AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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Batch 66

1. SUBJECT CLASSIFICATION	A. PRIMARY: Food production and nutrition	AS10-0000-0000
	B. SECONDARY: Food composition	

2. TITLE AND SUBTITLE
Research to determine the cost and effectiveness of alternate means of controlling vitamin A deficiency; and evaluation of three alternate strategies in the Philippines

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4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1977	138p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
Cornell

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(Final rpt.of contracts: AID/ta-C-1319 and AID/ta-C-116)

9. ABSTRACT
Gives brief background on Vitamin A deficiency, details a three-year study of Vitamin A deficiency in the Philippines which included alternate means of control, and gives recommendations for a national policy to prevent xerophthalmia. The study, carried out by the Cebu Institute of Medicine in Cebu City and Cornell University, sought to determine the magnitude of the problem of Vitamin A deficiency in the Philippines. It examined the relative importance of the various factors associated with xerophthalmia and designed programs to eliminate and to prevent the affliction. Another goal was to determine the nutritional and economic effect of each program after the programs had operated for one year. Some 2715 sample children ages 1-16 were drawn randomly from 600 families in four Philippine ecologic zones. Clinical, biochemical, dietary, and socioeconomic information was obtained from the families. Among the study's findings: xerophthalmia was more prevalent in urban than rural areas, and it peaked in the 4 to 6 and 14 to 16 year age groups. The means of controlling Vitamin A deficiency in the project were a (1) public health disease elimination and horticultural program, (2) massive dosage capsule program, and (3) fortification with monosodium glutamate (MSG). Overall effects were a reduction of active clinical xerophthalmia by about 57%. Comparison of individual interventions showed that the MSG fortification program produced the best results in reducing active clinical xerophthalmia and improving serum A levels. The report points out that formulation of a national policy to deal with the problem of Vitamin A deficiency should consider whether there has been an examination of possible intervention strategies and their effectiveness, and the feasibility and cost-effectiveness of such intervention.

10. CONTROL NUMBER
PN-AAE-298

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Children	Strategy
Cost analysis	Vitamin deficiencies
Evaluation	Vitamin A
Philippines	Xerophthalmia?

13. PROJECT NUMBER

14. CONTRACT NUMBER
AID/ta-C-1319 Res

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Recommends that a national policy include a multiple-intervention approach in which programs are integrated into existing health services and in which other governmental agencies, such as those for agriculture and education, are involved.

AID/ta-C-1319 Rec
PN-AAE-978

June 30, 1977

Report on:

"Research to determine the cost and effectiveness of alternate means of controlling vitamin A deficiency"

and

"Evaluation of three alternate strategies to prevent xerophthalmia in children in the Philippines"

Supported by U.S.A.I.D.

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Preface

This report to U.S.A.I.D. constitutes the final report in respect to "Research to determine the cost and effectiveness of alternate means of controlling vitamin A deficiency" and "Evaluation of three alternate strategies to prevent xerophthalmia in children in the Philippines".

These projects in the Philippines received support from U.S.A.I.D. for the Cornell component. Other financial assistance was received from the National Science Development Board of the Philippines and from the World Health Organization in Geneva. UNICEF donated vitamin A capsules and Hoffmann-La Roche provided valuable technical assistance. Union Chemicals (Manila), the Philippine associate of the Ajino Moto Company of Japan, cooperated with the team in the fortification of their product.

Assistance has been received from numerous people in all these organizations and in others during the three years of the project. We are grateful to all of them and to the staff of the Office of Nutrition of U.S.A.I.D., all of whom made the completion of the task possible. The government of the Philippines and the Nutrition Center of the Philippines provided cooperation. Above all we are extremely thankful to the families in the 12 barangays in Cebu who were central to the study and whose patience, cooperation and friendliness were essential and much appreciated. We believe that the help of all of these will contribute to the control of vitamin A deficiency and a scourge of blindness in the Philippines.

APPENDIX I

CHAPTER 1

INTRODUCTION

This pilot project attempts to systematically determine the best programs for eliminating xerophthalmia in the Philippines. The goals are to:

1. Determine the magnitude of xerophthalmia, or severe vitamin A deficiency in one region in the Philippines;
2. Understand the relative importance of the various factors associated with xerophthalmia;
3. Design optimal programs for eliminating and preventing xerophthalmia for different ecological conditions; and
4. Determine the nutritional and economic effects of each program after the programs have operated for one and one-half years.

The need for systematic planning to develop useful strategies and programs for combatting malnutrition has become widely recognized in recent years. This stems partially from the major changes in the perspective on human resource development and the numerous technological breakthroughs which have led to renewed interest in specific nutrition interventions. Further, planners have become increasingly aware of the developmental efforts of the previous decades which have benefited not those most in need, but the middle and upper classes of society. These previous investment-oriented developmental

approaches ignored the issues of employment, income distribution and other major welfare issues such as nutrition.

This interest in nutrition has meant that more efforts are being directed towards developing effective nutrition strategies. This would ideally include four steps: (1) a determination of the magnitude of the general or specific nutrition problem; (2) an understanding of the importance of various determinants of this nutrition problem; (3) an analysis of the optimum means of eliminating, alleviating, or preventing the problem; and (4) an evaluation of the health, nutritional and economic benefits resulting from its elimination.

The 1970's represent the decade of equity considerations for many interested in the development of low income nations. Attention is being focused on directly reaching those most in need through various health, nutrition and other programs as well as through enhanced employment opportunities, etc. The term rural development is often used to represent the confluence of all these interests as it relates to rural areas. It is recognized that in the past many developmental programs intended to reach the bottom 30, 40 or even 50% of the population simply have not met this goal.

At the same time, advances in agricultural, nutritional, and health technology have allowed some nutrition intervention programs to be developed within the present framework of most low-income nations without waiting for major economic transitions to take place. Examples of this are the Green Revolution and malaria eradication. In the nutrition area, recent advances

in fortification and synthetic nutrient technology provide exciting new possibilities. For instance, minimal costs are involved in the fortification of salt with iodine or the provision of children with massive dose of capsules of vitamin A.

The Nutrition Planning Process and This Pilot Project

The first step was the determination of the general nutrition problem. This included the identification of the particular segment of the population affected (age, sex, rural/urban, etc.) on the island of Cebu through the use of household and individual dietary surveys; biochemical, anthropometric, and clinical/medical examinations.

The second stage proceeded at two levels. One level examined the various factors related to xerophthalmia in a strict cause-and-effect framework. The nutritional problems were viewed as an aspect of health and examined for the medical, environmental, as well as nutritional factors. This analysis determined where nutrition intervention can take place.

The second level considered the possible nutrition interventions with other non-nutrition programs. To maximize or improve the nutritional status of a population or any target group, numerous points in a social system need to be examined. There are many ways to improve the nutritional status without direct nutritional intervention. Some of these are: the provision of jobs; subsidization of food through price manipulation or direct distribution; technological change to improve the yields or nutritional content of various food crops; and the elimination of infectious diseases which interact synergis-

tically with food ingestion to increase dietary needs or to cause malabsorption. It must be determined how intervention, through these and other non-nutritional approaches, would substitute for or be complementary with direct nutritional intervention such as child feeding or fortification programs.

Once the link between the various forms of development and nutritional change are made, the point of nutritional intervention is determined. Often, of course, nutrition intervention programs will not be as meaningful in the broad context of national development as other developmental programs will be. It is important that the nutritional programs not be developed in a vacuum.

CHAPTER II

BRIEF BACKGROUND OF VITAMIN A DEFICIENCY*

A. Introduction

In natural situations a pure vitamin A deficiency seldom exists as an isolated condition, especially in Asia. Rarely does the deficiency of Vitamin A occur without the presence of other nutritional deficiencies or in conjunction with other disease. Many forms of malnutrition occur in the presence of infectious and parasitic diseases which often are interacting synergistically with malnutrition. Thus the conditions of interest here, xerophthalmia and keratomalacia, occur concurrently with dietary deficiencies such as protein, calories and riboflavin and with diarrhea and other forms of infectious or parasitic disease. Vitamin A deficiency produces a variety of pathological lesions but this study is concerned chiefly with the deficiency as it relates to the eye and to the resultant blindness, mortality and morbidity which are the most significant consequences of this deficiency.

Xerophthalmia is the general syndrome which covers all eye lesions and the general public health problem implied in vitamin A deficiency. The affix xero- suggests a dryness, lusterless condition of the eyeball. Keratomalacia relates to the softening of the cornea with ulceration and loss of vision. The root malacia differs from xero as it is the weakening, softening and melting process which follows xerophthalmia. This last stage of xerophthalmia may develop very rapidly.

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*This discussion represents the synthesis of many scientific papers dealing with various aspects of vitamin A and xerophthalmia. A more detailed study will document these sources at a later date.

Vitamin A includes the preformed vitamin A (retinol) or the pro-vitamins A or carotenoids. Preformed A is ready for utilization by man while the preformed carotenes must be converted to vitamin A in the intestines of man. It should be noted that the preformed A is four to six times as efficient as the beta carotene in that much of the beta carotene is lost in the process of absorption and conversion before it can be utilized by the human organism.

B. Consequences of xerophthalmia

A deficiency of vitamin A affects many central life processes of the human organism. Many of these relationships may have important economic manifestations which will be discussed later. The following are some of the relationships:

a) Resistance to infection - a deficiency lowers the resistance to infection in general and especially lowers the integrity of the epithelial tissues. Vitamin A is synergistic with almost all infectious diseases in which the relationship has been studied. Children and adults with xerophthalmia are highly susceptible to infections, particularly the respiratory and genito-urinary systems.

b) Reproduction - vitamin A is essential for the normal functioning of the reproductive system;

c) Utilization of dietary protein - The addition of vitamin A increases the utilization of protein. On the other hand, a deficiency of vitamin A may reduce food intake and growth.

d) Visual cycle - vitamin A is essential in the formation of rhodopsin. Rhodopsin is important for vision in dim light. Furthermore, blindness is a common occurrence for those who have suffered from xerophthalmia. Often the lesions are asymmetric; the numbers of people blind in both eyes and one eye is about equal. Disagreement exists on this point. In one study, among the survivors of xerophthalmia, 27% were blind, 59% had greatly reduced vision and only 14% had undamaged eyes. McLaren estimated that a minimum of 1 in 800 children surviving the age of 5 in Indonesia would be totally blind from xerophthalmia.

e) Mortality - vitamin A deficiency greatly increases the mortality rate of children. Between 25 to 60 percent of those with xerophthalmia die. Observations in India suggest 50 per cent survive while in areas of North Africa survival may be a rarity. At the same time, many children with xerophthalmia die of kwashiorkor or nutritional marasmus who might otherwise survive and become blind.

C. Nutritional and Biochemical factors

Two of the key processes which determine the effects of dietary intake over time on the human organism's vitamin A nutriture are the absorption and conversion of the preformed beta carotene. The biosynthesis (conversion) of vitamin A from beta carotene takes place mainly in the intestinal mucosa,

during the absorption of dietary B-carotene. The presence of various diseases interferes with this absorption process of either carotene or vitamin A. Acute febrile infectious disease and perhaps also diarrheal disease have a trigger effect, which cannot always be explained by depletion.

Basically the provitamin A (carotenoids) is converted into retinol (vitamin A) and then absorbed. Fat affects the amount of carotene absorbed since vitamin A is a fat soluble vitamin. Protein deficiency markedly depresses the intestinal conversion of beta-carotene. After absorption, the nutrient is either utilized or stored. A study carried out in India showed that mild protein calorie malnutrition does not impair the absorption of beta-carotene. Protein is necessary for the utilization of the vitamin A and is also responsible for the transport of this A (retinol) in human plasma while vitamin E affects the utilization and also the storage of the A in the liver. Scientists are finding that some vitamin A is stored in skin and muscle.

Previously it was mentioned that vitamin A affects protein metabolism, reducing the utilization of the ingested protein. A severe protein deficiency may prevent vitamin A from reaching the liver and keep the remaining reserves unavailable to the other tissues of the body for utilization. This does not mean kwashiorkor or xerophthalmia will necessarily occur concrrently. Rather, this means programs which provide protein and subsequently accelerate the rate of growth in children, may produce the appearance of xerophthalmia.

An unrelated but important factor is the effect of maternal nutriture. Poor maternal vitamin A nutriture results in a low storage in the unborn child and a low content of vitamin A in the mother's breast milk.

There are several biochemical indicators of vitamin A nutritional status. The clinical indicator used in this study is the xerophthalmia ranking discussed in the introduction. The amount of vitamin A stored in the liver can be determined by a biopsy of liver tissue taken with a biopsy needle injected into this organ. Although this test is very useful, it may be painful, it produces side effects and complications in some patients and was not utilized. It is not a field test. Determinations of the levels of vitamin A (retinol) and of carotene in the serum (plasma) are the two basic methods. Also there is some evidence of a poor correlation between vitamin A in the liver and the plasma unless the deficiency is very severe. The same is true for clinical symptoms of vitamin A deficiency and serum A levels. Part of the explanation may be the storage of vitamin A in the skin and muscle.

The serum carotene, on the other hand, reflects recent dietary intake. Beta-carotene is not stored for very long; it is converted to vitamin A. The finding of low carotene levels is informative as to the type of diet consumed over recent weeks and months. There is a problem with the serum carotene because more of the carotenes are not converted to retinol.

The guidelines for interpreting the biochemical data are supplied by the Interdepartmental Committee on Nutrition for National Development. These are found in Table 1.

Table 1 Biochemical Data Interpretation*
ICNND

	Deficient	Low	Acceptable	High
1. Plasma vitamin A ug/100 ml	10	10-19	20-49	≥50
2. Plasma carotene ug/100 ml		20-39	40-99	≥100
Pregnant women				
Trimester 1		20-39	40-99	≥100
Trimester 2		30-79	80-199	≥200
Trimester 3		40-79	80-249	≥250

*Serum levels of nutrients in children do not differ appreciably from those of adults.

D. Dietary Aspects

In the previous discussion, vitamin A sources were described as retinol and as carotenoids. The main carotenoid is beta-carotene. The importance of these distinctions lies in the relative effectiveness in each in providing the necessary biological activity for the human body.

