AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY: Public Health

B. SECONDARY: Nutrition

2. TITLE AND SUBTITLE

Nutrition and productivity; their relationship in developing countries

3. AUTHOR(S)

Weisber, S.M.; Reese, K.M.; McDonald, Peggy; League for International Food Education

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1972	24 p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

Agency for International Development, Office of Nutrition, Technical Assistance Bureau, Washington, D.C. 20523

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

Authorities concerned with economic progress in the developing nations are growing more receptive to the view that poor nutrition may be restraining productivity to a significant degree. This view does not agree with conventional economic planning models which consider investment in nutrition to be of relatively little benefit to Gross National Product. These models are designed first to raise the GNP; the consequent increase in income then would provide better nutrition automatically. More often than not this concept has not worked out in practice. Recommendations offered here are to have small interdisciplinary teams study nutrition programs in developing countries; to establish a collection-data program on the effects of food fortification; to organize an interdisciplinary workshop; to examine additional military sources for the relationship of nutrition to combat effectiveness and energy output; to obtain additional data on the effects of supplementary feeding programs and worker productivity and the quality of life.

10. CONTROL NUMBER	11. PRICE OF DOCUMENT
PN-AAC-693	
12. DESCRIPTORS	13. PROJECT NUMBER
	14. CONTRACT NUMBER: AID/TA/N
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

LEAGUE FOR INTERNATIONAL FOOD EDUCATION

PN-AAC-612

Nutrition and Productivity

Their Relationship in Developing Countries

Based on a survey conducted by the
League for International Food Education
for the
Office of Nutrition,
Agency for International Development

Washington, D.C.
U.S.A.

October 1972

NUTRITION AND PRODUCTIVITY

THEIR RELATIONSHIP IN DEVELOPING COUNTRIES

Based primarily on the results of a survey by the
League for International Food Education
conducted in 1969-70 for the
Office of Nutrition
Agency for International Development

Samuel M. Weisberg

K. M. Reese

Peggy McDonald

Washington, D.C.
U.S.A.

October 1972

TABLE OF CONTENTS

	Page
Summary and Recommendations	1
Introduction	5
L.I.F.E. Survey: Background and Results	6
Real-Life Data: Perspective and Sources	11
Elements of "Productivity"	12
The Scientific Framework	15
Low-Cost Nutritious Foods: Industrial Feeding	17
Conclusion	18
References	19
Appendix	
--L.I.F.E. Survey Questionnaire	20
--Supplementary References	21

SUMMARY AND RECOMMENDATIONS

Authorities concerned with economic progress in the developing nations are growing more receptive to the view that poor nutrition may be restraining productivity to a significant degree. This view is not in accord with conventional economic planning models, which consider investment in nutrition to be of relatively little benefit to Gross National Product. These models are designed first to raise GNP; the consequent increase in income would then provide automatically for better nutrition. More often than not, this concept has not worked out in practice.

The past two decades or so have seen the emergence of an economic development theory that stresses investment in nutrition, education, and other elements of "human capital." Implementation of the theory has remained difficult in part, however, because of a lack of direct, real-life correlations of nutrition with productivity. Existing experimental and field data, moreover, have come largely from the developed nations and are not readily transferable to the widely differing context of underdeveloped areas.

In the search for pertinent evidence, L.I.F.E. sent questionnaires in 1969-70 to 292 organizations with experience in employee nutrition programs. The focus of the survey was the developing nations. The response provided useful insights and experience and tended to confirm the lack of real-life data on nutrition and productivity. It suggested also that obtaining such data will be a complex task. A major problem is to disentangle the effects of nutrition from those of motivation and other influences on productivity.

The voluminous literature on nutrition and productivity draws on a relatively few sources for real-life data. In the best of these the evidence is circumstantial, by strict scientific standards, and not readily quantifiable in a form that planners can use. The evidence suggests strongly, however, that poor nutrition can restrain productivity not only in the conventional, narrow sense, output per unit of input (units produced per man-hour, for example). Nutrition-related restraints may arise as well from increased absenteeism, lowered resistance to disease, and lethargy and lack of drive.

Poor nutrition also may cripple a nation's productive capacity by more subtle, longer-range mechanisms. Early malnutrition may have long-range, harmful effects on the physical and mental quality of the work force. The malnourished child loses irrecoverable learning time in his school years through apathy and illness. Shortened life span can significantly reduce the return on the investment in rearing and training a nation's youth.

Scientists have built a considerable body of knowledge on nutrition and human performance capacity in the past 30 years. Requirements for various nutrients, the caloric cost of many types of work, the effects of ambient conditions, and other phenomena have been elucidated with reasonable accu-

racy. Such knowledge has been applied in field studies of farmers, military personnel, and other workers, but much more of this kind of research is required, particularly in developing areas.

Tools are available to the planner who wishes to attack nutrition problems in a developing nation. They include low-cost nutritious foods that can be formulated readily by existing technology. They also include industrial feeding, which may be one means of helping to solve the nutrition problems created by rapid urbanization in developing countries. Both low-cost, nutritious foods and industrial feeding have moved slowly, but there is reason to forecast continued steady progress.

The belief is clearly growing that a case can now be made for nutrition as an element in planning for economic growth in developing nations. A need remains nevertheless for hard, real-life supportive data couched in the planner's context.

In the meantime it is worth noting that many business enterprises in developing countries do subsidize canteen feeding for their workers. Businessmen in these countries have therefore decided already that better nutrition can improve the productivity of their workers, and that this improvement appears profitable.

There is at least an indication that better nutrition can improve the quality of life of workers. Thus, for example, bad habits fostered by monotonous and inadequate diets may in some degree be ameliorated -- such habits as repeated desertion from the job, excessive drinking, and lethargic work performance. This topic seems to merit investigation in developing countries.

There are also at least indications that absenteeism and incidence of severe respiratory diseases among workers may be reduced by subsidized canteen feeding of nourishing food. This subject also merits investigation in developing countries.

