature deaths. Investments in medical care, clothing, food, and education comprise some of these wasted resources. The loss in national product to the economy may be quite significant. It was calculated at 6% of the St. Lucian national income at the beginning of the 20th century by Andreano.[32] For developed countries such as the United States and the United Kingdom, this figure has been found to be less than 1%, while Ghosh found it to be close to 3% for India in 1931 and 1951.[33]

The analysis of changes in morbidity (days lost from work) is difficult as very few countries have good collection systems for this kind of information. It is very simple to analyze the effect of change in morbidity in work performance and productivity in the U.S. economy, as we know the average number of days lost per year for workers of various socio-economic, sex, race, regional categories. However, this is not the case for most countries in the world.

There are a number of additional benefits which at this stage can't be quantified. The foremost category is the external benefits. Others include improvements in mental health and structural development. So little actual analysis has been done of the linkage between better nutrition and fertility changes that the subject cannot be treated.

C. Cost Analysis

It is difficult to discuss costs until we know the specific programs. In most cases, costs will be measured by public outlay. However, the appropriate costs to measure are the opportunity costs of the inputs used. In the U.S. the cost of food for surplus commodity programs is not the cost of that food at supermarket prices. The appropriate cost, reflecting the value at its next best alternative use (perhaps rotting in storage) is zero. Likewise the use of otherwise idle government bureaucrats and facilities for administering a program would be zero (in an economic sense). That is not to say it would be easy to convince a government that the cost of these inputs is zero.

The appropriate cost with which the government is concerned is the total cost independent of who pays for this. Even though the government may be able to capture part of the costs of a nutrition program through various charges to recipients, the total costs to society must be considered.

D. Program Analysis

In this section, we will draw together some of the concepts we have expounded previously. It will be simplest to do this by example. We will use examples which have different time streams of benefits and costs and which would

appear to be difficult to compare. Preschool feeding programs and a lunch program for factory workers are used here.

First, benefit-cost analysis will be used to look at the best pre-school program. A pre-school program might feed a few children aged 0-5 or more children aged 3-5 or 1-3. Obviously there are many possibilities with different amounts and types of costs and benefits attached to each possibility. There are many other parameters such as intensity of programs. Program X feeding a cohort of children from the ages of 1-3 daily would provide some benefit stream. When the cohort begins its working life benefits will result from the increased mental and physical performance and lowered mortality of its members. See Figure 1.

The costs for program X occur from the ages of 1-3. Program Y would affect these same children aged 1-3 but would be more complete. It would cost more and provide greater benefits. The dashed lines in Figure 2 show this program.

A hypothetical calculated value of the benefit-cost ratio of program X is 3. The ratio of increased benefits resulting from the increased costs of the more intensive program Y is 2. It follows that the benefits from enlarging the size of the population of program X would be more beneficial than program Y. Now we'll compare program X with a food program for factory workers.

The program for factory workers provides immediate benefits through increased productivity and attendance. The appropriate cohort is the workers in plant Z. They will be fed over a five year period. Figure 2 shows these benefits and costs. The benefit-cost present value term is 2.8. Thus preschool feeding program X is better than the factory lunch program but the latter would be preferred to program Y (intensified preschool program). We have not included externalities