The carotenoids are not utilized as efficiently as retinol by the human body. The standard relationship is 1 ug beta-carotene equals .167 ug retinol or beta-carotene is one-sixth as efficient as retinol. The other carotenoids are much less efficient than beta-carotene and are given a retinol equivalence of one-twelfth. The other standard of measurement for vitamin A activity is International Units (IU). One I.U. of vitamin A is equivalent to 0.3 ug of retinol.

These relationships are significant, especially when carotenoids provide 65-95% of the total vitamin A activity in the diets of the developing areas. The principal sources of vitamin A in the diets of developing areas are fruits and vegetables—predominantly the green leafy and yellow vegetables.

Sources of Vitamin A

Foods containing previtamin A as retinol are fairly expensive and consumption may be prohibited by religious or cultural mores. It occurs widely in animal tissues, especially in the livers where it is stored. The fat content of the meat, milk or fish may be important; the retinol is often found in these tissues. Thus lean meat or fish and milk from which the fat has been skimmed are almost devoid of vitamin A. While

fish provide an excellent source of vitamin A, sun dried fish loses most of its vitamin A value. "Eggs are an excellent source of retinol and may prove to be a practical method of supplementing vegetable diets."

Beta-carotene is found in all the green parts of plants. Green leafy vegetables, such as the young leaves of Ipomoea (sweet potato and swamp cabbage), cassava, amaranth, horse-radish, etc. are rich sources of carotenes. ...Fresh immature legumes (green string beans, lima beans, peas, etc.) before they reach the mature dried stage (grain legumes) are also good sources of both proteins and carotenes. Breast milk is another important vitamin A (preformed) source. For infants breast feeding is of unquestionable importance in forestalling vitamin A deficiency.

Beta-carotene is also found in abundance in red palm oil, carrots, mangoes, papayas and other yellow vegetables and fruits. Red palm oil, a very rich source of beta-carotene is extensively produced in West and Central Africa and parts of the Far East. It is often used to treat xerophthalmia. Coca, consumed in the highland areas of Bolivia, has a high carotene A content.

Carotene and retinol are relatively stable towards heat and in the canning and processing. In some cases such as carrots the foodstuff must be cooked to release all of the carotene. At the same time traditional techniques such as the drying of leaves and the storage of vegetables such as squash do not lead to a loss of carotene. Extensive exposure to the sun (e. g., sun dried fish appears to be the major cause of carotene or retinol loss.

Often the main staple determines the diet content of vitamin A. When it provides little or no carotene as in the case of rice and white corn, the incidence of xerophthalmia is very high. Thus the rice-eating populations of Asia and the Far East usually consume lower amounts of carotene than do those whose staple is yellow maize, sweet potatoes or millet.

Requirements

The requirements for vitamin A, expressed in weights of ug, vary by age and sex. The recommended daily amount of retinol for an adult is 750 ug (micrograms). An amount as low as 390 ug retinol per day is required to prevent visual symptoms of vitamin A deficiency in adults. During pregnancy the recommended daily allowances (RDA) remain constant; however, lactating women have an RDA of 1200 ug retinol per day. Growth requirements are greater for infants. At the end of three and five months 420 ug/day or about 65 ug/kg. and 50 ug/kg, respectively are recommended. Table 2 reports the recommended levels of retinol.

Table 2

Recommended Intake of Retinol at Various Ages

Age	Recommended intake ug retinol per day	International units	Age	Recommended intake ug retinol per day	I. U.
0-6 months	1/		7-9 years	400	1333
6-12 months	300	1000	10-12 years	575	1917
1 year	250	833	13-15 years (boys-girls)	725	2417
2 years	250	833	16-19 years (boys-girls)	750	2500
3 years	250	833			
4-6 years	300	1000	Adults (man-woman)	750	2500

Note: For diets containing both carotene and retinol, adjustment must be made as described in the text.

1/ For infants 0-6 months, it is accepted that breast feeding by well-nourished mother is the best way to satisfy the nutritional requirements for vitamin A.

E. Etiological Relationships

The incidence of xerophthalmia differs from area to area. with the same vitamin A dietary intake. The causes of this disease are complex and vary seasonally and by age and sex as these factors are related to food supply, disease, poverty and urbanization and numerous cultural forces. This section summarizes these factors, in particular the issue of age and sex.

A common profile begins with the pre-school child who is undernourished but does not display clinical symptoms of xerophthalmia or any other form of malnutrition. Then the child becomes infected with a serious gastrointestinal or respiratory infection at the age of 3 which precipitates xerophthalmia. A month later the child's vision becomes blurred and the mother takes the child to a local clinic 20 miles away. But, it is too late. The child's condition is irreversible and eyesight in both eyes is lost.

Dietary factors

A low intake of vitamin A or carotene can be consumed by a child or by the infant because the milk of the mother is low in these nutrients. In Java, the vegetables and young pulses are placed in a soup (sajur) along with peppers and other spices. This soup is very spicy and many children refuse to eat it. Thus, the children consume very little carotene. In some areas in Java among the poor there are periods right before the rice harvest when no sources of carotene are available and the dietary-related incidence of xerophthalmia is high. In Europe, xerophthalmia used to appear in the spring after the provitamin A reserves were exhausted at the end of a greenless winter.

Other examples of dietary causes are kwashiorkor and the resultant effects on the metabolism of vitamin A, a low intake of dietary fat lowering the intestinal absorption of all forms of vitamin A (especially the carotenes), and a maldistribution of food in the family resulting in the good sources of retinol and beta-carotene being given to the child very sparingly. In one study of 180 children with xerophthalmia, 90% of the children were classified as malnourished.

Disease

The direct effects of various diseases on the absorption of retinol and carotene were already highlighted. Most authors associate the average case of xerophthalmia, especially keratomalacia, with diarrhea, measles, tuberculosis, hookworm, fever or ascaris. The diarrhea months occur simultaneously with the highest incidence of xerophthalmia cases in Japan, Korea, South Asia, and the Near East and North Africa. Often the onset of diarrhea leads to a reduced diet of rice, barley water tea or herb infusions. This exacerbates the problem. Xerophthalmia cases frequently come in waves. These prove to depend rather more on epidemiological variation of the contagious diseases of childhood than on seasonal variation of food intake. Some conflicting evidence on the relationship between xerophthalmia and diarrhea has been presented.

The best documentation of the effects of various diseases on the incidence of xerophthalmia was a study done in North Vietnam. Two distinct periods with a high incidence occurred. In the hot summer months there were numerous cases of intestinal infection. In October to December, the cold season, the inci-

dence of respiratory infection was high. The incidence of xerophthalmia related directly to these diseases and was highest during these two periods. Measles, tuberculosis, ascaris and giardia are some of the diseases which can increase the incidence of xerophthalmia. Most of this information has come from studies of children admitted to hospitals and has not followed children over a period of time. Thus these associations might be spurious in the sense that these diseases do not trigger xerophthalmia. It is, of course, possible that xerophthalmia triggers them.

Poverty

Xerophthalmia is felt to be a poor man's disease. Rarely is a case found among middle income or rich children. For example in Jogjakarta, Indonesia, Oomen collected 11,000 case histories (of xerophthalmia) from the free clinics, but not one while scanning thousands of records of paying patients.

Urbanization

The rapid urbanization of the past several decades has produced hundreds of squatters colonies and slum areas in large and small metropolitan areas. Alternately termed bustees, jhuggi, jhonpris, urban barrios, or shanty towns, these urban villages or squatters colonies are the scene of some of the most seriously malnourished children. The existence of most inhabitants in the urban villages is marginal; the chief occupations are the crafts of basket-weaving, clothes washing, etc., and similar marginal urban occupations such as pulling rickshaw, or selling sugar water on a corner. Often their destitution forces them to resort to begging.

These people carry their old food habits with them to the cities. They often will consume only the same grains, fruits and vegetables which they had available in their villages. Grains are obtained, though they may be much more expensive. These staples will be purchased first. However, the more perishable fruits and vegetables often cannot be obtained. When they are available, the quantity purchased is much less than that same family would have consumed in rural areas. Another factor is important. In rural areas, many of the fruits and vegetables are consumed with little or no cost. When a price is placed on these foods, families are most likely to consume less of them and more of their staple food which is usually low in carotene.

The unavailability of fruits and vegetables in the urban market is a second factor in the different levels of consumption of these foods in urban and rural areas. In the Philippines fruits and vegetables are usually produced as a cash crop by the Chinese. Most often farmers normally produce only for their own consumption.

There are detrimental social forces which become important in urban areas. The advertising of commercial food induce many families to purchase these much more expensive foods and their nutritional status suffers. Or, the mother may be forced to work and be unable to breast feed the baby. The substitute of powdered milk or other forms of baby milk is diluted or fed in smaller quantities to the child. Often the skimmed milk is not fortified to replace the retinol lost with the skimmed-off fat.

Before World War II xerophthalmia attracted much attention in Singapore where it was related to the use of artificially fed infants. For a long time the powdered skimmed milk sent to developing areas from the U.S. through Public Law 480 was not fortified. Now U.S. exports of powdered skimmed milk are fortified with vitamin A.

Age-Sex

Incidance of xerophthalmia trends in age rates are the same for males and females. The peak incidence is during the third year. The incidence is much higher among males; this gap increases with age. The statistics vary slightly but the general ratios are about 58% males: 42% females for preschool children age 2-5; 85% males: 15% females, ages 10-13; and 87% males: 13% females, ages 14-24. Oomen and Ten Doesschate feel this bias toward the male sex (higher incidence of xerophthalmia) is an intrinsic factor just as is the relationship between xerophthalmia and protein malnutrition.

In the geography of xerophthalmia, climate plays a role far different from what one would suspect. The humid, rich and green tropics where carotene sources are plentiful, especially in the Far East often have a high incidence of xerophthalmia. These also are the rice-eating areas and the areas with the greater incidence of gastrointestinal infection. Also these are the poor and more highly populous areas.

A very high incidence is found in the slums of Manila and Cebu City, Saigon, Dacca and the large cities of Southern India such as Madras and Hyderabad.

Among the regions of the world the most prevalent and serious problem is found in South and Eastern Asia, the Far East, North Africa, and parts of the Near East. And a less serious problem is found in Central and South America, and North Asia and East Africa. The lowest incidence in the developing world is in West Africa where cooking in red palm oil is common. Few cases are found in the Caribbean.

CHAPTER 3

VITAMIN A DEFICIENCY IN CEBU

A. Survey Design

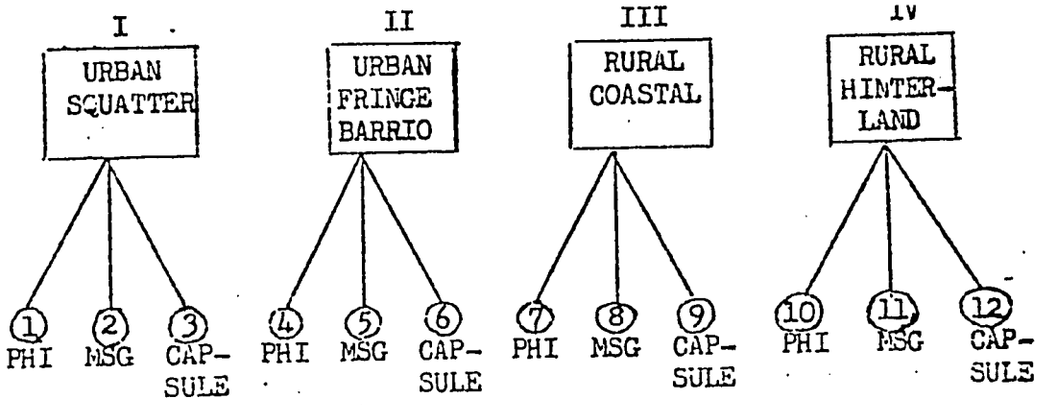
The survey was conducted in four ecological zones: urban squatter and slum areas; urban barrios (fringe of cities); coastal barrios; and hinterland semi-mountainous barrios. These areas were selected because they represented four major economic and nutritional geographic groupings in terms of diet, market accessibility, sanitary conditions, labor markets, etc. This means each area may have different public health problems or have the same problems caused by different factors. Furthermore, the delivery systems for public services such as health and nutritional care may be very different.

Three separate areas were selected in each zone. This was done so three different programs could be run concurrently in separate areas within each ecological zone. Also the representativeness of the survey data is better. This design is shown in Figure 1 for three possible programs in each zone. There were approximately 100 children aged 1-6 and 40 children aged 7-15 selected from each of the twelve areas for a sample population of about 1700 children. Stratified sampling procedures were followed by obtaining the necessary socioeconomic, clinical and biochemical information from each child and his/her family. Each barrio was separated into ten sections and subsamples of ten children 1-6 and four children 7-16 were taken per section.

Figure 1

RESEARCH DESIGN

FOUR ECOLOGICAL ZONES



12 AREAS

EACH ZONE

DIFFERENT ECONOMIC, HEALTH, DIETARY CONDITIONS

SAMPLING BASIS

NO COMMUNICATIONS BETWEEN 12 AREAS ACCESSIBLE

SIZE: OVER 300 FAMILIES EACH

B. Demographic and Socioeconomic Background of Sample Population

Nestled in the middle of the 7,000 Philippine Islands is Cebu — the center of trade and commerce for the central section of the Philippines and Cebu City, the second largest metropolitan in the country. The cultural heritage of Cebu is rich and old. It was a major port of commerce with Chinese, Cambodian (Sawankhalok), Siamese, and Arab traders centuries ago. It enjoys the distinction of being visited by the Portuguese explorer, Fernando de Magellan, in 1521. Indeed Magellan was killed by Lapulapu, a warrior-hero there. The Spanish era began as Cebu's (Zubu then) Rajah and his wife were baptized as Christians.

Since that time people in Cebu City have developed from a fishing and trading center into a busy center of education, industry, and commerce. The metropolitan population is close to a half million people who are especially famous for their very sweet mangoes.

Cebu has a moderate climate with about 70 inches of rain a year. It is sheltered by islands on all sides and does not suffer from the serious typhoons which affect many of its neighbors. Coconut and corn are the principal agricultural products on this elongated mountainous island. It is one of the most densely populated areas in the Republic of the Philippines.