Direct indications of increased productivity resulting from supplementary feeding programs also appear in the literature and in our questionnaire responses. This central topic also merits attention in developing countries in order to supplement and document the reported findings.

Recommendations

1. It is proposed that small interdisciplinary teams be sent out to study, on-the-scene, the programs of a few private companies or institutions in developing countries which have introduced a nutritional approach aimed at improving productivity and the quality of life of their workers and families. These teams might bring back an updated summary of current results and offer useful suggestions for improving the data feedback from such programs. Some financial help should be offered to encourage data gathering.

2. It is proposed that, if feasible, there be added to current food fortification programs a subprogram that would permit collection of data on the effect of these programs on worker productivity and more generally on the quality of adult life.

3. It is proposed that a small informal workshop be organized representing the disciplines of economics, nutrition, physiology, education, industrial psychology, and national planning. The participants should have had experience in government and industry. The theme might be "The Conservation of Human Capital". From such a workshop one might look for help in the better placing of national priorities to insure the conservation of human capital.

4. It is recommended that an in-depth attempt be made to examine additional military sources for the relationship of nutrition to combat effectiveness and energy output -- especially under tropical conditions. The results could help to establish basic nutrition needs under stress.

5. It is recommended that L.I.F.E. use its increased network of overseas contacts to obtain additional real-life data on the effect of canteen or other types of supplementary feeding programs and worker productivity and the quality of life.

6. It is proposed that an effort be made to correlate nutrition with real-life habits. Does continual, inadequate, monotonous diet foster alcoholism, absenteeism, and loafing? Would an improved and more varied diet help reverse such habits in developing countries?

The survey reported in this publication was undertaken at the request of the Office of Nutrition, Agency for International Development, Washington, D.C.

INTRODUCTION

The planners who are involved in allocating resources to spur economic progress in the developing nations are growing noticeably more aware that their consistent neglect of nutrition may be restraining productivity significantly. The neglect has been not an oversight, but a result of accepted economic strategy. No one questions the long-range value of good nutrition to a nation's well being. The planners' goal, however, has been first to raise Gross National Product without huge investment in the infrastructure (roads, housing, and the like). The consequent increase of income would diffuse among the people, whose standard of living, including the quality of nutrition, would then rise as a matter of course. More often than not, unfortunately, things have failed to work out quite in that way.

Conventional economic planning models, at any rate, have not as a rule taken explicit account of direct investment in human beings. In terms of these models, investment in health, education, nutrition, and the like is much less beneficial to Gross National Product than is the more traditional investment in productive capital. In the past two decades or so, in contrast, certain economists have become friendlier to the notion of developing "human capital." The concept grew from the observation that several nations had achieved increases in national output too high to be explained by conventional economic prescription. The main reason for the difference, these economists felt, was investment in human capital, including nutrition.

To translate this concept convincingly into greater direct emphasis on nutrition has remained difficult in large part because of a lack of real-life data. Alan Berg and Robert Muscat, who are sympathetic to the idea, concluded as recently as 1969, in fact, that from the planner's point of view a solid case for increased emphasis on nutrition had not been made. Information has continued to accumulate, however. Berg and Muscat have reexamined their views and lately have concluded that "the case can now be advanced for the role of nutrition in the mainstream of development."[1]

Nutritionists, of course, are generally in accord with this kind of thinking, and support is growing in other quarters. The president of the World Bank warned in 1971 that development will fail without serious action on malnutrition (and on rising unemployment and inequality in income distribution). A few nations, including Chile, Colombia, India, and Zambia, have made nutrition planning an element of their overall development planning. Many developing countries, however, have not even started to work on a national nutrition program. More than a few authorities, moreover, remain convinced that investment in human capital is unwarranted in the early stages of industrialization. One must infer, then, that the sort of real-life data that the planner finds immediately compelling are not freely available.

One would like to be able to show, for example, not only that improved nutrition raises the productivity of a work force over the short term. One would like to show also that the gain is sufficient both to pay for the extra food and to provide a clear-cut margin for economic growth. This ideal is difficult to achieve. To begin with, the effects of nutrition on productivity are not readily sorted out from the effects of other influences, such as education and motivation. The existing studies of nutrition and productivity have been made largely in developed countries, where the nutritional status of the people is generally high, if not always perfect. The worker in the developing nation, on the other hand, may be suffering the debilitating effects of too little protein in his weanling diet 10 or 15 years previously. The work-ethic and similar factors may differ substantially in developed and developing nations. For such reasons, correlations of nutrition with productivity in developed countries do not necessarily provide a certain guide to what might happen in a developing country.

L.I.F.E. Survey: Background and Results.

In 1969-70, L.I.F.E. undertook to unearth some practical, real-life information on the effects of nutrition on the productivity of a work force. We mailed 292 questionnaires to industrial organizations with experience in employee nutrition programs, including nutrition education, provision of food as a part of pay, provision of free or low-cost, on-the-job meals, and the like. The organizations queried were located all over the world, but the focus of the survey was the developing nations.

Our questionnaire (see Appendix) did not treat productivity solely in the commonly-accepted sense: output per unit of input (units produced per man-house, for example). This narrow definition clearly oversimplifies the relationship between nutrition and productivity in a developing nation. Respondents were asked as well to comment on factors such as absenteeism and accident rates and on certain nonquantifiable points. The 28% response to the survey contained little hard data, and the replies were generally imprecise and subjective by scientific standards. Respondents did, however, provide a variety of insights and experience with industrial feeding that we believe ought not to be ignored. The results of the survey are covered selectively below; the complete response is on file in the L.I.F.E. office.

***

In 1963 in Mexico a work force that ranged up to 12,000 was building cement-lined canals as part of an irrigation project. Monday through Friday, each worker received daily one 3000-calorie meal consisting of vegetables, cooked beans, and rice. The charge was 8 cents. After four months of this arrangement, 1/3 liter of food beverage was added to each worker's daily meal at a cost of about 2 cents per person per day. The beverages were Incaparina, based on cottonseed flour, and Refresco de Soya, based on full fat soy flour; both provided a high level of protein with vitamin and mineral fortification. The two were served warm on alternate days.