FIGURE 1

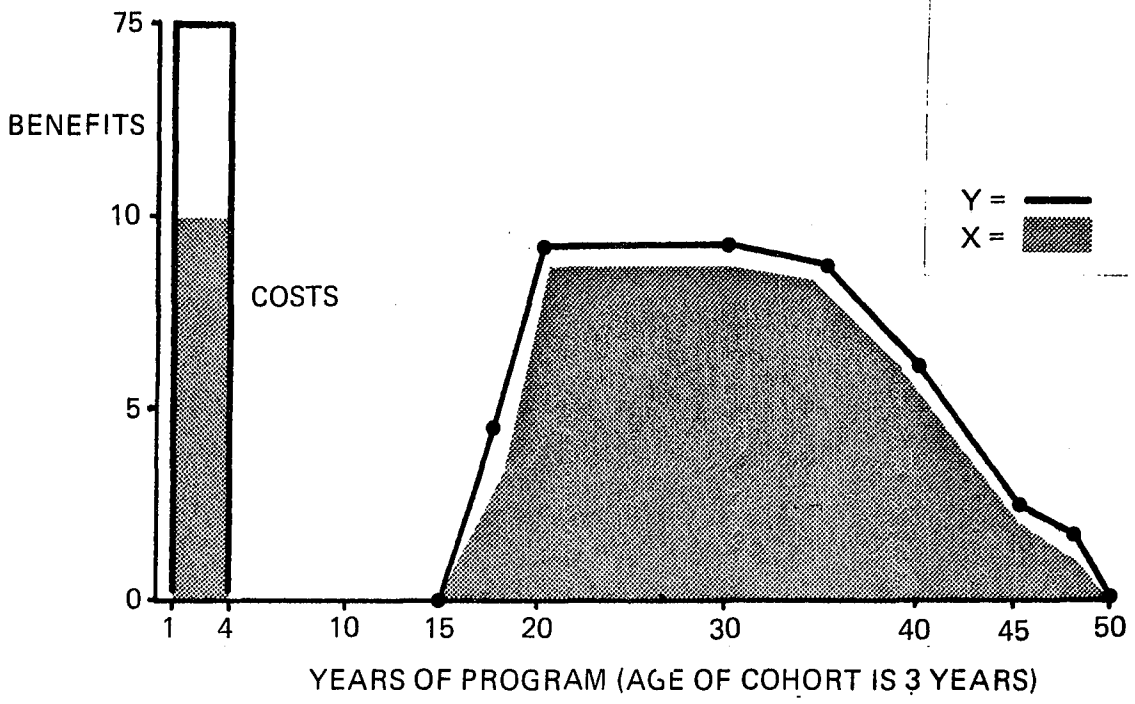


FIGURE 2
PROGRAM Z

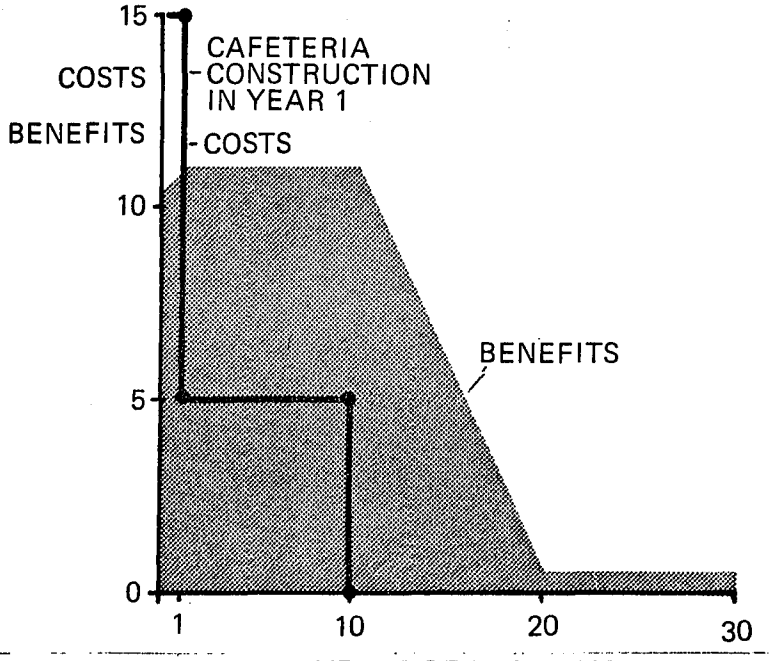
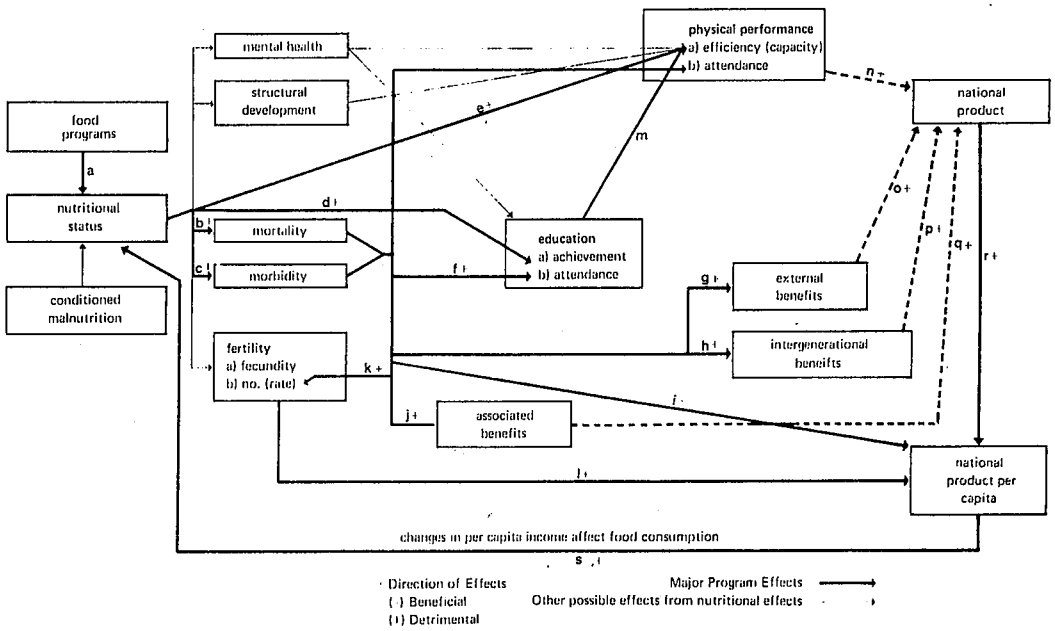


FIGURE 3


mental health
physical performance
a) efficiency (capacity)
b) attendance
structural development
national product
food programs
a
nutritional status
b
mortality
c
morbidity
d
e
m
n
o
p
q
r
education
a) achievement
b) attendance
f
g
external benefits
conditioned malnutrition
fertility
a) fecundity
b) no. (rate)
k
h
intergenerational benefits
j
associated benefits
i
l
national product per capita
changes in per capita income affect food consumption
s
Direction of Effects
(-) Beneficial
(+) Detrimental
Major Program Effects
Other possible effects from nutritional effects

but in an analysis of a real situation one would have to do so.

Use of the conceptual model of Benefits (Figure 3) shows how the various benefits for the pre-school feeding program would be calculated if all relevant data were available. The program (path a) changes nutritional status of the infants. The initial effects of this are: lower child mortality (b) and morbidity (c), and increased mental development (d). The changes in mortality and morbidity will lead to an increase in the labor force (e) in about 15 years and an increase in the school population (f) in several years. Additionally, these changes will increase external benefits (g, disease transmission reduced, etc.) and intergenerational benefits (h). The increased population will lower per capita national product (i). There will be lower hospital and burial costs (j, associated benefits). After a long lag families may respond to lower mortality with a decline in fertility (k).

These effects in turn will produce other changes. Lowered fertility rates, if they do arise, are associated with increased per capita income, (l), in the future. Increased education will have a positive impact on workers' productivity, (M), and then the increased physical performance will increase national product (n). Other factors adding to GNP will be external, inter-generational and associated benefits (o,p, and q, respectively). Some of the benefits of these changes will come in 15 or more years after the initiation of the program. In the short run, gross national product (GNP) will change very little (r) while the population will increase (i) so per capita national product will decrease.

Fifteen years later (n) may lead to large increases in GNP. The pressures of diminishing returns from the larger population may be offset by greater labor efficiency and the other favorable effects to lead to an overall increase in GNP per capita. This overall change in per capita GNP (s) will result from the interaction of these demographic and economic effects.