The twelve barrios and squatter areas included in this study are located in and on the fringes of Cebu City, and up to 60 miles south of the city. They vary in topography from hinterland barrio which has many houses nestled on the top

of mountains to the beautiful coastal barrios to some squatter areas which can get semi-flooded during the mild monsoon season.

The sample population is quite homogeneous. Over 95% of the sample is Roman Catholic and most of the remainder adhere to religious groups which have split off from the main Catholic Church for political reasons. Other than 1-2% of the people who have Chinese, Moslem, or Spanish (Mestizo) background, the rest fall into a Filipino ethnic group. No big cultural differences separate these groups like one would find in India between two castes in the same village. Cultural differentiation based on caste allowed Levinson to understand many behavioral characteristics based on whether a household was a Jat or a Ramdasia. Among the Cebuano sample, no ethnic, occupational or income group held to a pattern similar to those found in other regions in India and so many other countries. Similar differences would be expected in the Negrito and Moslem areas in the Philippines. The belief and other behavioral patterns which exist in the sample population appear to be based on numerous other factors which do not allow a simple delineation of groups.

The population is young. Of the persons studied in the 662 families, the majority are under 12 years of age and 64.25% are younger than the age of 20. Partially this is the result of the more rapid population growth of the Philippines. However, the sampling techniques of accepting only families with at least one child younger than seven was important in producing such a young sample. According to the 1970 Philippine census, only 53.15% of the population was younger than 20.

The rapid Filipino growth rate results in large family sizes. Among the sample the average family has 6.14 members. The inclusion of relatives and other non-nuclear family members who live in the same house raises this average to 6.77 peoples per household. The size of families is larger in the rural areas (see Table 3). Also both the family and household size increases with rising incomes. Income quartile 1 represents 25% of the families in terms of their family income while quartile 4 represents the 25% with the highest income.

The sample population is very poor. The average household per capita income is $71. The incomes are highest in the rural coastal barrios and lowest in the equator areas (Table 4). There is a large increase in per capita income between the first three and the fourth income quartiles. This is representative of the large income disparity between the rich and the poor in this region. These income quartiles group the households according to their relative position within their own zone. Thus the income range of each quartile varies from zone to zone. This quartile breakdown also about [illegible] families per quartile or 40 per quartile per zone is used frequently in this analysis to allow one to determine the distribution of various factors between income classes.

The sources of this household income for the total sample are found in table 5. Credit and other forms of deficit financing were not included in this income data which was the basis for all preceding [illegible] of income. The first interesting issue is that 75% of the families [illegible] a household income less than $491.73. This is surprisingly similar to the results from

Table 3 Size of Family and Household
(Average number)

	Family size	Household size
Urban		
Squatters	5.92	6.66
Barrio	6.10	6.69
Rural		
Coastal	6.27	6.87
Hinterland	6.30	6.89
Total	6.14	6.77
Income quartile		
1	4.83	5.30
2	6.47	6.99
3	6.50	7.14
4	6.78	7.67
Total	6.14	6.77

Table 4 Total Household Income Per Capita*
(U.S. Dollars)

Income quartile	Area				
	Urban		Rural		
	Squatter	Barrio	Coastal	Hinterland	Total
1	12	14	17	21	16
2	45	42	49	38	44
3	68	64	85	67	71
4	128	169	181	136	153
Total	63	72	83	66	71

* Includes all cash and in-kind income sources but excludes three families from quartile 4 with incomes greater than 20,000.

Table 5 Sources of Total Household Income (per year in U.S. dollars), Total Population

Income Quartile	In-kind Income[a] Garden Total	Garden % total income	Farming Total	Farming % total income	Fishing Total	Fishing % Total income	Cash Income Farming Total	Farming % Total income	Fishing Total	Fishing % total income	Business Total	Business % Total income	Contributions from other household members Total	Contributions % total income	Total house-hold income	Per Ca pita Income
First	8.99	9	5.36	5	1.49	1	-2.50	-2[b]	1.84	2	67.25	67	18.04	18	100.46	16.01
Second	10.10	4	4.57	2	5.53	2	1.00	0	5.35	2	240.97	87	10.39	4	277.90	43.91
Third	14.06	3	7.23	2	6.41	1	1.19	0	8.04	2	403.60	89	14.20	3	454.73	70.68
Fourth	21.42	2	10.15	1	10.39	1	3.39	0	20.06	2	925.04	90	37.27	4	1027.72	153.11
Total	13.61	3	6.82	1	5.93	1	.76	0	8.78	2	407.13	88	19.92	4	462.94	70.59

a/ A major value of in-kind income in Philippine government statistics, the rental value of owner-occupied homes were not included in this study. This group represent about 1/3 of the in-kind income of the Philippines in 1971 (10, 139-E).

b/ All negative values are the result of all costs being attributed to the farming and fishing cash income during the coding process and not being allocated proportionately to the in-kind aspect.

a 1971 Filipino government study of income. In 1971, 74.3% of the Eastern Visayan families had an income less than $448. Second, it is interesting to note the decline in the relative contribution of in-kind income, especially from the garden as household income increases. In the first quartile, 15% of the income is from in-kind (home production) sources and in the fourth quartile, only 4% comes from these sources. Also the contribution of household members who do not belong to the nuclear family declines from 18% in quartile 1 to 4% in quartile 4. These are relative decreases, while the absolute contribution of in-kind and nonfamily member contributions to household increases as income increases.

The fathers have more education than the mothers but the differences are smaller than is found between males and females in most Asian countries. Most of the parents have 3-7 years of schooling. The urban parents, in general, are more educated than the rural ones. (Table 6)

The last issue is the description of the wealth of this population. Given the low incomes it is not surprising that most of these families possess few expensive items. Traditionally land has been perceived as a key factor in the wealth of most Filipino families. In the more densely populated island of Cebu, we would expect this to delineate clearly the economic position of most families. This does happen for the richer families. The difference in average land owned by the first three quartiles and the fourth quartile is almost one-half hectare or greater than one acre (Table 7). The difference

Table 6 Distribution of Mothers by Education Level
(percent)

Education level (years of schooling)	Area: Urban Squatter	Urban Barrio	Rural Coastal	Rural Hinterland	Total
None	13.1	12.9	7.0	16.6	12.5
1-2	7.4	3.5	5.1	8.9	6.2
3-4	12.5	28.8	26.6	29.3	24.0
5-7 a/	39.2	23.5	36.7	26.1	31.4
8-9	11.4	10.0	10.1	6.4	9.5
10-11 b/	8.0	10.0	7.0	7.0	8.0
College c/	8.5	11.2	7.6	5.7	8.3
Total	100.0	100.0	100.0	100.0	100.0

Distribution of Fathers by Education Le el
(percent)

Education level (years of schooling)	Area: Urban Squatter	Urban Barrio	Rural Coastal	Rural Hinterland	Total
None	13.1	12.4	12.0	12.7	12.7
1-2	3.4	10.6	4.4	12.7	7.7
3-4	14.2	14.1	19.6	26.1	18.3
5-7 a/	24.4	24.7	31.0	24.8	26.1
8-9	14.2	12.4	12.7	11.5	12.7
10-11 b/	17.0	15.3	8.2	8.3	12.4
College c/	13.6	10.6	12.0	3.8	10.1
Total	100.0	100.0	100.0	100.0	100.0

a/ Equivalent to grade school graduate
b/ Equivalent to high school graduate
c/ One or more years of college

Table 7 Total Land Ownership (hectares)

Income quartiles	Urban Squatter	Urban Barrio	Rural Coastal	Rural Hinterland	Total
1	.0	.574	.051	.042	.167
2	.324	.070	.0	.029	.112
3	.045	.148	.110	.170	.117
4	.888	.512	.174	.779	.594
Total	.310	.324	.083	.255	.246

is even greater for the families in the top 10% income group (10th decile). Each of these families own about 1 hectare. Other forms of wealth are distributed among a small minority. Ownership statistics show that: 71% own their house with 80% paying no rent; only 34.1% own any type of furniture other than simple benches; 5.7% own a kerosene, gas or electric stove; 2.3% own a radio; 21.9% own a sewing machine; 2.3% own motor bikes and 5.1% own bicycles.

C. Xerophthalmia in Cebu

1. Definition of Xerophthalmia

Xerophthalmia literally means "dry eye" and in this restricted sense is a term used exclusively by ophthalmologists to describe the changes in the eye that occur when the secretions of the paraocular glands of the goblet cells of the conjunctiva dry up, leading to discontinuity of the fluid films usually present over the surface of the conjunctiva and cornea. This dessication may result from a variety of clinical conditions, but the xerosis or dryness consequent upon Vitamin A deficiency is by far the most common and important cause.

In a broader sense, and in a public health content, the term xerophthalmia was chosen to apply to the syndrome of severe Vitamin A deficiency.

For many years there has been a need for a classification of xerophthalmia to permit clearer reporting of the various ey changes generally agreed to be characteristic of the condition The first classification scheme to gain some degree of general acceptance was that proposed by ten Doesschate which was based on a scheme commonly used in Indonesia. The baseline figures this study was accordingly classified according to this (Table 8).

This classification was subsequently expanded to include also night blindness and corneal sequelae (Table 9). This was done in view of the diffculty in attaining desired objectivity of ocular findings especially in the category of conjunctival xerosis.

Serum A values were classified according to ICNND standards described earlier in this report.

2. Criteria for Community Diagnosis of Xerophthalmia and and Vitamin A Deficiency

Application of the classification alone for the purpose of arriving at a conclusion as to whether or not a xerophthalmia problem of public health magnitude exists in a community has several shortcomings. Certain of the indicators lend themselves more readily than others to field use. XIA, conjunctival xerosis, is especially liable to misinterpretation. In the absence of other indicators a decision about the presence or absence of conjunctival xerosis is highly subjective. The classification alone provides no indication as to how serious the situation may be in comparison with past experience and conditions elsewhere. Some criteria, admittedly arbitrary, that, when fulfilled, suggest a problem of public health magnitude might be useful. The new classification is based on only one method of examination for assessing Vitamin A status — i.e., clinical. Incorporation of biochemical assessment is desirable to provide additional information of an independent nature for community diagnosis of xerophthalmia and Vitamin A deficiency.

The following point prevalence rates are suggested as criteria:

Clinical

X1B in more than 2.0% of the population at risk

X2 + X3A + X3B in more than 0.01% of the population at risk

XS in more than 0.1% of the population at risk

Biochemical

Plasma Vitamin A level of less than 10 mcg/100 ml in more than 5.0% of the population at risk

In a vulnerable population the presence of one or more of the three clinical criteria should be considered as evidence of a xerophthalmia problem. The biochemical criterion is only indicative of significant Vitamin A deficiency and may be used alone if the objective is to improve Vitamin A status. The value of corroborative evidence of more than one indicator has to be stressed.

3. Prevalence of Xerophthalmia

Classification of clinical signs according to the scheme proposed by ten Doesschate gave a very high prevalence of conjunctival xerosis qualified only as conjunctival wrinkling. This was a problem that clearly emphasized the need for extreme objectivity of clinical signs and the need for association of wrinkling with other signs, which, together will be highly suggestive or indicative of conjunctival xerosis.

Table 8
Prevalence of Xerophthalmia - Old Classification
per cent

CLASSIFICATION	PREVALENCE
XO - Only nightblindness present	0.1%
X1 - Conjunctival xerosis (dryness) with or without nightblindness, with or without Bitot's spots	66.4%
X2 - Corneal xerosis, reversible changes of corneal epithelium	0.6%
X3A - Irreversible corneal changes, loss of substance, perforations	0.0%
X3B - Softening of parts of cornea (Keratomalacia)	0.0%
X4 - Scars, blindness, large or total whiteness of eye	0.2%

N = 1715

The new classification emphasized descriptive categories and had taken into account the need for the categories to indicate severity of the problem. The baseline figures were subsequently reclassified according to this and so many of those cases previously identified as conjunctival xerosis on the basis of wrinkling alone, were excluded.

Detailed description of signs in this classification is attached as Appendix I.

Table 9
Prevalence of Xerophthalmia - New Classification
per cent

CLASSIFICATION	SIGNS - PRIMARY	PREVALENCE
X1A	Conjunctival xerosis	2.0%
X1B	Bitot's spots with conjunctival xerosis	1.7%
X2	Corneal xerosis	0.5%
X3A	Corneal ulceration with xerosis	0.0
X3B	Keratomalacia	0.0
	SIGNS - SECONDARY	
XN	Night blindness	1.8%
XF	Xerophthalmia fundus	-
XS	Corneal scars	0.3%

N = 1715

The magnitude under the category X1A represents those cases with wrinkling and pigmentation only and were included in that these were the only ones with a plurality of signs that make up the syndrome of X1A, although admittedly, not the majority that is required.

A total of 4.2% showed primary signs and some 2.1% showed secondary signs, or a total prevalence of 6.3% for all categories of both active and non-active clinical xerophthalmia.

Serum A values classified according to ICNND standards showed some 57% of the sample with deficient and low levels, 40% normal and only 3% with high levels (Table 10). It is recognized that serum A levels are affected by a host of factors like recent intake and disease and that expectedly, there would

be children with low serum A values but without clinical signs of xerophthalmia and those with clinical signs but with high serum values.

The serum A values were therefore not treated independently but in association with other data collected; more significance was attached to the mean values in the ecologic groups prior to and after the use of intervention methods rather than to individual measurements.

Table 10 Distribution of Serum A per cent

mcg/100 ml	ICNND Category	Baseline
below 10	Deficient	17
10-19	Low	40
20-49	Normal/Acceptable	40
50 plus	High	3

It will be recalled that the first objective of the study was to determine the magnitude of the problem of xerophthalmia and that from a public health point of view certain criteria have to be fulfilled. The application of such criteria to baseline figures showed that two of the clinical and the sole biochemical criteria were more than fulfilled satisfactorily; the combined magnitudes of corneal xerosis, Keratomalacia, and corneal scars, and deficient serum A levels exceeded the criteria figures of 0.01%, 0.1% and 5% of the population at risk.