After four and one half months of feeding the food beverage in addition to the 3000-calorie daily meal, officials on the construction project made an on-the-spot evaluation. Among their conclusions:

--The general health, vigor, and strength of the workers had improved noticeably compared to the four months when they had received the daily meal only.

--Working efficiency had increased markedly. In some cases, workers receiving the food beverages for several months were able to do in three days the amount of work it had taken them five days to do before the beverages were added to the daily ration.

***

The company in South Africa that produces the high-protein, high-vitamin food supplement, ProNutro, reported a "fairly well controlled experiment" at a large sugar estate where two ounces per day of ProNutro soup was added to the normal diet supplied to the laborers. The experiment involved two compounds: the 350 laborers in the first compound received the ProNutro; the 250 laborers in the second did not. After six months, absenteeism in the first compound was 2% and in the second compound 9%. In a later experiment, on 325 laborers, absenteeism fell from 12% to 7% after six months of supplementary feeding of ProNutro at two ounces per day.

The company itself operates a feeding program for the 400 Indian and Bantu laborers at its factory. The canteen offers a daily hot meal and sandwiches, both paid for by the workers. It also provides free supplies of ProNutro and Mahewu, a nutritious, precooked product which is mixed with water and left to ferment for 18 to 24 hours. In 1966-68, about 52% of the Bantu laborers and 37% of the Indians patronized the canteen. The company gives no statistics, but reports a "significant" decrease in absenteeism in those three years, particularly in the winter. It also reports a decrease in flu and pulmonary infections.

***

A petroleum company in Saudi Arabia reports "very important indirect indicators" of the value of several long-term employee programs that emphasize nutrition. The work includes a public health education program (since 1953), subsidized industrial feeding (1952-64), subsidized sale of staples (since 1953), and a maternal and child health care program (since 1962). Here are two results of these programs:

--The mortality rate for Saudi Arab employees' children dropped from an estimated 70 deaths per 1000 live births in 1955 to 27 deaths per 1000 in 1967. The estimated national average is roughly 150 deaths per 1000 live births.

--Compared to employees' children born in 1961-62, those born in 1966-67 had cut by one half the difference between their weights and an ideal U.S. standard at age 24 months.

The company's Saudi Arab work force, meanwhile, fell from about 15,000 in 1952 to 9000 in 1969. Nutrition-related productivity gains presumably contributed to the reduction, but no accurate appraisal can be made of their importance relative to other factors: improved education and industrial skill, supervision, a declining rate of facilities expansion, increasing automation, and turnover of many construction and service functions to local contractors. The company says, for example, that "it is impossible to attribute directly either increased safety or decreased absenteeism to improved nutrition."

It is worth noting also that the petroleum company's industrial feeding program (1952-64) was put out of business, in effect, by economic progress. The program involved an industrial cafeteria which sold a hot breakfast and hot lunch to employees each working day at a cost of 5.5 cents per meal to the employee. In 1961 the cafeteria sold more than 700,000 meals. As employees became more skilled and their salaries rose they tended to stop eating at the industrial cafeteria. Many, for reasons of prestige or variety, preferred the regular company-operated cafeterias, which were subsidized to a far lesser degree (a meal cost 50 to 60 cents in 1965). In 1964 employees began to demand a food allowance and boycotted the industrial cafeteria, whose business already had dropped sharply from its peak. The facility finally was closed after eight months of inactivity. (The food allowance was not granted, but a special allowance related to the cost of living was introduced soon afterward.)

***

Long experience adds value to the remarks of a retired gentleman who for many years operated the canteens and food stores that supplied the work forces of various mining companies in the old Belgian Congo. In a district where food was distributed to meet only the minimum legal requirement and was of poor variety, he says, "we sold much beer and little food. Desertions were frequent...where the labor were fed generously and diversely we sold much less beer but abnormally large quantities of food. Desertions were the exception." Workers who were poorly fed, housed, and cared for were submissive and apathetic. The better-fed workers were prone to complain, to ask for more, to assert their rights. Some 13 years of observation led this gentleman to the conclusion that "a poor and dull diet leads to drinking as an unconscious means of escape and that a good and varied diet leads to the desire for a still better life." (Other observers have remarked that in some parts of the Andean highlands undernourishment and low living standards are linked closely with addiction to alcohol and the chewing of the coca leaf, the traditional antidote for hunger and fatigue.)

***

A South African company notes that many of its 1700 African workers are illiterate and come from simple pastoral backgrounds. Their move into industry and life in town is often associated with overdependence on bread, cakes, sweets, and soft drinks. Malnutrition is thus fairly common. In 1960, this company set up a canteen to provide its workers a nutritious meal at minimum cost. Protein supplementation and vitamin support, particularly B group and C, were considered essential. The canteen sold a basic meal, consisting of a slice of good quality meat, two vegetables, and gravy, for 4 cents. Fried fish slices were introduced soon afterward. Average monthly servings of the basic meal climbed from 1000 in 1960 to 7500 in 1969; sales of fish slices rose from 850 to 11,500 in the same period. The range of foods available, meanwhile, had been expanded to include a full meal for 12 cents. Data on the effects of this program on productivity are not yet available.

***

In 1968 a fruit company in Central America started a comprehensive nutrition program "as a result of the reports of retarded brain development and capacity for learning, low productivity, and shortened life as related to malnutrition and a growing interest at the management level in the welfare of company personnel." The firm planned to collect data on the growth of children in the company schools to help measure the effectiveness of its effort. Records of absenteeism and accidents were being kept already and also will be used to measure the effectiveness of the work.