E. Other Aspects

By looking at the historical roots of malnutrition in a general way, we see a variety of other ways economics can be utilized. One cause of malnutrition is technological change and economic growth and the transmission of values from the developed to less devebpped countries (demonstration effect). A second is the rapid population growth and continued destitution of the population in most less developed countries. The demonstration effect over the past several centuries has brought the polishing of rice and wheat in large mills, the refining of sugar, the increased selling of milk--three ways in which there has been a great loss in nutritional adequacy. Alan Berg spells out in more detail what these shifts have meant for India.[34] He found that an increase in wealth for a family would mean that they would move from sorghum or millet to rice and moreover from the home pounded rice to the esthetically more pleasing though nutritionally less valuable polished rice. He also found a shift from jaggery (unrefined sugar) to the less beneficial refined sugar. He felt that a statistically significant drop in protein intake takes place as incomes rise and the creal diets are "upgraded". Additionally, he noted that while most low income Indians breast fed their children, this percentage falls off with a rise in income so that in families with a monthly income above $9 only 8% of the mothers offer their breast to their children during the first 6 months after birth. Breast feeding is healthier.

Pricing has also been significant. A study of the agricultural trends in India from 1891-1947 found a significant increase in the amount of acreage going to cash crops such as cotton and a decrease in the amount of acreage going to food crops such as wheat, millet, pulses, or rice because of the various price incentives involved with the differential

in the relative pricing between cash crop and food crop.[35] This enigma is produced by the balance of payments problem of many less developed countries. While vast malnutrition exists, cash crops must be produced for export to obtain capital for industrialization and for other imports.

Berg found that in rural India price incentives usually lead to a reorientation of traditional agricultural production. The attractive price incentives for wheat along with many increased incomes in India have led to declining acreage for growing high protein pulses. As wheat production has increased over the last three non-drought years in India, the per capita production of pulses declined 27%. Pulses are one of the major sources of protein in the Indian diet.[36]

An economist can make some input into at least two of the three areas. The demonstration effect, sometimes referred to as coca-colonization, provides the least opportunity. Changes in taste brought by advertising might be changes through a long process of nutrition education. For example, Peru's Inca Cola competes against the imports with the slogan "My Cola, My Land". The payoff to such programs appears small. Fortification of milled cereals and grains makes the best of a problem to which many countries must be resigned. India has already fortified the traditional ground wheat used in making the chapati and is considering the fortification of tea and salt. Another possibility is that genetic changes can be developed in various food crops such as high lysine corn. Costs and benefits accrue to these programs.

One can choose to employ highly sophisticated Madison Avenue techniques in manipulating a population's diet. The payoff from this approach may be high. However, there are very serious questions, which one might call 'costs', involving the morality or propriety of this. The U.S. government shipped some of its Bulgar wheat to Vietnam's Mekong Delta,

but few people were using this. U.S. administrators looked around to discover ways to get women to cook the bulgar wheat and to use it. They hit on a solution. Vietnamese women were very conscious of their small breasts, so the U.S. government began to advertise that bulgar wheat builds bigger breasts. Very quickly Vietnamese women began to eat bulgar wheat.

Dealing with the balance of payments by exporting cash crops may point up a possible misallocation of resources. Other ways of dealing with this problem involve restricting imports encouraging import substitution, or slowing the pace of capital accumulation. The benefits foregone from continued malnutrition may outweigh the gains from current practices. Also, food imports are often a sizeable import item which can be reduced.

Changes in the pattern of demand have led to changes in the relative prices among food crops. Farmers have responded through changes in the pattern of supply. The government can increase the supply of nutritious foods (pulses) available to the population in a variety of ways. For the less developed countries these include: monetary incentives to farmers, subsidies in the market place through government purchase and resale and in-kind transfers of foods to the poor through government stock. More advanced countries have additional means such as food stamps, direct income transfers or tax benefits for land cultivating certain crops.