Table 11

Baseline Survey Results vs. Criteria for Diagnosis of Xerophthalmia and Vitamin A Deficiency

CRITERIA	BASELINE
Clinical	
1 X1B > 2.0%	1.7%
2 X2 + X3A + X3B > 0.01%	0.5%
3 XS > 0.1%	0.3%
Biochemical	
Serum A < 10 mcg/100 ml > 5%	17%

4. Analysis of Related Factors

a. Ecology

In general, xerophthalmia was found to be more prevalent in the urban than in rural areas. The highest prevalence was found in the urban squatter areas and the lowest in the rural coastal areas (Table 12).

Table 12

Prevalence of Ocular Xerophthalmia by Ecologic Zone
per cent

Urban	
Squatter	10.6
Barrio	6.9
Rural	
Coastal	3.9
Hinterland	4.1

N = 1715

When ocular xerophthalmia is matched with serum levels, the similar ecologic relationships are obtained (Table 13). This means that the figures represent those cases with both clinical signs and either low or deficient serum A levels

Table 13

Prevalence of Xerophthalmia : Clinical Signs Plus Low or Deficient Serum A Levels

Urban	
Squatter	6.0
Barrio	3.5
Rural	
Coastal	2.9
Hinterland	2.9

N = 1715

b. Sex

A higher prevalence of xerophthalmia was found among males than among females for all age groups studied and the difference is more pronounced in the older children. (Table 14)

Table 14
Prevalence of Xerophthalmia: Clinical Signs Only by Sex and Age
per cent

	1-6 years	7-16 years
Boys	6.2	11.4
Girls	5.5	4.4

N = 1715

Matching the clinical signs with low or deficient serum A levels shows a similar male preponderance of xerophthalmia, which is again true for all age groups (Table 15). Reasons for sex differences in the prevalence of xerophthalmia might be differential vegetable consumption patterns and certain cultural factors.

Table 15

Prevalence of Xerophthalmia: Clinical Signs Plus Low or Deficient Serum A Levels by Sex, Age and Zone
per cent

Zone	AGE GROUPS					
	1-6 years		7-16 years		Total	
	Male	Female	Male	Female	Male	Female
Urban						
Squatter	4.3	5.1	12.7	4.3	7.2	4.8
Barrio	3.7	3.9	1.9	4.4	3.1	4.0
Rural						
Coastal	4.1	2.9	3.1	0.0	3.8	2.0
Hinterland	3.4	2.1	5.5	1.4	4.1	1.8
Total Average	4.0	3.5	5.9	2.6	4.5	3.2

N = 1715

c. Age -

A peak prevalence of xerophthalmia showed in the 4-6 years age group and another in the 14-16 years age group (Table 16). The former could be reflective of deficient intake occasioned by inadequate supplementation and frequency of diseases while the latter could be due to increased demands with adolescent growth spurts.

Table 16

Prevalence of Xerophthalmia by Age : Clinical Signs Plus Low or Deficient Serum A Levels per cent

ZONE	AGE GROUPS 1-3	4-6	7-9	10-13	14-16
Urban					
Squatter	2.7	7.1	6.3	9.6	11.8
Barrio	3.5	4.1	5.3	2.0	0.0
Rural					
Coastal	0.0	7.0	1.9	1.6	0.0
Hinterland	0.7	4.8	4.2	1.6	8.3
Total	1.7	5.7	4.5	3.6	5.2

N = 1715

d. Income

An inverse relationship was seen between the prevalence of xerophthalmia and income quartiles. As a whole, the prevalence is higher among the poor than among the rich (Table 17).

Table 17

Prevalence of Xerophthalmia by Income Quartiles: Clinical Signs Plus Low or Deficient Serum A Levels
per cent

INCOME QUARTILE	ECOLOGICAL ZONE				
	URBAN		RURAL		TOTAL
	Squatter	Barrio	Coastal	Hinterland	
1	5.8	10.5	2.6	2.0	4.7
2	6.8	3.1	1.8	3.4	3.9
3	7.0	0.9	1.1	5.5	3.7
4	3.6	0.0	6.1	1.2	2.8

N = 1715

e. Employment of the Mother

Children of working mothers were found to have a higher prevalence of xerophthalmia (Table 18). This probably represents a loss of mother's child care time in general.

Table 18

Prevalence of Xerophthalmia and Employment of Mother
per cent

Zone	Not Employed	Employed
Urban		
Squatter	5.8	6.6
Barrio	3.3	4.1
Rural		
Coastal	3.2	2.1
Hinterland	2.5	4.0
Total	3.8	4.0

It was likewise found that a higher prevalence of xerophthalmia obtains for children of working mothers only in the lower income quartiles while the converse was true for the higher income families (Table 19). This could mean a loss of child care time for the poor which could not be compensated by an increase in income, while among the rich, time substitutes could be purchased with the income increase.

Table 19

Prevalence of Xerophthalmia by Income Quartile

and Employment of Mother
per cent

Income Quartile	Non-Employed	Employed
1	3.4	5.9
2	3.6	3.9
3	4.4	1.4
4	3.8	2.9

f. Factors Affecting Vitamin A Intake

1) Garden

A positive garden effect on Vitamin A intake was seen in the rural areas while a negative effect obtained for urban areas (Table 20). This could be due to increased consumption of garden produce in the rural areas while a strong market orientation in the urban areas could very well encourage selling of produce rather than consumption.

Table 20

Comparison of Child's Average Daily Vitamin A Intake

Based on Whether or Not Household Have Garden

Zone	IU Have Garden	IU No Garden
Urban		
Squatter	388	563
Barrio	467	963
Rural		
Coastal	642	121
Hinterland	1860	861

N = 130

2) Employment of Mother

An increase in the average daily Vitamin A intake was seen in the urban areas when the mother works but the reverse was true for the rural areas (Table 21). This could mean increased expenditures for food when the urban mother works, but in the rural areas the effect of work may well cause a loss of child care time.

Table 21

Comparison of Child's Average Daily Vitamin A Intake

Based on Whether or not Mother is Employed

Zone	IU Employed	Non-Employed
Urban		
Squatter	725	428
Barrio	1174	337
Rural		
Coastal	503	647
Hinterland	813	2164

N = 130

3) Diseases

In general, the presence of either mild or severe disease was associated with increased intake of Vitamin A (Table 22). This probably reflects better child care in the home when mild disease is present and institutional care in the case of severe disease — both conditions producing increased intakes of Vitamin A.

Table 22

Relationship between average daily Vitamin A Intake and Child's Disease Pattern

IU

Zone	Mild Disease		Severe Disease	
	Absent	Present	Absent	Present
Urban				
Squatter	614	431	508	504
Barrio	477	658	841	167
Rural				
Coastal	709	466	613	505
Hinterland	1038	1124	779	3133
Total	920	1123	679	963

CHAPTER IV

ALTERNATE MEANS OF CONTROLLING VITAMIN A DEFICIENCY

A. Introduction

In ancient Egypt, ox liver or the liver of a cock would have been prescribed for night blindness. Jeremiah of Biblical fame would have prescribed grass for the wild asses whose vision failed. Progress toward preventing xerophthalmia, though slow, has accelerated in recent decades. Large scale production by chemical synthesis of Vitamin A began in the 1950's and today hundreds of forms of the carotenes are available. At the same time, techniques of communication and food fortification have advanced rapidly. Radio, TV, advanced forms of marketing, vitamin A fortification in all forms in butter, margarine, milk, etc. are extant. Another factor in reducing the deficiency is the conquest in many countries of infectious and parasitic diseases as smallpox and hookworm. Thus, the technology exists and the primary question becomes the delivery system.

The foremost aspect for consideration in the design of alternate means would understandably be practical and technical feasibility for nationwide application. The possibility of integration into existing health programs and cost-benefit ratios would likewise be considered.

In the light of these aspects several possibilities were considered, viz.,

1) Educational programs aimed at increased consumption of Vitamin A sources
2) Horticulture and related production activities
3) Prevention and control of infectious and parasitic diseases
4) Periodic massive dose program
5) Food fortification

Educational programs for increased consumption of Vitamin A sources, horticulture and disease prevention and control were deemed integral components of existing basic health services in the Rural Health Unit and obviously only needed emphasis and orientation towards the problem of xerophthalmia. For this reason, these three were lumped together as Public Health Intervention, to which a fourth component, the Botica sa Baryo was added.

Periodic massive dose program was considered very acceptable in the light of the experience of other countries and the availability of the massive dose capsules.

Food fortification is widely practiced and the requisites for such a program were found available.

A. Public Health Intervention - PHI

The working principles behind this intervention aimed to control Vitamin A deficiency through the following mechanisms:

1) control and prevent infectious and parasitic diseases, thus minimizing demands and losses of Vitamin A, lessening the probability of predisposition to xerophthalmia and early identification of clinical cases, and improvement of general health status

2) horticulture program aimed at increased home production of sources of Vitamin A which could consequently increase income and consumption especially as related to nutrition education

3) nutrition education to create awareness of and concern for the problem of xerophthalmia, the role of the family in the identification, treatment and prevention, appreciation of common Vitamin A sources and the unpleasant consequences of xerophthalmia

a) Mechanics

The operating methodologies of the PHI involved weekly one-day visits to the area by a health team composed of one physician and three paraprofessional health workers (Family Health Aides). Services included morbidity clinics, deworming, establishment of a Botica sa Baryo (village cooperative pharmacy), training of Medical Auxiliary Workers (MAW), environmental sanitation with emphasis on water purification and sanitary toilets, horticulture and establishment of a community organization (Barangay Network) to serve as channel for education, for monitoring of vital events and for program implementation. The details are attached as Appendix II.

b) Performance

Accomplishments over a 52-week period included the following:

1) 3,696 consultations
2) deworming of some 250 sample children
3) home gardens in some 49% of sample families
4) sanitary toilets in 30% of sample families
5) Intensive Family Care (IFC) for some 45% of sample families

c) Effect on Xerophthalmia

Obviously, the period of implementation was too short to allow for valid conlusions to be made as to the efficacy and efficiency of the PHI. While the effects desired are expectedly lasting, they usually take some time in coming, and are never dramatic. Nevertheless, a measurement had to be made of its impact on the problem, xerophthalmia.

It should be mentioned here that the effects of the interventions are measured on active clinical xerophthalmia, made up of the categories XN, X1A, X1B, X2 and X3. Corneal scars, XS being sequelae are not included, as well as X1A represented in this series as mere conjunctival pigmentation, for the reason that the other signs needed for the X1A syndrome are lacking.

Public Health Intervention was found to have reduced the prevalence of active clinical xerophthalmia by an average of about 44% (Table 23).

Table 23

Effect of PHI on Active Clinical Xerophthalmia

Category	per cent Before	After	Change	
XN	2.1	1.1	-1.0	(48%)
X1B	3.0	1.6	-1.4	(47%)
X2	0.4	0.2	-0.2	(50%)
X3	0.0	0.2	+0.2	
Total Active Signs	5.5	3.1	-2.4	(44%)

d) Effect on Serum A levels

The changes in serum A levels before and after the PHI were a reduction of the mean serum A value and an increase in the percentage of sample children with low and deficient serum A levels (Table 24).

Table 24 Effect of PHI on Serum A Level

	Before	After	Change
Mean Serum A mcg/100 ml	18.4	16.5	-1.7 mcg
% with low and Deficient Serum A levels	65	75	+ 10 percentage points

C. Massive Dosage Capsule Program

It is recognized that about 30-50% of a 200,000 IU dose of Vitamin A is stored by the body, and the protection period for a growing child has been calculated to be about 100 days. Man is usually susceptible to the blinding effects of Vitamin A deficiency only during childhood. On the basis of these observations periodic massive dosage programmes have appeared to be a feasible control measure.

Experience in countries like Jordan, India, Bangladesh, Indonesia and El Salvador showed that oral dosing with 200,000 IU of retinyl palmitate in oil once every 6 months produced remarkable reduction in the prevalence of eye lesions and caused no serious acute hypervitaminosis symptoms.

The objective in utilizing this approach was not to question the results of other workers but rather to try out modes of distribution in an effort to come up with a conceivably efficient system of reaching the vulnerable groups.

a) Mechanics

Four distribution strategies were drawn up and implemented in four physically separate areas, namely:

1. Barangay or Village Council
2. School Teachers
3. Youth Groups
4. Health Team (1 physician and 3 Family Health Aides)

The community was prepared through distribution of information leaflets dwelling on what the capsule contained, what it was for, who will receive them, how often, who will distribute them and so on.

The distributors were prepared in that they were thoroughly briefed on the capsule, the strategies, forms to be filled and reporting. Details like how the capsule will be administered were likewise given. All necessary supplie- were issued to distributors prior to each distribution.

The flow charts for each strategy are attached as Appendix III.

b) Distribution Performance

Analysis of the strategies showed that the health team reached more children per person-day than any of the other three, followed by the youth groups (Table 25). While the strategy using school teachers looked very poor, it should be mentioned here that most of the reactions from the capsule were observed in this area and caused subsequent refusals.

Table 25

Analysis of Capsule Distribution Strategies

Strategy	Dosing	Coopera-rators	Days	Target	Number Reached	Reached Per Person-Day
I Village Council	1	10	4	1136	950	23.75
	2	10	3		1113	37.10
	3	6	6		395	10.97
	Average	8.66	4.33		819.33	21.85
II School Teachers	1	6	5	829	815	27.16
	2	6	2		634	52.83
	3	10	7		403	5.75
	Average	7.33	4.66		617.33	18.07
III Youth Groups	1	6	6	791	791	21.97
	2	7	4		791	28.25
	3	6	3		744	41.33
	Average	6.33	4.33		775.33	28.29
IV Health Team	1	4	4	768	729	45.56
	2	4	4		753	47.06
	3	4	3		755	46.25
	Average	4	3.66		744	46.37

c) Reactions

Some 3.4 per cent of capsule recipients had reactions six to twenty-four hours after the ingestion of the capsule. A few of the reactions lasted for about two days. The most common were vomiting, headache, and fever (Table 26). One child passed out worms. These reactions were an important factor in the increase of the refusal level especially in the rural coastal area where the reaction rate was highest to the first capsule distribution. Many children affected by the first capsule refused the second and the third. Neighbors of these children also had understandably higher refusal rates.