Among other activities, the company planned to encourage the use of Incaparina if the food beverage became available in the area. It was working with a Japanese firm on the addition of rice fortification granules to the cheapest rice sold in company commissaries. And it was financing a worker-education program in nutrition, using booklets, visual aids, the company newspaper, and personal contact by nurses, teachers, and social workers. Data on the effect on productivity are not yet available.

***

The employee relations aspects of nutrition programs are stressed by a U.S. company with subsidiaries in Brazil, Colombia, and Mexico. The company subsidizes about 80% of the cost of employees' meals at subsidiary sites. The meals cost the employees 8 to 25 cents per day and probably are by far the best that they get throughout the day. For that reason the meals are designed to provide a full day's subsistence. This program, the company believes, is about in line with those of other U.S. companies in Latin America.

***

The L.I.F.E. survey turned up one case of apparently total failure of a factory canteen. It occurred in South Africa, where successful programs are not uncommon. A company shop had sold a variety of foods and other articles to staff members for some years, and the firm decided to augment

this operation with subsidized hot meals. A plate of meat, potatoes, and two vegetables, for example, was priced at 15 cents for Europeans, [illegible] cents for Coloureds, and 10 cents for Africans, who formed by far the largest fraction of the employees. The company noticed no change in absenteeism or accident rate during the life of the cantoon, which was closed down after two years because of lack of support. The Coloureds were dissatisfied with the food, "but were unable to inform us what it was they wanted." The African staff preferred a late meal when they returned home and neither desired nor could afford a second main meal in midday. The Europeans also preferred a late meal at home, with only a snack at midday.

***

Sociological problems are evident in the breakdown described above, but another respondent sees similar problems as a reason for starting a feeding program, which was to have begun in 1971. The facility is in the Republic of the Congo. At the time of the survey it had primarily new employees working in new surroundings. The basic food in the area is cassava. The main meal is taken at night, and workers think nothing of working all day with no nourishment since the previous evening. In some cases of "sickness," patients had explained to the physician that they had not eaten for periods exceeding 36 hours.

Food, in this respondent's opinion, "has a very low want-satisfying value." When a Congolese is earning money, "he almost always would rather buy things such as a radio, a bicycle, sunglasses...than spend it on food." For such reasons, the organization feels "that any program that will provide one meal a day will greatly increase the productivity of the employees."

***

A backfire with an amusing side was reported by a firm that sponsored an Incaparina Club in one of its supermarkets in Panama. Incaparina was mixed with water, a little evaporated milk, vanilla, and sugar, and employees got all they could drink for 5 cents a day. The employees liked the drink so much that some had 10 or 12 glasses a day. They lost so much time going to the tank to drink it that the program was closed down after three months.

The original idea was no caprice, however. The firm suspected that lack of protein had something to do with the very high absenteeism caused by the common cold. The minimum wage was 40 cents an hour, "and you cannot buy much protein with that unless you buy a lot of Incaparina."

***

An indication of the contrasts between developing and developed countries appears in the experience of a respondent who operates one factory cafeteria in France and two in Germany. The company bears about two thirds of the cost of these programs, in which about 35% of the work force participates. The firm believes that its food program has reduced neither the

rates of absenteeism nor of on-the-job accidents, but still it regards the program as "an indispensable employee service." The German and French employees and their elected representatives take great interest in the program. Uncorrected defects in service or quality could lead to "very serious labor problems." A hot noon meal service, the company says, is one of the more important incentives in attracting and retaining personnel in Germany and France.

Real-Life Data: Perspective and Sources.

The responses to the L.I.F.E. survey, in addition to the range of experience that they portray, suggest two broad and familiar observations:

--Very little quantitative information is available on the relationship of nutrition to productivity under real-life conditions, particularly in the developing nations.

--Obtaining really good data of this kind, defensible by the normal scientific standards, will be a very complex task, a major problem being to disentangle the effects of nutrition from those of motivation, social and political context, and similar factors that can influence productivity.

It is true that the literature of the past 30 years contains numerous papers on nutrition and productivity. For real-life, on-the-job data, however, such publications draw on a relatively few sources. Two that are cited widely are a series of studies in Germany during and just after World War II and a report on a road-building project in Costa Rica, also during the war.

The German work, by H. A. Kraut and E. A. Muller, included a study of 20 workmen who were dumping debris from railroad cars[6]. When the study began, in 1942, the workmen were not getting rations for heavy work. They had 820 work calories available per man per day and were dumping 1.5 tons of debris per hour. Then they began getting rations for heavy work, but were not told that their performance was being studied. After one year, they were dumping 2.2 tons per man per hour on a ration that provided 1300 work calories per day. Average body weight increased about 4 kilograms in that year. The job they were on being urgent, the workers next were promised cigarettes for greater production, first for 2.5 tons per hour minimum, later for 3 tons, and still later for 4 tons. Rations remained constant during the half year of the premium system. Soon after the cigarette premium was offered, nearly every man was doing 3 tons per hour; after the last increase of the premium limit, average output reached 3.4 tons. In the same period, however, the 20 workers lost an average of 3.5 kilograms of body weight.

The data from this study, the German scientists argued, showed clearly that before the cigarette premium was offered production varied directly

with available calories, which were, however, sufficient to allow body weight to rise. The cigarettes than motivated the workmen to use more calories than they were consuming, hence the decrease in body weight under the premium system.

Kraut and Muller also reviewed extensively the rations and output of coal miners in the Ruhr from September 1939 to September 1944. Their correlations covered the entire coal production of the Ruhr and demonstrated "quite clearly that the fall of coal output during the war was primarily due to the cuts in rations."

Overall, the German scientists concluded that to ration food in a country is to ration its industrial production. In administrative terms, rationing diverts control of production from management to those who are responsible for distributing food. And in the context of postwar Germany, "Reconstruction is a problem of calories."