A fourth concern of economists is that providing adequate nutrition to populations is a basic systems problem. There is a distribution as well as a consumption and milling system. The question is defining the possible points of intervention and those that are susceptible to any type of modification. Understanding the various incentives and disincentives, the various market forces, and more so the social-cultural setting is essential. Change is not simple. Nor is it often

possible to bring about change in people who are malnourished and often very apathetic about their own well-being. Alan Berg has stated that the place to start is not by looking at the specific food and fortification possibilities, but, "One should examine what a child eats, why he eats it, and how it gets to him."[37] In the case of India, he found that improving diets inexpensively without requiring conscious decisions by consumers to buy, cook or eat differently, improved significantly the likelihood of success.[38]

The issue is more complex because malnutrition is only one of a variety of social problems affecting human beings. There is also the matter of how to treat and analyze nutrition problems when we do not know the etiology of many of the multiple deficiency diseases. Many deficiencies are attributable to the interplay of several nutrients rather than to deficiencies of individual nutrients.[39] Likewise, deficiencies of one nutrient will lead to other nutritional disorders. We know that protein deficiencies impair the intestinal absorption, transport, and utilization of Vitamin A and will often lead indirectly to Vitamin A deficiency.[40] A deficiency in calories will result in the use of proteins for energy rather than for cellular growth and lead to a protein deficiency. 80-90% of the world population consumes cereals and has an otherwise adequate high protein intake but often a relatively low caloric intake. Another example is the requirement for Vitamin D for the maintenance of calcium and phosphorus homeostasis.[41]

Understanding this problem of balance leads to the question of the adequacy of certain types of nutritional programs, such as fortification. However, these are problems for the nutritionist and not those of the economist. Some evidence suggests that hybrid corn with a higher lysine content will not produce diarrhea while fortified lysinated corn does.[42]

One lesson of development programs of the last few decades is that piecemeal approaches may be more unacceptable than inaction. Introduction of western health practices without consideration of the resultant increase in population growth rates has produced the chaos and misery associated with overpopulation. In hindsight it is obvious that birth control programs should have accompanied these changes in health. Likewise, any effective nutrition program will affect mortality and fertility. The magnitude and impact of this must be understood before major nutritional programs should be implemented.

Our goal is to enhance the quality of life. This raises certain questions about some types of nutrition programs. We know feeding pregnant and lactating women and infants will lower infant mortality rates. Many hypothesize this reduction in infant mortality will lower birth rates. At best, the lag between perceiving this change in infant mortality and responding to it with a drop in fertility will be several decades. In the meantime, better health will improve fertility and lower the stillbirth rate. These factors will increase fertility rates. Combining the drop in infant mortality rates with a rise (or even a constant) fertility rate will increase the proportion of the population which is unproductive (dependency ratio). For some number of decades, then, this dependent population will require resources which could be used for other purposes, such as investment. This probably will be reflected in both a lower growth rate of G.N.P. and a smaller G.N.P. per capita.

There will be a need for additional complementary inputs. Increased mental and physical capacity and lowered mortality must be utilized Increases in schools and factories will be necessary to capture the benefits of these programs. This suggests that perhaps nutrition programs should be implemented only where the proper facilities exist. Alternatively,

nutrition programs may be part of a larger development plan. The basic point is that nutrition must be provided along with other inputs such as schools, sanitation, etc. If any of these charges are introduced separately, few benefits are likely to be captured.

F. Conclusions

This discussion has laid out many of the issues which economists face in attempting to aid in the planning for improved nutrition. One area to which economics points is the need to look at the costs and benefits which will accrue to each type of program and to understand the tradeoffs which exist between programs which benefit different age, sex, occupation groupings and which provide different types of external benefits.

By necessity, this paper is more a discussion of the problems which must be researched than of research which has been done. Even in this respect, we have not fully completed the task. The enormity of the problem is such that even defining the scope of the problem is the work of many people.