The reactions may relate to Serum A levels. It could be that children with very low initial serum A levels absorbed much higher amounts of retinyl palmitate and hence had reactions.

Table 26

Frequency of Reactions to Mass Dosage Capsule

	During First Deliver per cent
Vomiting	0.8
Headache	0.4
Fever	0.4
Abdominal Pain	0.2
Vomiting and abdominal pain	0.4
Multiple or unclassified reactions	1.2
TOTAL	3.4%

d) Effect on Xerophthalmia

The massive dosage capsule program reduced nightblindness and Bitot's spots by about 70 per cent and eliminated all cases of corneal xerosis. Overall, the capsule program reduced the prevalence of active clinical xerophthalmia by about 73 per cent (Table 27).

Table 27

Effect of Massive Dosage Capsule on Active Clinical Xerophthalmia

per cent

Category	Before	After	Change	
XN	1.7	0.5	-1.2	(70%)
X1B	0.7	0.2	-0.5	(70%)
X2	0.2	0.0	-0.2	(100%)
X3	0.0	0.0		
Total Active Signs	2.6	0.7	-1.9	(73%)

e) Effect on Serum A Levels

A technical problem arose during the evaluation period due to the delayed arrival of reagents ordered from outside the country causing delay in the Serum A analysis which was finally done some five (5) months after the last capsule distribution. This could have a bearing on the Serum A profile

that was obtained (Table 28). The mean serum A value dropped by about 0.9 mcg from baseline to evaluation and the percentage of children with low and deficient serum A levels increased by some seven (7) percentage points.

Table 28

Effect of Massive Dosage Capsule on Serum A Levels

	Before	After	Change
Mean Serum A mcg/100 ml	19.9	19.0	-0.9 mcg
% with low and Deficient Serum A levels	57	64	+7 percentage points

D) MSG Fortification Program

Fortification of foods with appropriate amounts of Vitamin A has the advantage of reaching all those who consume the fortified food and requires neither the active participation of the population nor an elaborate and costly delivery system. The problem however, is to select a food vehicle for fortification that meets the following requisites:

1. it is widely consumed especially by children at risk
2. passes through a manufacturing process where fortification is feasible
3. shows little variation in per capita consumption
4. organoleptically suitable for fortification
5. the fortified food product should be stable

a) Mechanics

To determine which food or combination of foods could provide the role of universal carrier, information on the frequency of intake, method of cooking, and method of obtaining a variety of food was collected. Potential carriers included rice, corn grits, white refined and brown sugar, salt, chocolate, coffee, margarine, monosodium glutamate (MSG), soft drinks, biscuits, breads and other flour-based foods.

The mother was asked the frequency of the consumption of each potential carrier item for each child. Table salt, MSG and biscuit, bread and other flour-based products were consumed most frequently (Table29). Much of the salt was obtained from evaporating sea water in the sun. This process does not readily lend to fortification. The other items were obtained through commercial outlets. Biscuits, bread and other flour-based products could be fortified satisfactorily except that sources of flour and/or biscuits and bread are numerous such that control on a national basis would be expectedly difficult. MSG is produced and marketed by two leading locally-based firms but about 90% of the market is controlled by only one company.

Table 29

CHILDREN REACHED WITH POTENTIAL FORTIFIED FOOD

AT LEAST ONCE A WEEK

Food Item	Percentage Who Consume This Item
Rice	38
Corn Grits	93
Refined White Sugar	63
Table Salt	95
Margarine	39
M S G	94
Biscuit/Bread	97

N = 1779

A further study showed that the families surveyed consumed an average of two 2.4 gram packs of MSG daily, added to the usual food. Examination of the MSG and the process of manufacture showed that this item fulfilled the criteria for fortification.

The leading local MSG manufacturer agreed to provide the required MSG for the study and the process for fortification as soon as the U.S. pharmaceutical company provided the Vitamin A.

Each 2.4 gram packet was fortified with 15,000 IU of Vitamin A and testing of contents and loss rates in storage at different temperatures was done on samples sent to laboratories in the U.S. and in Switzerland. The results showed

that at maximum Philippine temperatures and after one year storage, the average content per packet was 11,600 IU.

The fortified MSG was distributed to sample families on a two-pack day rate on a weekly basis. Empty packets were subsequently collected and replaced with new packs every week for at least one year.

Initial reactions to the fortified MSG as surveyed included the following:

1. improves the taste of cooked foods better than commercial MSG
2. children consumed more of the food
3. food has "vitamin" smell
4. regulates bowel habits
5. improves sleep

Of course these are merely expressions of subjective observations after the initial use of MSG. Some of these may very well be entirely unrelated to consumption of fortified MSG.

b) Effect on Xerophthalmia

The fortified MSG program eliminated most of the cases of nightblindness and the majority of corneal xerosis and Bitot's spots with conjunctival xerosis (Table 30). Overall, the effect on active clinical xerophthalmia was a reduction by about 77%.

Table 30

Effect of MSG Fortification on Active Clinical

Category	Xerophthalmia per cent Before	After	Change
XN	1.6	0.2	-1.4 (88%)
X1B	1.4	0.5	-0.9 (64%)
X2	0.9	0.2	-0.7 (78%)
X3	0.0	0.0	
Total Active Signs	3.9	0.9	-3.0 (77%)

c) Effect on Serum A Levels

The mean serum A value increased by about 8 mcg between baseline and evaluation and the percentage of children with low and deficient serum A levels decreased by some 14 percentage points (Table 31). This reflects a general improvement of the status of Vitamin A nutriture.

Table 31

Effect of MSG Fortification on Serum A Levels

	Before	After	Change
Mean Serum A mcg/100 ml	21.4	29.4	+8 mcg
% with low and Deficient Serum A levels	51	37	-14 percentage points

E. Summary

All the three interventions produced an impact on the problem of Vitamin A deficiency. Overall, for the three methods, active clinical xerophthalmia was reduced by about 57% (Table 32). The general effect on Serum A levels was actually an improvement although small. The overall mean for Serum A values for all zones, all interventions was estimated to be about 19.9 mcg/100 ml for baseline and 21.6 mcg/100 ml for evaluation or an increase of about 8.5 per cent.

There are several aspects to be considered in evaluating the effects of interventions. First, PHI effects may not be expected in as short a period as one year. Second, the technical problem of reagents may have affected serum A values in the capsule areas. Thirdly, there is the possibility that a general economic deterioration may be presently obtaining and may therefore be reflected in the parameters used.

It is clear, however, that the interventions produced impact in areas which affect xerophthalmia indirectly as improvement of nutritional status, increased awareness, and other health factors.

Table 32

Overall Effects of All Interventions on Active Clinical Xerophthalmia

per cent

Category	Before	After	Change
XN	1.8	0.6	-1.2 (67%)
X1B	1.7	0.8	-0.9 (53%)
X2	0.5	0.1	-0.4 (80%)
X3	0.0	0.2	+0.2
Total Active Signs	4.0	1.7	-2.3 (57%)
	N = 1715	N = 1667	

CHAPTER V

RECOMMENDATIONS FOR A NATIONAL POLICY

Recommendations for a national policy to deal with the problem of vitamin A deficiency should be based on answers to the following questions:

1. Is there a sufficiently serious problem to justify action?
2. Has there been an examination of possible intervention strategies?
3. Which one, or combination, of these intervention strategies is likely to be most effective?
4. How feasible will it be to introduce such a national strategy?
5. What will the costs be of such an intervention, what is the effectiveness likely to be, and who will benefit?
6. Are there any preliminary investigations that need to be undertaken prior to introducing a national intervention program?
7. What methods should be used to monitor and evaluate the effectiveness of the program?
8. Can the intervention be used to produce benefits, other than on vitamin A deficiency?

(1) Extent and seriousness of the problem

The baseline study in Cebu clearly indicates a very high prevalence of deficient and low serum vitamin A levels, and the presence of significant numbers of children with clinical signs of xerophthalmia. Our findings are supported by the extensive surveys of the Food and Nutrition Research Institute which also showed a high prevalence of low serum vitamin A levels and a large percentage of persons on diets deficient in Vitamin A. Cases of keratomalacia often leading to total or partial blindness, or death are frequently seen in hospitals in Cebu and elsewhere.

It should be noted that countries such as Guatemala have introduced national vitamin A fortification programs even though clinical evidence of xerophthalmia is rare and mean serum vitamin A levels are higher than in the Philippines.

(2) Examination of possible interventions

As stated we have evaluated three intervention strategies namely the massive dose capsule, fortification, and a public-health-hoticulture intervention. These are the principal methods of control suggested by the WHO Report on Xerophthalmia.

In the case of fortification our investigation indicated that MSG was the most suitable food product for fortification.

(3) Which intervention, or combination of interventions is likely to be most effective?

Based solely on the criteria of effectiveness in (a) raising serum vitamin A levels and (b) reducing active clinical

signs of xerophthalmia it is clear that MSG fortification is the most effective intervention. It served to raise the level of serum vitamin A from a mean of 21.3 mcg/100 ml. (Table 33). The serum vitamin A levels of the group who were initially classified as "deficient" rose from a mean of 6.4 to 25.4 mcg/100 ml. an increase of 19 mcg/100 ml. (Table 34). A similar impressive rise was shown in those classified as "low". In an examination of those with active clinical signs of xerophthalmia these dropped from 3.9 per cent to 0.9 per cent following MSG fortification. The difference is significant at .001 level (Table 35). MSG fortification lowered by 77 per cent the percentage of children with active clinical signs. That is, for every 100 children who had active signs before MSG fortification only 23 would have signs after 12-18 months.

There were positive effects also resulting both from the high dose capsule and public-health-horticulture intervention. These effects were less marked on vitamin A nutritional status than were those resulting from the MSG intervention. The public-health-horticulture intervention has benefits of several kinds on nutrition and health factors other than vitamin A deficiency. These benefits such as on child growth are not produced either by MSG fortification or the high dose capsule.

We recommend as a result of the study in Cebu that serious consideration be given to a national program of MSG fortification with vitamin A. We believe that this would be feasible, would produce marked benefits and would be of low cost.

We recommend also that elements of the other two interventions namely the high dose capsule and the public-health-horticulture approaches be incorporated where appropriate into existing government health and agricultural programs. For example we recommend that physicians and health workers be made more aware of the vitamin A problem and of the diagnosis and classification of xerophthalmia, and that they have available high dose capsules for use in children with, or at high risk of developing, xerophthalmia. We recommend that capsules containing 100,000 IU rather than 200,000 IU be used, at three rather than six months intervals.

A list of risk factors will be drawn up by the National Nutritional Council through its Xerophthalmia Committee for dissemination by the Department of Health.

(4) Feasibility of introduction of proposed national program

The pilot trial of MSG fortification and its successful use in the four areas in Cebu indicates that the method is feasible. With technical assistance from Hoffman-La Roche, Inc. a suitable product was formulated, and its stability and lasting quality tested. Subsequently with the help of Union Chemicals (Manila) the vitamin A was mixed with Aji-no-moto MSG. There were no problems of palatability. The product was well accepted and was used for 12-18 months in the field.

Moving to a national program would present no new forseeable technical problems and would involve mainly a major change in the scale of the operation.

Consideration would need to be given as to whether an attempt would be made to secure voluntary agreement from the two manufacturers to add vitamin A to their MSG, or whether to introduce legislation for mandatory fortification of MSG with vitamin A. The possibility that some unfortified MSG in different packages be available on a small scale for those deliberately choosing to avoid the vitamin A enriched product deserves consideration.

The use of high dose capsules in the health centers and hospitals, the training of health personnel, and certain horticultural activities would be suggested to the Health and Agricultural Departments.

(5) Cost, effectiveness and beneficiaries

The costs of such a program will be relatively small. We believe that it might be feasible for such a national program to be introduced without any cost either to the government (other than that of monitoring and evaluation) or to the general public. The cost to the manufacturers would be relatively small in relation to their overall business. The major initial expense would be for a Nauta Mixer (estimated cost $22,000) and the only recurrent costs would be the staff to supervise the operation. It is proposed that vitamin A (retinol palmitate) plus the flow enhancing agent (silicon dioxide) be added to replace a small quantity of MSG in each packet, and not be in addition to the 2.2 grams of MSG currently in each packet. The fortified packet of MSG would then contain approximately 2.1 grams of MSG and 0.1 gram of

the vitamin A - agent mixture. Because the cost of the vitamin A - agent mixture is not significantly different from that of MSG, the final cost to the purchaser of fortified MSG would be the same as for currently unfortified MSG, namely 5 centavos for 2.2 grams of product.

If there is no increase in the total number of packets purchased, then the total national consumption of MSG, and that consumed per family, would be slightly reduced in amount (by an average of approximately 4 per cent). The total revenue accruing to the manufacturers and retailers would also remain unchanged by the program.

Our review of the literature and consultation with a number of authorities satisfies us, that the dangers of toxicity either from the MSG or from the vitamin A are negligible. One of the advantages of MSG, like salt (and unlike sugar, tea and other suggested vehicles for fortification) is that persons currently using MSG are unlikely to increase their consumption of the product to any great degree. MSG if used daily by a family is used to the same extent whether the family is in the upper or lower income groups. Toxicity from excess consumption of vitamin A would not occur from fortification of MSG at the suggested levels, for the same reason that toxicity has not been reported as a result of vitamin A fortification of margarine and other foods in Europe or North America.

The effectiveness of a national program of MSG fortification can be predicted from the Cebu experiment. It will however vary according to the level of utilization and prevalence of vitamin A deficiency in each area of the country. If the situation in the island of Cebu is taken to be representative of the Philippines both with regard to the prevalence of vitamin A deficiency and the utilization of MSG then a national program could be predicted to result in the following benefits:

(a) Raising of serum vitamin A levels of children by 7.2 mcg/100 ml., and

(b) a reduction by 77 per cent of the active clinical lesions of vitamin A deficiency or xerophthalmia in the first year of the program.

The program also would be expected to diminish to a great extent both blindness and mortality resulting from xerophthalmia in the Philippines. The main beneficiaries of the program would be children at risk of vitamin A deficiency especially young children in the low socio-economic group of the population. But adults and older children would also benefit in that their intakes of vitamin A would increase as a result of the program, and would more often than now reach the RDA levels.