The Costa Rican experience[8] involved the building of the Inter-American Highway. When the work began, in 1943, a work force consisting of 30% U.S. laborers and 70% Costa Ricans, using modern equipment, moved 240 cubic meters of earth per man per day. Then the U.S. contractor, prodded by the U.S. Public Roads Administration, introduced refrigeration, strict sanitation, and sharply improved rations in the construction camps. Workers were served a balanced diet of meat, vegetables, and fruit instead of the skimpy diet of beans and rice or corn they were accustomed to. By roughly two years after the start of this program, when the work force had increased to 88% Costa Ricans, output had climbed to 1157 cubic meters per man per day, almost five times the original amount.

Detailed examination of the German and Costa Rican experiences makes plain that nutrition was not the only influence at work, although clearly it was an important influence. For the economic planner, multiple influences on productivity are a pervasive problem. A recently-completed study[5] remarks that "...there does not seem to be in existence a well established specific relationship between productivity and caloric intake to the exclusion of other factors, although there is considerable indication that a relationship at this time must be based on circumstantial evidence." The circumstantial evidence in fact is rather good, if not readily quantifiable. In line with the more liberal definitions of productivity, the Food and Agriculture Organization of the United Nations has contended that poor diet reduces working efficiency by increasing absenteeism, decreasing resistance to disease, and causing lethargy and lack of drive.

Elements of "Productivity".

Of the elements that together comprise productivity in the broad sense, absenteeism certainly is one. Not only does it reduce the output of the absent worker; it may also affect the output of his fellow workers. It might be argued that a relatively high level of absenteeism is acceptable among unskilled labor, particularly where the workmen outnumber the jobs.

Even an unskilled worker, however, may acquire a degree of know-how at his task, and absenteeism surely is damaging among skilled workers, who often are in short supply in developing nations. Absenteeism can result from illness, accident, or lack of motivation, which may be related in turn to inadequate nutrition. We know without question, for example, that the malnourished man is more susceptible to infection, and that the infection strikes him more severely than it does the well nourished man.

Lethargy or the inability to maintain a sustained rate of work also can result from poor nutrition. Myron Stearns describes such a case most graphically in his account of the Costa Rican road-building project:

> "On the job, the men would dig away gently for half an hour or so and then go sit under a tree. There they would take swigs of water sweetened with brown sugar that they brought with them in bottles. After a rest of 10 or 15 minutes--or in some cases, half an hour or more--they would get up and wearily start digging again.... The diggers still hated to dig, dug no more than they had to, rested when they could, and thankfully quit work entirely on each of the frequent fiesta days."

In addition to the effects of nutrition on productivity in the relatively short range, the scientific evidence indicates that poor diet can cripple a nation's productive capacity in more subtle and far-reaching ways. These longer-range effects involve not only nutrition but other elements of human capital not treated in detail here, such as education and public health.

The extensive literature on prenatal, infant, and childhood nutrition shows clearly that the building of a sound body and an educable mind begins very early in life. Whether early malnutrition permanently stunts mental and physical growth appears to be an open question, assuming that nutrition becomes adequate later in the growth process. If it does not, the more likely case in areas of endemic malnutrition, irreversible stunting seems much more probable.

Within reasonable limits a work force of small men is not known to be necessarily less productive than a work force of large men, but intelligence is another question. The effect of early malnutrition in intelligence is a relatively new field of investigation in which knowledge is far from comprehensive and the evidence is often conflicting. Not the least of the difficulties is separating the effects of nutritional variables from those of genetic and environmental variables. At least one research team, however, sees little doubt that early malnutrition severe enough to require hospitalization has a long-term effect not only on measured intelligence, but on the ability to learn basic academic skills. "Survivors of early severe malnutrition," these authorities contend, "are different from normal children."[4]

The malnourished child in any event loses irrecoverable learning time because of apathy and illness. According to one estimate, children in the

U.S. lose eight school days per year, on the average, because of illness. In four Latin American countries the loss was estimated at more than 50 days per child per year.

Long-range implications lie also in the fact that malnutrition is the biggest single cause of the high infant mortality rates found often in developing nations. It has been estimated that 22.5% of the national income of pre-independence India was spent to rear children who did not live long enough to contribute to the nation's productive capacity. The Food and Agriculture Organization estimates, moreover, that the populations most vulnerable today to malnutrition problems include 65 million mothers and 130 million preschool children.

Of the children born live in Brazil, in India, in the United Arab Republic, roughly 25% die before the age of five. In the U.S. the figure is 2.5%; in Japan it is 1.9%. Nor is early death the only problem. At least one million people in India are blind as a direct result of Vitamin A deficiency, and 10 to 15% of all children in that country display some ocular manifestation of the same deficiency.

Early malnutrition is related as well to the pressing problems of population growth, which are steadily compounding the economic difficulties of the developing nations. A growing body of opinion holds that parents will not voluntarily limit the number of children they have until each child's chances of survival become much better than they are today in many developing areas. That being the case, the success of family planning schemes will depend heavily on the reduction of infant mortality rates; and reduction of infant mortality rates will depend to a significant degree on sharply improved nutrition for mothers and children.

Still another long-term issue is the relationship of productivity to life span. Assuming that the individual becomes productive at age 20, the worker whose life span is 60 years has twice the effective working life of the worker whose life span is 40 years. Or consider the cost of feeding and training the individual in his first 20 years. The nation with a 60-year life expectancy receives twice the return on this investment as does the nation with a 40-year life expectancy. Differences of this magnitude could exert tremendous effects on the development of a nation.

It can be argued, of course, that the economic importance of life span is largely negated by the surplus of labor commonly available in developing countries. The productivity of a work force, however, depends on quality as well as on quantity, and the measures, including nutrition, that tend to lengthen life span would appear inevitably to upgrade quality. In the context of human capital, moreover, the interdependence of nutrition, health, education, and productivity is becoming increasingly more evident.

Finally, it seems especially to the point to recognize the ever-increasing importance of motivation and the world-wide yearning to improve the quality of life. Food has a dual role. It provides the fuel for human work and, at the same time, a goal toward which humans can work (notwithstanding the

fact that a sudden increase in income may be as likely to be spent on transistor radios as on better nutrition). Motivating people by satisfying a need as basic as food surely must relate to improved productivity.