FOOTNOTES

1. The literature in this area is broad and diverse. An adequate discussion of the most important issues cannot be presented here. See,

   Samuel B. Chase, Jr., ed., Problems in Public Expenditure Analysis, (Washington, D.C.: Brookings Institute, 1968). especially Bruton A. Weisbrod, "Concepts of Costs and Benefits"

   Robert Dorfman, ed., Measuring Benefits of Government Investments (Washington, D. C. : Brookings Institute, 1965).

2. Berg and Levinson discuss various nutrition programs.

   Alan D. Berg and F. James Levinson, "A New Need: The Nutrition Programmer", The American Journal of Clinical Nutrition, 22, No. 7 (July, 1969): 893-895.

3. Ralph L. Andreano and Burton A. Weisbrod, "A Framework for Analysis of Health Systems and National Health Care Proposals", Health Economics Research Center Research Report, Series No. 14 (Madison: University of Wisconsin, 1971): Ch. 2.

4. The definition of malnutrition is complicated by conditioned malnutrition. This includes disorders of digestion and assimilation of nutrients associated with disease and fever.

   Norman Joliffe, ed., Clinical Nutrition, 2nd Edition (New York: Harper and Brothers, 1962).

5. Moises Behar, "Prevalence of Malnutrition Among Preschool Children of Developing Countries", in Malnutrition, Learning, and Behavior, ed. by Nevin S. Scrimshaw and John E. Gordon (Cambridge: MIT Press, 1968).

6. Excellent surveys on the relationship between the elimination of malnutrition and economic performance exist.

   David L. Call, "Research Findings on the Social Consequences of Malnutrition", Cornell Agricultural Economics Staff Paper No. 8 (Ithaca: August, 1969).

   W. D. Keller and H. A. Kraut, "Work and Nutrition", from Geoffrey N. Bourne ed., World Review of Nutrition and Dietetics, 3 , (New York: Hafner, 1962).

   United Nations FAO, "Nutrition and Working Efficiency", Freedom From Hunger Campaign Basic Study 5 (Rome: FAO, 1962).

A detailed 12-paper bibliography is available from B. Popkin, The Economics of Nutrition, unpublished monograph (Madison: Poverty Institute, May, 1967). One of the reasons for problems with these relationships relates to the poor controls on which many of these studies are based. Questions of attitude and motivation were not dealt with properly.

7. The Keller and Kraut and UNFAO articles summarize many of these studies. Also,

   W. W. and H. E. Tuttle, "Work Capacity with No Breakfast and a Mid-Morning Break", Journal American Dietetic Association, 37 (August, 1960).

   C.E.A. Winslow, "The Cost of Sickness and The Price of Health", UNWHO Monograph (Geneva: UNWHO, 1951): 33, 35.

8. Cravioto and DeLicardie qualify their findings by the duration of the untreated malnutrition and the period of infancy. Also they feel the question of permanent retardation remains open. Also they feel it is difficult to "distinguish the particular contributions of early sever malnutrition, adequate environment, and experimental opportunities to defective cognitive function."

   J. Cravioto and E.R. DeLicardie, "The Long-Term Consequences of Protein-Calorie Malnutrition", Nutrition Reviews, 29, No. 5 (May, 1971): 111.

   Also,

   Joaquin Cravioto, "Malnutrition and Behavioral Development in the Preschool Child," from Pre-School Child Malnutrition, National Academy of Sciences--National Research Council, Publication 1282, Washington, D. C. 1966.

   Joaquin Cravioto, Elsa DeLicardie and Herbert G. Birch, "Nutrition Growth, and Neurointegrative Development: An Experimental and Ecologic Study", Pediatrics, 38, No. 2, part II (August, 1966).