The program of vitamin A fortification would also be supplemented by the suggested Public Health and horticulture intervention including the controlled use of high dose capsules of vitamin A. This additional action would be expected to have benefits beyond that of the MSG fortification program.

(6) Needed preliminary investigations

The high rate of consumption of MSG in the Philippines makes it certain that the program would benefit many millions of families. However, though not essential, investigations would be warranted of MSG use in the different regions and provinces of the Philippines, by different age groups and by different segments of the population. Such an investigation could quite simply and rapidly be undertaken during the period while manufacturers were gearing up for the fortification program. The MSG utilization survey might form the basis for a future monitoring and evaluation system.

Negotiations and investigation of the acceptability of the proposals to the manufacturers would be necessary. Similarly a determination would have to be made of the availability of the necessary quantities of retinol palmitate. Only then could a prediction be made of the date of implementation of a national program.

(7) Monitoring and evaluation

It is proposed that a national program be monitored to obtain regular data on the utilization both of the vitamin A fortified MSG, and also on the Public Health Intervention including the capsule distribution. Tests would be conducted to determine the average length of time between fortification in the factory and eventual purchase and utilization by the consumer in the provinces.

The total utilization of fortified MSG per year in each province would be monitored. The use of MSG at risk groups would also be assessed.

A small sample of subjects, mainly children, in each region would be carefully selected for the purposes of program evaluation. Evaluation would rely mainly on serum vitamin A levels of these subjects prior to the initiation of the program, and at 12-month intervals thereafter. At the same time the Department of Health would be asked to maintain statistics on cases of xerophthalmia and keratomalacia in selected government hospitals. The Malnutrition Registry maintained by Rural Health Units and Government Hospitals would also be used to evaluate the program's effectiveness.

(8) Use of the intervention to produce other benefits

Fortification of MSG with vitamin A cannot be expected to produce other benefits besides its effects on vitamin A nutritional status.

However because MSG is so widely utilized by the population in the Philippines consideration should be given to fortifying this product with other nutrients which are deficient in Filipino diets. The obvious candidate for consideration would be iron, because iron deficiency anemia is very prevalent in the country. Another possibility would be iodine. Goiter though less prevalent than anemia remains an important public health problem.

The Hoffman-La Roche Company have been consulted about the possible combination of vitamin A and iron in MSG. They are prepared to provide technical assistance. It is possible that unforseen difficulties will arise in selecting an iron compound which is both suitable for combination with MSG and vitamin A, and one which also well absorbed. If a combination of iron and vitamin A proves difficult, then it may be recommended that alternate packets of MSG be fortified separately with vitamin A and with iron. Then a consumer purchasing for example 4 packets of MSG would take home two containing added vitamin A and two containing added iron.

The Public-Health-Horticulture intervention proposed could be expected to have long term benefits on morbidity, mortality, nutritional status, and food consumption.

Conclusions

The proposals and recommendations contained in this report are those of the Principal Investigator and Co-Researchers of this NSDB supported Research Project. They are based on a detailed review of the results of the research, and an understanding from experience of three different types of intervention.

Prior to any final decision to implement these proposals they will need to be widely discussed and reviewed by knowledgeable experts both in and outside the Philippines.

Table 33

EFFECTS ON SERUM VITAMIN A LEVELS OF MSG FORTIFICATION

COMPARED WITH OTHER INTERVENTIONS

	Non MSG Group mcg/100 ml.	MSG Group mcg/100 ml.
BEFORE	19.3	21.3
AFTER	17.9	28.5
CHANGE	-1.4	+7.2

Table 34

EFFECT OF MSG FORTIFICATION ON SERUM VITAMIN A LEVELS

USING ICNND CLASSIFICATION

	mcg/100 ml.	N
DEFICIENT (Below 10 mcg)		
Before	6.4	71
After	25.4	63
Change	+19.0	
LOW (10-19 mcg)		
Before	14.4	173
After	28.8	139
Change	+14.4	
ACCEPTABLE (20-49 mcg)		
Before	29.3	216
After	27.8	173
Change	-1.5	
NORMAL (50+ mcg)		
Before	57.9	14
After	53.6	14
Change	-4.3	

Table 35

PRESENCE OF ACTIVE CLINICAL SIGNS OF XEROPHTHALMIA

BEFORE AND AFTER FORTIFICATION OF MSG

		BEFORE	AFTER	CHANGE	PERCENT REDUCTION IN CLINICAL SIGNS
		%	%	%	
XN	Night blindness	1.6	0.2	-1.4	88%
X1B	Bitot's spots with xerosis	1.4	0.5	-0.9	64%
X2	Corneal xerosis	0.9	0.2	-0.7	78%
X3	Keratomalacia	0	0	0	-
	TOTAL ACTIVE SIGNS	3.9[1]	0.9[1]	-3.0[1]	77%

NOTE: X1A not included. WHO Report states "conjunctival xerosis - X1A not recommended for community diagnosis."

XS - Corneal scars are not active lesions.

[1] Chi Square significant at .001 level.

CHAPTER VI

SUMMARY

Vitamin A is a necessary nutrient for man and animals. In the absence of an adequate dietary intake of Vitamin A, or of its carotenoid precursors, for a significant period, a number of abnormalities appear in experimental animals. These include loss of appetite, loss of weight, increased keratinization of epithelial tissues, a reduced frequency of mucus-secreting cells, and a negative nitrogen balance. As the deficiency becomes progressively more severe, stomach emptying becomes defective, nervous disorders of balance and motor skills appear, and nightblindness, eye lesions, and then blindness occur. Resistance to infection is much reduced and the reproductive process is disrupted. Death ultimately ensues.

In man, and particularly in children, Vitamin A deficiency most commonly and prominently affects the eyes, both externally by disrupting the epithelia of the cornea and conjunctiva, and internally by lowering the sensitivity of the retina to light. The former condition is known as xerophthalmia, and the latter as night blindness. In severe Vitamin A deficiency, blindness can result from ulceration of the cornea, keratomalacia and corneal opacity. Vitamin A deficiency, usually accompanied by protein-energy malnutrition, is also linked with an increased frequency of infection and with defective immunological defense mechanisms. Although all of the reported

effects of vitamin A deficiency in experimental animals have not been confirmed in man, the deficiency does seem to follow the same general pattern in all species studied and ultimately it affects adversely essentially all tissues of the body.

The Cebu Project

This was a collaborative venture of the Cebu Institute of Medicine in Cebu City and Cornell University in New York. Started in July 1973, the project set the following goals for a three-year study period:

1. Determine the magnitude of the problem of Vitamin A deficiency
2. Understand the relative importance of the various factors associated with xerophthalmia
3. Design optimal programs for eliminating and preventing xerophthalmia for different ecological conditions.
4. Determine the nutritional and economic effects of each program after the programs have operated for one year.

Some 1715 sample children aging 1-16 were drawn randomly from 600-odd sample families in four representative Philippine ecologic zones, namely urban squatter, urban fringe barrio, rural coastal and rural hinterland barrios. Clinical, biochemical and anthropometric data were collected from the children and dietary and socioeconomic information were obtained from the households.

The prevalence of xerophthalmia was found to be about 6.3% out of some 1715 children and 57 percent had low and deficient serum A levels. The figures for prevalence exceeded those set in the criteria for public health problems.

Xerophthalmia was found to be more prevalent in the urban than rural areas, affected males more than females, showed prevalence peaks in the 4-6 and 14-16 years age groups, affected children in lower income families more than the children of rich families and was more prevalent among children of working mothers especially in the poor families.

Gardens produced a positive effect in the rural areas and a negative effect in the urban areas insofar as Vitamin A intake was concerned. Working mothers in urban families produced increased intakes of Vitamin A while the converse was observed in the rural areas. In general, the presence of either mild or severe disease was associated with an increase in the Vitamin A intake.

The alternate methods of controlling Vitamin A deficiency that were used were a public health disease elimination and horticulture program, massive dosage capsule program and fortification of monosodium glutamate. The overall effects of the three programs were a reduction of the prevalence of active clinical xerophthalmia by about 57% and a marginal improvement of the mean serum A value. Comparison of individual interventions showed that the MSG fortification program produced the best

results in terms of improvement of serum A levels and reduction of active clinical xerophthalmia.

Tentative recommendations for a national policy include a multiple intervention approach to the solution of the problem, integrations of some intervention programs into existing health services and involvement of other governmental agencies such as the agriculture and education departments.

APPENDIX II

A BACKGROUND DISCUSSION OF VITAMIN A DEFICIENCY AND KEY FACTORS RELATED TO IT

a. Introduction

In natural situations a pure vitamin A deficiency seldom exists as an isolated condition, especially in the Third World (Oomen, 1969). Rarely does the deficiency of vitamin A occur without the presence of other nutritional deficiencies or in conjunction with other disease. Many forms of malnutrition occur in the presence of infectious and parasitic diseases which often are interacting synergistically with malnutrition. Thus, the conditions of interest here, xerophthalmia and keratomalacia, occur concurrently with dietary deficiencies such as protein, calories and riboflavin, and with diarrhea and other forms of infectious or parasitic disease. Vitamin A deficiency produces a variety of pathological lesions but this study is concerned chiefly with the deficiency as it relates to the eye and to blindness which is one of the most significant consequences of this deficiency.

Xerophthalmia is the general syndrome which covers all eye lesions and the general public health problem implied in vitamin A deficiency. The affix, xero-, suggests a dryness, lusterless condition of the eyeball. More specifically, it relates to a dryness of the conjunctival and corneal epithelia. Keratomalacia relates to the softening of the cornea with ulceration and loss of vision. The root, malacia, differs from xero as it is the weakening, softening and melting process which follows xerophthalmia. Keratomalacia is a special manifestation of xerophthalmia. This last stage of xerophthalmia may develop very rapidly.

The clinical aspects of xerophthalmia have been divided into four stages--stages which do not encompass all essential manifestations of the syndrome but are as complete as is possible (Xerophthalmia 1, p. 2; Ten Doesschate).

Stages of Xerophthalmia

X_0 - only night blindness present

X_1 - conjunctival xerosis (dryness) with or without night blindness, with or without Bitot's Spots

X_2 - corneal xerosis, reversible changes of corneal epithelium (cover)

X_3 - a) irreversible corneal changes, loss of substance, perforations

b) softening of parts of cornea (keratomalacia)

X_4 - scars, blindness, large or total whiteness of eye

Vitamin A includes the <u>preformed vitamin A</u> (retinol) and the <u>provitamins A</u> or carotenoids. Preformed A, found in foods of animal origin, is ready for utilization by man, while the preformed carotenes from vegetable sources must be converted to vitamin A in the intestines of man. It should be noted that the preformed A is many times as efficient as the beta carotene in that much of the beta carotene is lost in the process of absorption and conversion before it can be utilized by the human organism.

b. Consequences of Xerophthalmia

A deficiency of vitamin A affects many central life processes of the human organism. Many of these relationships may have important economic manifestations which will be discussed later. The following are some of the relationships:

a) Resistance to infection - a deficiency lowers the resistance to

infection in general, and especially lowers the integrity of the epithelial tissues (Roels, 1969, p. 906). "Vitamin A is synergistic with almost all infectious diseases in which the relationship has been studied. Children and adults with xerophthalmia are highly susceptible to infections, particularly the respiratory and genito-urinary systems" (Taylor, p. 213).

b) Reproduction - vitamin A is essential for the normal functioning of the reproductive system;

c) Utilization of dietary protein - the addition of vitamin A increases the utilization of protein. On the other hand, a deficiency of vitamin A may reduce food intake and growth (Roels, 1969, p. 905).

d) Visual cycle - vitamin A is essential in the formation of rhodopsin. Rhodopsin is important for vision in dim light. Furthermore, blindness is a common occurrence for those who have suffered from xerophthalmia. Often the lesions are asymmetric; the numbers of people blind in both eyes and one eye is about equal (Oomen, 1964 (b), p. 307). Disagreement exists on this point. Some researchers feel the effects are symmetric (Goldsmith, p. 401). In one study, among the survivors of xerophthalmia, 27% were blind, 59% had greatly reduced vision, and only 14% had undamaged eyes (McLaren, 1963, p. 214). McLaren estimated that a minimum of 1 in 800 children surviving the age of 5 in Indonesia would be totally blind from xerophthalmia (ibid).

e) Mortality - vitamin A deficiency is associated with a high mortality rate among children (Roels, 1969, p. 907). Between 25 to 60 percent of those with xerophthalmia die (McLaren, 1963; Oomen,

1964(b)). Observations in India suggest 50 percent survive, while in areas of North Africa survival may be a rarity (Oomen, 1964(b), p. 36-41). At the same time, many children with xerophthalmia die of kwashiorkor or nutritional marasmus who might otherwise survive and become blind.

c. Nutritional and Biochemical Factors

Two of the key processes which determine the effects of dietary intake over time on the human organism's vitamin A nutriture are the absorption and conversion of the preformed beta carotene. "The biosynthesis (conversion) of vitamin A from beta-carotene takes place mainly in the intestinal mucosa, during the absorption of dietary β-carotene" (Goodman, p. 963). The presence of various diseases interferes with this absorption process of either carotene or vitamin A. "Acute febrile infectious disease and perhaps also diarrheal disease have a trigger effect which cannot always be explained by depletion" (Oomen, 1969, p. 1104). Ascaris may utilize carotene. It is believed that the ascaris (roundworm) can convert carotene to vitamin A in its intestinal wall.

Basically the provitamin A (carotenoids) is converted into retinol (vitamin A) and then absorbed. Fat affects the amount of carotene absorbed since vitamin A is a fat soluble vitamin (National Institute of Nutrition, p. 65). Protein deficiency markedly depresses the intestinal conversion of beta-carotene. After absorption the nutrient is either utilized or stored. A study carried out in India showed that mild protein-calorie malnutrition does not impair the absorption of beta-carotene (Lele). Protein is necessary for the utilization of the vitamin A and is also responsible for the transport of this A (retinol) in human plasma while vitamin E affects the utilization and also the storage of the A in the liver (Roels,

1969, p. 904). Scientists are finding that some vitamin A is stored in skin and muscle (Olson).