The Scientific Framework.

The evident lack of clear-cut, real-life correlations of nutrition with productivity should not be allowed to obscure the extensive experimental data that scientists have built up on the subject. We know with reasonable accuracy, for example, the optimum supply of calories, protein, and other nutrients for humans doing a variety of types of work. We know something of the results when they consume less than the optimum. We know something of how the caloric cost of work is affected by extremes in ambient temperature. And we know how to develop low-cost nutritious foods adaptable to use in developing nations. What is required now is to translate the available scientific knowledge into field data of the type that the economic planner can use to justify the allocation of significant resources to nutrition.

The relationship of nutrition to human performance capacity is immensely complex, and the scientific findings are often controversial, but the essentials are not in doubt. A man's ability to work depends in the long run on the supply of energy or calories he consumes in his food. His need for protein, vitamins, and minerals appears not to vary so much with work output, although the body will begin to derive calories from protein if they are not available from other food sources in sufficient quantity to balance the energy being expended. When this happens the protein is not available for its normal building functions in the body.

The experimental evidence indicates in any event that significant protein or caloric deficiency for no more than, say, 10 days does not notably reduce a man's working capacity providing he is well motivated. Chronic undernutrition can have more serious effects, and under severe dietary limitations, such as semistarvation, the ability to work depends primarily on food intake. As the food supply increases, motivation becomes a more important factor.

Such knowledge certainly has practical significance, but the planner works in a broader context. A pertinent example is agriculture, which occupies perhaps three quarters of the adult males in the tropical areas of Africa, Asia, and Latin America[7]. Several studies have shown that farming is hard work in terms of calories expended. Farmers in some areas, including northern Ghana and Nigeria, are known to have their lowest caloric intake in the period of the heaviest work load when, as a result, they lose 10 to 15% of their body weight. What is not known is how the shortage of calories affects their working efficiency, particularly in relation to other factors that might limit agricultural productivity. If the quality of the soil is the major restraint, for example, the planner might want to put his resources into fertilizer instead of nutrition. In the developing nations,

however, real-life data are sparse both on caloric balance among farm workers and on how it relates to their productivity.

A question that may be pertinent is the maintenance of full working efficiency on intentionally deficient diets, as opposed to survival nutrition or plain starvation. The relatively few experiments in this area include one by the British Army in 1967[2]. It involved 18 soldiers who were fed for six days on rations providing an average daily energy intake of 3900 calories per man. Then, for 14 days half the men received rations supplying about 1900 calories; the other half received ration packs that were similar in appearance, bulk, and weight, but that supplied about 3500 calories per man. During those 14 days, both groups patrolled continuously through a heavily-forested training area. The men knew they were eating experimental rations, but they did not know of the difference in energy content.

A variety of measurements were made on the men during the test period, but none showed any difference between the two groups in physiological work capacity or performance. One difference did turn up: "Men of the low-calorie group became listless and lethargic. They never stood when they could sit and never sat when they could lie." The conclusion: "Rations of 1900 calories per day for 10 days have no effect on the performance or efficiency of well-motivated soldiers doing a hard physical task."

This experiment was part of a British Army program to reduce the weight of food carried by a soldier on a long foot patrol. The Army was thus seeking in part the short-term break-point at which caloric intake became limiting. That signs of the break-point did not begin to appear until the last few days of the 14-day patrol must be attributed in significant degree to the fact that the subjects were healthy, well-trained, well-motivated men. Previous work had shown that good morale can obscure physiological disabilities, while bad morale accentuates them. The British workers minimized the confusing effects of fluctuating morale by studying the performance of the individual rather than of the group, whose morale tends to be leader-dependent.

Scientists have shown that the nutritional needs of workers are affected by ambient conditions although, again, most of the research has been done in the developed nations. Until roughly 1960 it appeared that caloric requirements declined as temperature rose. Then, a team of U.S. Army physiologists explored the problem in a series of comprehensive studies of metabolic balance in the field[3]. They found, in brief, that caloric need rises significantly in extreme heat and does not change significantly in extreme cold (provided the men are properly clothed). These studies were made in the U.S. and Canada, however; it is not known whether natives of the tropics react in the same way to extremes of temperature.

The extra calories required at high temperature, in any event, fuel the body's mechanisms for adapting to heat. One of these mechanisms is perspiration, which can have secondary effects. Dehydration can reduce working efficiency, and overhydration may be beneficial in extreme heat.

Heavy perspiration removes from the body varying amounts of salt, amino acids, lactic and pyruvic acids, and some vitamins and minerals. The full significance of these phenomena is not well understood, particularly for tropical areas. It appears, for example, that man can adapt both to low sodium intake and low protein intake. One authority nevertheless attributes the low performance capacity of farmers in northeastern Brazil to a combination of low caloric intake and the heat. The farmers studied consume 1910 calories daily and work an average of only four hours.

Low-Cost Nutritious Foods; Industrial Feeding.

That nutrition is closely related to a nation's productivity should be clear even in this very brief survey of the voluminous literature on the subject. One might ask also, however, what tools are available to the planner who wishes to attack nutrition problems in a developing nation. Improved crop varieties are vital, but the Green Revolution may be a mixed blessing for some time (in some areas, for example, high-yield cereal varieties have displaced pulses and oilseed crops that provide better-quality protein). Of the variety of other means available, two that can be mentioned briefly here are low-cost nutritious foods (LCNF's) and industrial feeding.

A considerable technology is available for formulating LCNF's such as beverages, weaning foods, confections, pasta products, and baked goods. Such products can be based on vegetable protein sources, which usually are available locally in greater or lesser degree. They could thus help to meet the deficit in animal protein found often in developing areas. LCNF's can be fortified, as with lysine; they can be formulated to have the color, viscosity, and flavor that consumers find attractive.