9. Cravioto, DeLicardie and Birch, op. cit., p. 359.

10. Ethel Austin Martin, Nutrition in Action (New York: Holt, Rinehart and Winston, Inc., 1963) p. 213.

    Nevin S. Scrimshaw, "Nutrition and Mental Development" (Paper delivered at the Twenty-Fifth Anniversary Commemoration of the Nutrition Foundation, Inc., November 17, 1966), pp. 13, 14.

    Roger N. Williams, Nutrition in a Nutshell (New York: Doubleday and Company, Inc., 1962).

11. Dr. Nevin Scrimshaw, a leading American nutritionist, has written extensively on this subject. For example,

    Nevin S. Scrimshaw, "Nutrition and Infection", in J.G. Brock, ed., Recent Advances in Human Nutrition (Boston: Little Brown and Company, 1961).

12. Ibid., 376. Also see

    Keller and Kraut, op. cit., p. 75, and UNFAO, op.cit., p. 26 from ILO Studies and Reports, New Series, No. 4, Nutrition and Industry: 41.

13. Mark Abramowicz and Edward H. Kass,"Pathogenesis and Prognosis of Prematurity," The New England Journal of Medicine, 275 (1966), p. 878.

    A premature infant is born with a weight of less than 2500 grams.

14. Ibid., p. 888.

15. For example,

    Report of a Study Group on Iron Deficiency Anemia, World Health Organization Technical Report Series No. 182, Geneva, 1959.

    W. A. Krehl, "A Concept of Optimal Nutrition", The American Journal of Clinical Nutrition, 4, No. 6 (1956).

16. John E. Gordon, "Nutrition Science and Society", Nutrition Reviews, 27, No. 12 (December, 1969): 331-338.

17. Quoted in Chase, "Introduction and Summary" from Chase, op. cit., p. 14.

18. See Cravioto (1971) and M. B. Stock and P. M. Smyth, "Undernutrition During Infancy, and Subsequent Brain Growth and Intellectual Development", in Malnutrition, Learning and Behavior, op. cit.,

19. J. M. Tanner, "Earlier Maturation in Man", Scientific American, 218, No. 1 (January, 1968).

20. There are conflicting theories on the economic effects of a shorter height. Waterlow feels "smallness may be a useful adaptation, since the small person needs fewer calories and less protein."

    J. C. Waterlow, "Observations on the Mechanism of Adaptation to Low Protein Intakes", The Lancet, v. 2 for 1968: 1091.

    An economist, Oshima, says: "There is some impressionistic evidence indicating that the average size of Asians is not optimal for factory work and machine operation. Employers complain that their workers' reach is short of efficient operation of many types of machines, vehicles, and equipment, and their muscle strength inadequate for certain types of work."

Harry T. Oshima, "Food Consumption, Nutrition and Economic Development in Asian Countries," paper presented at the 11th Pacific Science Congress, Tokyo (August, 1966): 21-22.

21. Kraut and Muller, op. cit.

22. Josef Brozek, "Nutrition and Psyche--with special Reference to Experimental Psychodietetics," The American Journal of Clinical Nutrition, 3, No. 2 (March-April, 1955).

22.5 Research done in the Punjab under Dr. Carl Taylor of Johns Hopkins University provides some evidence to support this hypothesis. They provided an infant feeding program along with a birth control program. Then they advertised the lowering of mortality rates among infants and found more success with their birth control program. This experience, while quite exciting, should be received carefully because of the more progressive nature of the Punjab peasantry plus numerous Hawthorne effects.

24. Theodore Schultz and Burton Weisbrod have written on this subject.

T. W. Schultz, "Education and Economic Growth", Social Forces Influencing American Education (Chicago: University of Chicago Press, 1961), pp. 74, 75.

Burton A. Weisbrod, "Education and Investment in Human Capital", The Journal of Political Economy 19, Supplement, No. 5, part 2 (October, 1962), pp. 117-118.