Previously it was mentioned that vitamin A affects protein metabolism, reducing the utilization of the ingested protein. A severe protein deficiency may prevent vitamin A from reaching the liver and keep the remaining reserves unavailable to the other tissues of the body for utilization (Arroyave, 1969). This does not mean kwashiorkor or xerophthalmia will necessarily occur concurrently. Rather, this means programs which provide protein and subsequently accelerate the rate of growth in children, may produce the appearance of xerophthalmia (ibid).

An unrelated but important factor is the effect of maternal nutriture. Poor maternal vitamin A nutriture results in a low storage in the unborn child and a low content of vitamin A in the mother's breast milk.

There are several biochemical indicators of vitamin A nutritional status. The clinical indicator used in this study is the xerophthalmia ranking discussed in the introduction. The amount of vitamin A stored in the liver can be determined by a biopsy of liver tissue taken with a biopsy needle injected into this organ. Although this test is very useful, it may be painful, it produces side effects and complications in some patients, and was not utilized. It is not a field test. Determinations of the levels of vitamin A (retinol) and of carotene in the serum (plasma) are the two basic methods (Interdepartmental, 1969). Also, there is some evidence of a poor correlation between vitamin A in the liver and the plasma unless the deficiency is very severe. The same is true for clinical symptoms of vitamin A deficiency and serum A levels. Part of the explanation may be the storage of vitamin A in the skin and muscle (National Institute of Nutrition, p. 64).

The plasma or serum A test represents vitamin A nutriture over a period of time because considerable vitamin A can be stored and long periods are required for its depletion. Seasonal fluctuations affect the supply of food containing vitamin A or its precursor, carotene, but do not necessarily affect the serum A. Thus, this index is often uncorrelated with recent dietary intakes.

The serum carotene, on the other hand, reflects recent dietary intake. Beta-carotene is not stored for very long; it is converted to vitamin A. The finding of low carotene levels is informative as to the type of diet consumed over recent weeks and months. There is a problem with the serum carotene because more of the carotenes are not converted to retinol. Biochemical levels are indicative of the nutritional well-being of a person; however, often values reflecting a given level of health vary significantly between each person.

d. Dietary Sources

In the previous discussion, vitamin A sources were described as retinol and as carotenoids. The main carotenoid is beta-carotene. The importance of these distinctions lies in the relative effectiveness in each in providing the necessary biological activity for the human body. The carotenoids are not utilized as efficiently as retinol by the human body (Aykroyd, p. 63). The standard relationship is 1 µg beta-carotene equals .167 µg retinol or beta-carotene is one-sixth as efficient as retinol (Joint, p. 24-25). The other carotenoids are much less efficient than beta-carotene and are given a retinol equivalence of one-twelfth. The other standard of measurement for vitamin A activity is International Units (IU). One IU of vitamin A is equivalent to 0.3 µg of retinol.

These relationships are significant, especially when carotenoids provide

65-95% of the total vitamin A activity in the diets of the developing areas (Joint, p. 6-8). The principal sources of vitamin A in the diets of developing areas are fruits and vegetables--predominantly the green leafy and yellow vegetables. Table 1 gives the estimated distribution of the sources of vitamin A activity in various foods.

Sources of Vitamin A

Foods containing previtamin A as retinol are fairly expensive and consumption may be prohibited by religious or cultural mores. It occurs widely in animal tissues, especially in the livers where it is stored. The fat content of the meat, milk or fish may be important; the retinol is often found in these tissues. Thus, lean meat or fish and milk from which the fat has been skimmed are almost devoid of vitamin A. While fish provide an excellent source of vitamin A, sun dried fish loses most of its vitamin A value. "Eggs are an excellent source of retinol and may prove to be a practical method of supplementing vegetable diets" (Joint, p. 57).

Beta-carotene is found in all the green parts of plants. "Green leafy vegetables, such as the young leaves of Ipomoea (sweet potato and swamp cabbage), cassava, amaranth, horseradish, etc., are rich sources of carotenes....Fresh immature legumes (green string beans, lima beans, peas, etc.) before they reach the mature dried stage (grain legumes) are also good sources of both proteins and carotenes" (Joint, p. 57). Figure 2 shows many of these sources. Breast milk is another important vitamin A (pre-formed) source. For infants breast feeding is important in forestalling vitamin A deficiency (van Veen, 1974).

Beta-carotene is also found in abundance in red palm oil, carrots, mangoes, papayas and other yellow vegetables and fruits. Red palm oil, a very rich source of beta-carotene is extensively produced in West and

Table 1. ESTIMATED DISTRIBUTION OF SOURCES OF VITAMIN A ACTIVITY (AS IU) IN VARIOUS FOODS

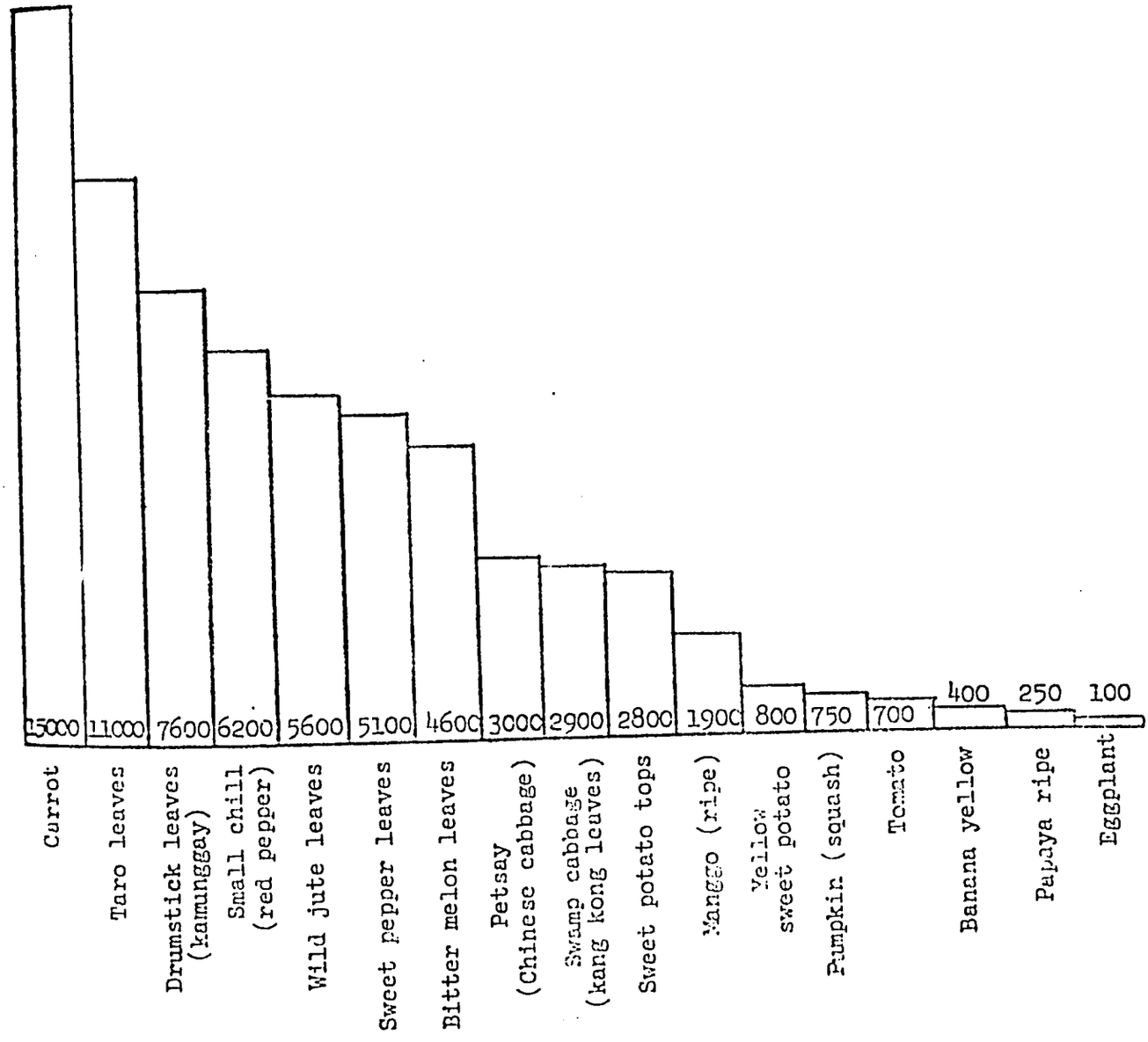
Source	From retinol	β-carotene	Other carotenoids
Animal origin			
Meat and meat organs	90	10	
Poultry	70	30	
Fish and shellfish	90	10	
Eggs	70	30	
Milk and milk products	70	30	
Animal or fish oil	90	10	
Plant origin			
Cereals			
Maize, yellow		40	60
Others		50	50
Legumes and seeds		50	50
Vegetables			
Green vegetables		75	25
Deep yellow (carrots, sweet potatoes - deep orange type, etc.)		85	15
Sweet potatoes - pale type		50	50
Fruits			
Deep yellow (apricot, sapote etc.)		85	15
Other fruits		75	25
Vegetable oils			
Red palm oil		65	35
Other vegetable or seed oils		50	50

Source: Joint FAO/WHO

Figure 2. CAROTENE CONTENT OF FOODS[a]

a/ Approximate provitamin A content of some leafy and yellow vegetables and fruits, International Units per 100 grams (as purchased).

Source: UNWHO Western Pacific Region, p. 26.



Central Africa and parts of the Far East. It is often used to treat xerophthalmia and in some cases as a dietary supplement to prevent xerophthalmia (Roels; UNICEF). Coca, consumed in the highland areas of Bolivia, has a high carotene A content.

Carotene and retinol are relatively stable towards heat and in the canning and processing. In some cases, such as carrots, the foodstuff must be cooked to release all of the carotene. At the same time, traditional techniques such as the drying of leaves and the storage of vegetables, such as squash, do not lead to a loss of carotene. Extensive exposure to the sun (e.g., sun dried fish) appears to be the major cause of carotene or retinol loss.

Often the main staple determines the diet content of vitamin A. When it provides little or no carotene as in the case of rice and white corn, the incidence of xerophthalmia is very high (van Veen, 1947). Thus, the rice-eating populations of Asia and the Far East usually consume lower amounts of carotene than do those whose staple is yellow maize, sweet potatoes or millet.

Requirements

The requirements for vitamin A, expressed in weights of µg, vary by age and sex. The recommended daily amount of retinol for an adult is 750 µg (micrograms). An amount as low as 390 µg retinol per day is required to prevent visual symptoms of vitamin A deficiency in adults (Joint). During pregnancy the recommended daily allowances (RDA) remain constant; however, lactating women have an RDA of 1200 µg retinol per day. Growth requirements are greater for infants. At the end of three and five months 420 µg/day or about 65 µg/kg and 50 µg/kg, respectively, are recommended. Table 2 reports the recommended levels of retinol.

Table 2. RECOMMENDED INTAKE OF RETINOL AT VARIOUS AGES

Age	Recommended intake µg retinol per day	International units	Age	Recommended intake µg retinol per day	International units
0-6 months	1/		7-9 years	400	1333
6-12 months	300	1000	10-12 years	575	1917
1 year	250	833	13-15 years (boys-girls)	725	2417
2 years	250	833	16-19 years (boys-girls)	750	2500
3 years	250	833			
4-6 years	300	1000	Adults (man-woman)	750	2500

1/ For infants 0-6 months, it is accepted that breast feeding by well-nourished mothers is the best way to satisfy the nutritional requirements for vitamin A.

Source: Joint FAO/WHO Expert Group, p. 22.

Few diets consist purely of retinol. These recommendations are corrected for the consumption of beta-carotene at various levels (Joint). The basis for many of these recommended levels is poor (van Veen, 1974). This is especially true for children and adolescents.

e. Fruit and Vegetable Consumption, Home Production and Preference Patterns

Carotene food sources contribute 50-90% of the vitamin A intake of persons in most low income nations. Because of the high carotene content of many fruits and vegetables, this group of foods contributes a disproportionate amount of this carotene relative to the small amount of money spent on them. For example, the bottom 2 deciles of Indians spend about 12% of their expenditures for a group of foods which include fruits and vegetables along with beverages and condiments (B. Desai). In many regions, fruits and vegetables are either picked from the abundant foliage or produced in farms or home gardens. In general, however, it apperas that there is little significance given to consuming them outside the Chinese culture.

Some of the cultural and sociological studies conducted in Asia were reviewed in an attempt to understand the types of belief patterns which would affect fruit and vegetable consumption. In general, they are not classified as a main food which for Malaysians and Filipinos includes only the staple rice or corn (Polson; Wolff). Along with fish, meat and eggs vegetables are classified as a viand.

A series of studies have shown that these carotene-rich fruits and vegetables are often withheld from children (McKay). In a N.E. village in the Visayan island of Leyte (near Cebu), "fruits, other than bananas, and vegetables are rarely fed to the child. Because of existing food prejudices it is inconceivable to many women that they are important" (Murge, p. 92). In total, Murge found "that historically, the weanling was not fed fruit,

vegetables, meat or fish" (p. 95). It is unclear if the onset of diarrhea which is often caused by the consumption of these foodstuffs was the reason for these taboos.

The most damaging belief pattern is the practice of limiting common fruits and vegetables for children with eye problems (McKay, p. 70-71). In one rural Malay area the consumption of "cooling" fruits and vegetables (mainly carotene-rich) was prohibited for the xerophthalmic child because these would irritate worms which "then migrate into the eyes causing night-blindness....and finally blindness" (P. Chen, p. 234).

The discussion of home production of fruits and vegetables will center on the role of home gardening because of the small amount of cropland planted to fruits and vegetables in most areas. There is little tradition of home gardening in most parts of the world. This partially relates to the small consumption of vegetables and fruits by these people. Exceptions are the Indonesian, Japanese and Chinese diets. For example, one study in the densely populated island of Java found that home gardens cover about 20% of the arable land (Van Eijnatten). This was reported in 1949 and an earlier study on the same area gave a figure of close to 15% of the cultivated land (Ochse).