Progress with low-cost nutritious foods on the whole has been slow in developing areas. A few such products are commercial successes; some are marginal; still others have failed for various reasons. New food products can be difficult to sell to consumers who are unfamiliar with the basic principles of nutrition and who tend to cling to traditional dietary customs. The food industries in developing nations, moreover, usually lag well behind the industries more oriented to raising Gross National Product. Training in nutrition, on the other hand, is becoming more widespread in developing areas, and the movement of people to urban areas is creating more concentrated targets for both educational and marketing efforts. A number of LCNF's are in the laboratory or pilot plant stage, and there is reason to forecast slow but steady progress.

The movement from rural to urban areas also can create malnutrition problems, and industrial feeding may be one way to help solve them. A properly designed feeding program might be used not only to improve workers' diets, but to expose them to the principles of nutrition. The Joint FAO/WHO Expert Committee on Nutrition noted in 1966, however, that the value of industrial canteens in helping to solve nutrition problems resulting from rapid urbanization had not been properly evaluated. The Com-

mittee took the same view of the relationship between industrial feeding and productivity.

The L.I.F.E. survey of 1969-70 detected little evidence that this situation had changed significantly. The responses did indicate that employers with experience in industrial feeding believe such programs are valuable, to the extent of being willing to subsidize them in whole or in part. The problem has been the severe shortage of personnel trained in catering and institutional feeding. Efforts have been under way for several years to train more people, particularly in India, and there is other evidence that interest is growing in the potential benefits of industrial feeding.

Conclusion.

Despite the accumulation of evidence that the quality of nutrition may well be an important limiting factor in development, the fact remains that the economic planner can allow himself to be convinced only by hard, real-life data. In the complex situations that he faces, intuition and indirect evidence are not enough. It is encouraging to note that the Agency for International Development is attempting currently to develop a planning model to estimate the economic benefits of improved nutrition in developing countries. This is one indication of the growing belief that the case can now be made.

The attitude of the military toward nutrition and human performance stands in sharp contrast to that found often in developing areas. Great military leaders universally have embraced the precept that "An army marches on its stomach." The general's situation differs sharply, no doubt, from that of the economic planner in an underdeveloped area. But each in his own way is dealing with men in crisis, and it is pertinent to note a military physician's comment that "combat nutrition is regarded not as a gastronomic feast but as a necessary refuelling operation." This concept surely is valid in many underdeveloped areas.

The issue here is not whether a malnourished human's performance can be improved by feeding him better. That much can hardly be questioned. The issue is whether the impact in a developing area is sufficiently clear-cut to justify the allocation of significant resources to nutrition to help spur Gross National Product. In this respect it is well to note Berg's and Muscat's admonition that "the planner should not insist on greater exactness in measuring the impact of malnutrition than he does in other fields in which he is accustomed to allocating large sums."

The organizations who subsidize industrial feeding programs clearly do not demand rigorous correlation of nutrition with productivity. The point is important because industrialists tend commonly not to spend money on activities in which they see no reasonable expectation of profit. The businessman, in brief, lives in a very real, short-term world. His willingness to subsidize nutrition carries a message that warrants serious attention. That message could be strengthened a great deal by a further rapid build-

up of hard, direct evidence, couched in the planner's context, for the beneficial effects of nutrition on productivity in the broad sense.

References

[1]Berg, A., Muscat, R., "Nutrition and Development: the View of the Planner," Am. J. Clin. Nutr., 25, 186 (1972).

[2]"Combat Nutrition: the Effects of a Restricted Diet on the Performance of Hard and Prolonged Physical Work," Report 2/71, Army Personnel Research Establishment, Ministry of Defence, United Kingdom.

[3]Consolazio, C. F., "The Energy Requirements of Men Living Under Extreme Environmental Conditions," World Rev. Nutr. Diet., No. 4, 1969.

[4]Cravioto, J., DeLicardie, E. R., "The Long-Term Consequences of Protein-Calorie Malnutrition," Nutr. Rev., 29, 107 (1971).

[5]"The Economics of Malnutrition," Vol. I & II, report by Battelle Memorial Institute to the U.S. Department of State, Agency for International Development, December 1970, page 37, Vol. 1.

[6]Kraut, H. A., Muller, E. A., "Calorie Intake and Industrial Output," Science, 104, 495 (1946).

[7]Lowenstein, F. W., "Nutrition and Working Efficiency (with Special Reference to the Tropics)," Special Paper No. 3, May 1968, Joint FAO/WHO/OAU (STRC) Regional Food and Nutrition Commission for Africa, P. O. Box 1628, Accra, Ghana.

[8]Stearns, M., "The Road that Food Built," Harper's Magazine, June 1954, page 82.

APPENDIX

I. L.I.F.E. SURVEY QUESTIONNAIRE.

In 1969-70, L.I.F.E. mailed the questionnaire below to 292 industrial organizations with experience in employee nutrition programs. The results of the 28% response are covered selectively in the foregoing paper; the complete response is on file in the L.I.F.E. office.

Questionnaire

There is a growing interest in trying to determine the economic value, to society, of programs in the field of nutrition. That is, just what are the benefits to be gained from such activities as industry-subsidized canteens, nutrition education programs, and the like. We are making a survey to see what information is available to help better plan the various types of food and nutrition programs which are to be set up in the developing nations.

It is our understanding that, over the years, many companies have provided nutrition programs. These have included providing meals for workers and their families, providing food as part of pay, stressing the importance of good food habits by using posters and other visual aids, and related activities. If your company has engaged in any food and nutrition activities, either in the U.S. or overseas, we would appreciate learning of your experiences.

Your response should include such items as:
--The reason(s) for undertaking the program;
--A complete description of the program (what was done? when? by whom? where? how long?)
--Any changes made while the program was going on and why;
--Reason(s), if applicable, for terminating the program.

Of foremost importance to us are the results of the program, from both management and labor viewpoints:
--Was there a reduction in absenteeism?
--Was there a reduction in the rate of accidents?
--Did workers seem more alert, healthier, more productive?
--Was any cost benefit analysis made? If yes, could we have a copy?
--Did the program fail? If so, why?