25. Popkin did a study of the benefits of elimination of malnutrition for the U.S. economy based on similar assumptions. This 1969 study done for the U.S. Senate Committee on Nutrition is summarized in:

B. Popkin, "Economic Benefits from the Elimination of Hunger in America", Institute for Research on Poverty Discussion Paper 102-71 (Madison: University of Wisconsin, 1971), forthcoming in Public Policy.

26. Burton A. Weisbrod, "Colletive Action and the Distribution of Income: A Conceptual Approach", from Robert H. Haveman and Julius Margolis, Public Expenditures and Policy Analysis (Chicago: Markham Pub. Co., 1970): 117-141.

27. Popkin, op. cit.

28. See Popkin, op. cit., for a more detailed discussion.

29. Income data was available for each grouping from the Current Population Survey. Present values were calculated using standard rates of survival, a 6% interest rate and a 2% growth rate (4% discount rate). An explanation of the present value concept and the tables of present values for various education levels can be obtained from the author.

30. Thomas I. Ribich, Education and Poverty, (Washington, D.C.: The Brookings Institution, 1968), pp. 68-70.

30.5. Marcelo Selowsky, "An Attempt to Estimate Rates of Return to Invest in Infant Nutrition Programs," presented at the International Conference on Nutrition, National Development and Planning, M. I. T., (Oct., 1971).

31. For a further discussion of this subject, see chapters 1 and 4. This income differential was calculated from the Current Population Reports, Series P-60, No. 56 which gives the present value of lifetime incomes for a normal population and the present value for the poor.

The poverty population values were not used due to peculiarity of the data for high-school graduates and above. Much research has indicated the difficulty with education and poverty linkage. These values were then deflated by about 20%. The reasons for this are straightforward. The income differential between drop-outs and graduates for the normal population must overstate this differential since persons in the poverty subgroup would have lower average and lifetime income. It is the ratio of the high-school graduate differential for people with less than $3,000 income versus people with income of $3,000-$6,000. Due to the fact that education is less important for poor people, their differential will peak earlier than the normal population. Thus, the results of the deflation are somewhat conservative. The 20% figure was obtained from unpublished research by Professor Robinson Hollister, Economics, Princeton University.

31. D. Ghosh, Pressure of Population and Economic Efficiency in India (New Delhi, 1956): 22.

W. L. Hansen, "A Note on the Cost of Children's Mortality", Journal of Political Economy, 65, No. 3 (June, 1957): 257-262.

Ralph Andreano, "A Note on the Cost of Children's Mortality: Some Caribbean Evidence", unpublished paper (Madison: University of Wisconsin Health Economics Report, 1971).

32. Andreano, op. cit., p. 4.

33. Hansen, op. cit.

34. Alan D. Berg, "Nutrition as a National Priority--Lessons from the India Experiment", The American Journal of Clinical Nutrition, No. 11 (November, 1970).

35. George Blyn, Agricultural Trends in India, 1891-1947: Output, Availability, and Productivity, (Philadelphia: University of Pennsylvania Press, 1966).

    Russell Lidman and Robert Domres, "India", from W. Arthur Lewis, Tropical Development 1880-1913 (London: George Allen and Unwin, 1970): 309-335.

36. Berg (1970), op. cit., p. 1399.

37. Ibid., p. 1405.

38. Ibid., p. 1399. It is interesting to note that little attempt at this type of analysis and modification of the nutritional status has been made in the U.S. At the same time, little mass nutrition education has been developed.

39. J. F. Brock, Recent Advances in Human Nutrition with Special Reference to Clinical Medicine (Boston: Little Brown and Company, 1961): 27.

40. D. S. McLaren, et. al. "Xeropthalmia in Jordan", The American Journal of Clinical Nutrition, 17, No. 3, (1965): 210.

41. Food and Nutrition Board, Pre-School Child Malnutrition, publication 1282 (Washington, D. C.: National Academy of Sciences National Research Council, 1966): 15.

42. Personal communication with Professor W. H. A. Morris, Professor of Agricultural Economics, Purdue University. This has been found about hospital patients by Purdue researchers working in Brazi.