Our final summary will not show the identity of your company, only the conclusions and factual findings. Any other limitations imposed on the data which you supply will be respected. We would be most grateful for your help.

If we have sent this letter to the wrong person, kindly route it to the proper one. If you know of other companies which are carrying out employee nutrition programs, or of literature which is available on this subject, please let us know about them.

Thank you very much for your help

II. SUPPLEMENTARY REFERENCES.

Astrand, P., Rodahl, K., "Textbook of Work Physiology," McGraw-Hill Book Co., New York, N.Y., 1970.

Banerjee, B., Saha, N., "Energy Cost of Some Common Daily Activities of Active Tropical Male and Female Subjects," J. Appl. Physiol., 29, 300 (1970).

Birch, H. G., Gussow, J. D. "Disadvantaged Children: Health, Nutrition, and School Failure," Harcourt, Brace, and World, Inc., New York, N.Y., 1970.

Blix, G. (ed), Symposia of the Swedish Nutrition Foundation, V, "Nutrition and Physical Activity," Almqvist and Wiksell, Stockholm, 1967.

Brozek, J., Vaes, G., "Experimental Investigations on the Effects of Dietary Deficiencies on Animal and Human Behavior," in "Vitamins and Hormones," Vol. 19, p. 43-94, Academic Press, New York, N.Y., 1961.

Brozek, J., "Nutrition and Behavior," in "Feeding the Military Man," proceedings of a symposium at U.S. Army Natick Laboratories, Natick, Mass., October 1969, p. 140.

Brozek, J., "Psychologic Effects of Thiamine Restriction and Deprivation in Normal Young Men," Am. J. Clin. Nutr., 5, 109 (1957).

"Child Nutrition in Developing Countries (A Handbook for Fieldworkers)," Office of War on Hunger, Agency for International Development, U.S. Department of State, Washington, D.C., 1969, 200 pp., for sale by Superintendent of Documents, U.S. Government Printing Office, $1.00.

Consolazio, C. F., "Nutritional Variation in World Populations and Performance Potential," Annals N.Y. Acad. Sci., 134, 885 (1966).

Dema, I. S., "Nutritional Adequacy as an Essential Factor for African Development Programmes," Food and Nutrition in Africa, December 1971, p. 11, P.O. Box 1628, Accra, Ghana.

"The Economics of Malnutrition," Nutr. Rev., 27, 39 (1969).

"The Food Industry in Asia: Its Potential for Providing Low Cost Nutritious Foods," summary report of a workshop in Singapore, November 1971, League for International Food Education, Washington, D.C.

Goldsmith, G. A., "Where Are We in the Race Against Starvation?", Am. J. Publ. Health, 61, 1478 (1971).

Hutchinson, R. C., Krehl, W. A., "The Effect of Food Intake on Performance," Borden's Review of Nutrition Research XV, 3, 33 (1954), The Borden Co., New York, N.Y.

Joint FAO/WHO Expert Committee on Nutrition, Seventh Report, FAO Nutrition Meetings Report Series, No. 42, Food and Agriculture Organization of the United Nations, Rome, Italy, 1967.

Keyter, C., "Feeding Customs and Food Habits of Urban Africans," Fact Paper No. 11, South African Institute of Race Relations, Johannesburg.

Keyter, C., "Industrial Feeding of African Workers," (Its relation to management policy and the wider problem of malnutrition), South African Institute of Race Relations, Johannesburg, 1962.

Levinson, F., Call, C., "A Model for Nutrition Planning," paper presented at the 17th meeting of the FAO/WHO/UNICEF Protein Advisory Group, New York, N.Y., May 1970.

Lowenstein, F. W., "The Cost of Malnutrition--A Brief consideration of two major problems," (protein-calorie deficiency, endemic goiter), Food and Nutrition in Africa, November 1971, p. 3, P.O. Box 1628, Accra, Ghana.

"Mental Development Following Kwashiorkor," Nutr. Rev. 27, 46 (1969).

Moroff, S. V., Bass, D. E., "Effects of Overhydration on Man's Physiological Responses to Work in the Heat," J. Appl. Physiol., 20, 267 (1965).

Nicol, B. M., "Protein and Calorie Concentration," Nutr. Rev., 29, 83 (1971).

"Nutrition and Working Efficiency," Freedom From Hunger Campaign Basic Study No. 5., Food and Agriculture Organization of the United Nations, Rome, Italy, 1962.

"Report of the Joint Symposium on Industrial Feeding and Canteen Management in Europe," FAO Nutrition Meetings Report Series, No. 36, Food and Agriculture Organization of the United Nations, Rome, Italy, 1963.

Rodahl, K., "Food Intake and Performance," in "Feeding the Military Man," proceedings of a symposium at U.S. Army Natick Laboratories, Natick Mass., October 1969, p. 133.

Schertz, L. P., "Economics of Protein Improvement Programs in the Lower Income Countries," Foreign Economic Development Service, U.S. Department of Agriculture (cooperating with U.S. Agency for International Development), July 1971.

Schultz, T. W., "Investment in Human Capital," Am. Econ. Rev., 51, 1 (1961).

Scrimshaw, N. W., Gordon, J. E. (eds.), "Malnutrition, Learning and Behavior," M.I.T. Press, Boston, Mass, 1968.

Simonson, E., "Influence of Nutrition on Work Performance," in "Nutrition Fronts in Public Health," Nutrition Symposium Series, No. 3, pp. 72-117, National Vitamin Foundation, New York, 1951.

"A Study of Workers' Feeding (Report to the Government of Zambia)," Nutrition Consultants Reports Series, No. 9, Food and Agriculture Organization of the United Nations, Rome, Italy, 1970.

Weisberg, S., "High Nutrition Foods for Developing Countries," League for International Food Education, Washington, D.C., June 1971.