Aside from taste and economic pressures, several other social factors are important in explaining the small proportion of the population which engages in home gardening. Fernandez found that in some urban squatters areas where space for gardening was available, fear of eviction prevented the development of home gardens. Many families often will not garden near their houses as they would be destroyed by neighbors' foraging goats and pigs. Also, theft or the fear of theft prevents many families from developing garden plots.

Many of these social constraints can be changed. In some areas, low-income farmers in West Africa and the Philippines have been induced to grow meaningful home gardens (Van Eijnatten). In many cases, this only will happen when some cash can be earned.

In the Philippines a major campaign has been launched by the First Lady, Mrs. Imelda Marcos, to increase the practice of home gardening. In some areas this has led to considerable interest in the cultivation of small home gardens. In many other areas the lack of a tradition of gardening coupled with the dearth of seeds, water and good land has prevented meaningful adoption of this program.

A second factor in the Philippines has led to increased interest in vegetable production and home gardening. This has been the vegetable breeding program at the University of the Philippines College of Agriculture (UPCA) at Los Banos and the multiple cropping project developed first at the International Rice Research Institute (IRRI) by Dr. Richard Bradfield and then at the UPCA. For example, the UPCA has a pilot project in several villages in Laguna Province in the island of Luzon. In these villages the production of a variety of vegetable and fruit vegetables appears to have increased significantly. In this project the farmers have shown a great desire to produce for commercial channels (e.g., A. A. Gomez).

The breeding program has helped to develop new varieties of higher yielding and more disease resistant vegetable varieties. It has also begun to deal with more specific problems such as the inability of tomatoes to bear fruit in warmer climate and the lack of seeds and cuttings (Munger; National Food and Agricultural Council).

The multiple cropping goal is the continuous cultivation of land during the seasons in which the staple or main crop is not grown and also the

use of unused portions of the land during the prime growing seasons. The purpose is to utilize scarce land and labor more efficiently. For example, after the rice season the puddled land could be used for the growth of a variety of crops such as sweet potatoes. The result of both these efforts will be an increased emphasis on vegetables in agricultural planning in the Philippines and a greater availability of high quality varieties. Some of these breeding and selection efforts have been transferred to the newer Asian Vegetable Research and Development Center in Shanhua, Taiwan.

A third element has been the Applied Nutrition Programs in the schools. They have produced school garden programs over the past 5-15 years. While it is difficult to weigh their effects since few evaluations have been completed, undoubtedly they will make it easier for home gardening programs to be developed in any nation in the world where these UNICEF-sponsored programs exist (e.g., G. Desai).

In the past the research neglect of tropical horticultural crops other than those for export-oriented cash crops (citrus, banana, pineapple, etc.) has been serious. When research has been conducted, it is usually tied to the crops preferred by the more Western-oriented segments of the population. These are the cabbages, tomatoes, eggplants, etc. toward which the Western-trained agricultural scientists have become oriented. Moreover, little consideration has been given to the carotene contribution even when deficiencies in this nutrient are important in their countries.

Economic and carotene yields for a variety of vegetables were studied to determine how meaningful the carotene contribution of a home garden could be. Yield data collected from home gardens in Java and commercial and experiment station vegetable crops in the Philippines are compared in terms

of their carotene production in table 3. Yields were computed on a daily basis. While tropical climates do permit multiple and even continuous cropping, crops must be varied over the seasons. It should be noted that these yield levels for the home garden can come only after several years of gardening. The initiation of such a garden is slow in areas where none exist; the surface around the houses is usually compacted, eroded and leached. The possibility of high fertility exists and can come with the build-up and care resulting from plant growth (Van Eijnatten, p. 7-8). Yields per unit of time per land unit are appropriate for tropical climates (Munger). The small size of 18.5 square meters was selected as this was the average of home gardens found in Cebu in 1973. In Africa, Van Eijnatten found an average home garden was 26 square meters.

These results can be compared with the recommended daily allowance (RDA's) of vitamin A. The Javanese home garden, whose yields are expected to be closest to the home gardens in Cebu, provide an annual amount of vitamin A equivalent to about 16% of a 3-year old child's annual needs of 333 IU. If a family with two children aged 3 and 5 gave all the vitamin A to these children, wasted none in preparation, and had to meet 50% of their RDA's throughout the year, they would need about 916 IU daily. Many of the experimental results met this requirement.

A more realistic requirement for the average family of seven (ages 1, 3, 5, 6, and 10, and 2 adults) would be for 33% of its vitamin A to be obtained from the home garden. If it wastes only 20% of the vitamin A between production and final consumption, it would require about 4300 IU of vitamin A each day. The commercial garden in Java, the sweet potato yield (tips plus root), the mung bean pods, and both the swamp and Chinese cabbage yields are adequate. Most of these are based on experimental and

Table 3.

YIELD OF VEGETABLES

Product	Days to last harvest	Economic yield/day/ha a/ Kg	Vitamin A/ 100 g IU	Daily yields of vitamin A/ 18.5 sq. meters
1. Swamp cabbage	30	333	4825	29711
1. Chinese cabbage b/	60	283	3600	18852
2. 1972 Philippine average--all vegetables	c/	12	3350	740
3. Bush sitao (green edible pod)	77	156	570	1645
3. Mung bean (edible pod)	67	229	1141	4834
3. Sweet potato roots	120	208	1025	3941
tips		69	5565	6590
				10531
3. Cauliflower	49	122	95	215
4. Home garden mixture in Java	c/	2	3350	130
4. Market gardens in same Java area	c/	68	3350	5328
4. Intensive market gardens (Java)	c/	205	3350	12710
5. Tomato	85	165	735	2244

Sources: The vitamin A data was obtained from the Food Composition Table, Food and Nutrition Research Center, Manila, 1968. All the figures are based on Philippine equivalents.

1. Field trials by Dr. Ruben L. Villareal, U.P.C.A. (National Food and Agricultural Council).
2. National Food and Agricultural Council.
3. Data from field trials by Dr. Hunry Munger, R. Villareal at U.P.C.A., 1969 (Munger).
4. Van Eijnatten, p. 22-24.
5. Villareal, Table 5, U.P.C.A. field trials.

a/ This yield is actual economic yield divided by length of growing period.
b/ It is assumed that pre-transplant growth requires no space and that maximum yield is obtained (Villareal, p. 15).
c/ Yields were only supplied on an annual basis.

selective growing conditions. Nevertheless this does point out that there are possibilities of increasing these vitamin A yields if the carotene content and/or economic yields could be increased for the home gardens. Most of the calculations in table 3 overstate the yields as no time was given for between crop preparation of soil. The Philippine average yield and the Javanese data are based on the more representative year-long averages.

f. Etiology and Geography of Xerophthalmia

The incidence of xerophthalmia differs from area to area with the same vitamin A dietary intake. The causes of this disease are complex and vary seasonally and by age and sex as these factors are related to food supply, disease, poverty and urbanization, and numerous cultural forces. This section summarizes these factors, in particular the issues of age and sex.

A common profile begins with the pre-school child who is undernourished but does not display clinical symptoms of xerophthalmia or any other form of malnutrition. Then the child becomes infected with a serious gastrointestinal or respiratory infection at the age of 3 which precipitates xerophthalmia. A month later the child's vision becomes blurred and the mother takes the child to a local clinic 20 miles away. It is too late, however, as the child's condition is irreversible and eyesight is lost or the child dies.

Dietary factors

An inadequate amount of vitamin A or carotene is often consumed by a child. For example, in Java the vegetables and young pulses are placed in a soup (sajur) along with peppers and other spices. This soup is very spicy and many children refuse to eat it (van Veen, 1947, p. 670). In some areas in Java among the poor there are periods right before the rice harvest when no sources of carotene are available and the dietary-related incidence of xerophthalmia is high (ibid., p. 671). In Europe, xerophthalmia used to appear in the spring after the provitamin A reserves were exhausted at the end of a greenless winter (Oomen, 1969, p. 1103).

Other examples of dietary causes are the presence of kwashiorkor with the resultant effects on the metabolism of vitamin A, a low intake of dietary fat which lowers the intestinal absorption of all forms of vitamin A (especially the carotenes), and a maldistribution of food in the family which results in inadequate vitamin A nutriture for the boys or the child aged 2-8. In one study of 180 children with xerophthalmia, 90% of the children were classified as malnourished (Fernandez).

Disease

The direct effects of various diseases on the absorption of retinol

and carotene were already highlighted. A case of xerophthalmia may be associated with diarrhea, measles, tuberculosis, hookworm, fever or ascaris. The diarrhea months occur simultaneously with the highest incidence of xerophthalmia cases in Japan, Korea, South Asia, and the Near East and North Africa (Oomen, 1964(b), p. 5). Often the onset of diarrhea leads to a reduced diet of rice, barley water, tea or herb infusions which exacerbates the problem. "Xerophthalmia cases frequently come in waves. These prove to depend rather more on epidemiological variation of the contagious diseases of childhood than on seasonal variation of food intake" (Oomen, 1972, p. 167). Some conflicting evidence on the relationship between xerophthalmia and diarrhea has been presented (Oomen, 1973).

The best documentation of the effects of various diseases on the incidence of xerophthalmia was a study done in North Vietnam. Two distinct periods with a high incidence occurred. In the hot summer months there were numerous cases of intestinal infection. In October to December, the cold season, the incidence of respiratory infection was high (ibid.). The incidence of xerophthalmia related directly to these diseases and was highest during these two periods. Measles, tuberculosis, ascaris and giardia are some of the other diseases which can increase the incidence of xerophthalmia. Most of this information has come from studies of children admitted to hospitals and has not followed children over a period of time. Thus, these associations might be spurious in the sense that these diseases do not trigger xerophthalmia. It is, of course, possible that xerophthalmia triggers some of them.

Poverty

Xerophthalmia is felt to be a poor man's disease. Rarely is a case found among middle income or rich children. For example, in "Jogjakarta,

Indonesia, Oomen collected 11,000 case histories (of xerophthalmia) from the free clinics, but not one while scanning thousands of records of paying patients (Oomen, 1964(b), p. 5).

Urbanization

The rapid urbanization of the past several decades has produced hundreds of squatters colonies and slum areas in large and small metropolitan areas. Alternately termed bustees, jhuggi jhonpris, urban barrios, favellas or shanty towns, these urban villages or squatters colonies are the scene of some of the most seriously malnourished children. The existence of many inhabitants in these urban villages is marginal; their chief occupations are the crafts of basket weaving, clothes washing, etc., and similar marginal urban occupations such as pulling rickshaw, or selling sugar water on a corner. Often their destitution forces them to resort to begging.

These people may carry their old food habits with them to the cities. They often will consume only the same grains, fruits and vegetables which they had available in their villages. Though they may be much more expensive, their traditional staples will be purchased first. The more perishable fruits and vegetables often cannot be obtained. When they are available, the quantity purchased is much less than that same family would have consumed in rural areas. Another factor is important. In rural areas, many of the fruits and vegetables are consumed with little or no cost. When a price is placed on these foods, families are more likely to consume less of them and more of their staple food which is usually lower in total vitamin A contribution.

Some detrimental social forces gain in importance in urban areas. The advertising of commercial foods induce many families to purchase these much more expensive foods and their nutritional status suffers (Popkin,

1973(b)). Or, the mother may be forced to work and be unable to breast feed the baby. The substitute of powdered milk or other forms of baby milk is diluted or fed in smaller quantities to the child. Often the skimmed milk is not fortified with vitamin A to replace the retinol lost with the skimmed-off fat.

Before World War II the presence of xerophthalmia attracted much attention in Singapore where it was related to the use of artificially fed milk (Oomen, 1964(b), p. 11). For a long time the powdered skimmed milk sent to developing areas from the U.S. through Public Law 480 was not fortified. Now U.S. exports of powdered skimmed milk are fortified with vitamin A.

Age-Sex

Incidence of xerophthalmia trends in age rates are the same for males and females. The peak incidence is felt by some to be during the third year (Oomen, 1969). The incidence is much higher among males and this sex differentiation has been found to increase with age. The statistics vary slightly but the general ratios are about 58% males : 42% females for preschool children aged 2-5; 85% males : 15% females, ages 10-13; and 87% males : 13% females, ages 14-24 (ibid.; McLaren, 1963, p. 213). Oomen and Ten Doesschate feel this higher incidence of xerophthalmia among males may be an intrinsic factor just as is the relationship between xerophthalmia and protein malnutrition (Oomen, 1973, p. 207-208). A discussion of the incidence at various ages follows:

a) Age 0-12 months--the incidence is rare among this group. The chief cause will be the disruption or cessation of breast feeding. It is also related to poor vitamin A nutriture of the mother which leads to a low storage in the neonate and low vitamin A content in the breast milk. In Denmark in the

early 1900's, many cases of xerophthalmia occurred in this age group (McLaren, pp. 198-199). The Oriya of India are another group in which xerophthalmia has been prevalent among infants (van Veen, 1974).

b) Age 1-5 years--the sudden cessation of breast feeding may be associated with the onset of gastrointestinal problems and a higher prevalence of xerophthalmia (McLaren, 1963). This could be caused by a new pregnancy and strong mores against breast feeding a child during this pregnancy (ibid.). Or the child may be fed only rice porridge after weaning as is done in Bali. Most people feel the peak is in the third year and that most cases of xerophthalmia occur between the ages of 2-4 (later than the peak incidence of kwashiorkor). This is because breast feeding develops a large storage of vitamin A which protects the child's vitamin A nutrition for a long time (ibid., p. 203). After the stored vitamin has been used, direct dietary effects or, more likely, the combination of some parasitic or infectious diseases and low dietary intake may lead to xerophthalmia.

c) Age 5-15 years--only 10% of the cases occur among this age group and they are usually less severe (ibid). In one study of 1678 children, 25% of the cases of xerophthalmia were found in this age group (Fernandez). Lower growth requirements and greater resistance to various diseases are probably the more important reasons for this. Older children have been ignored in most recent discussions of X, and most preventive programs are oriented toward children aged 1-6.

An appraisal of older nutrition surveys completed in 1962-64 by the ICNND in Northeast Brazil and Bangladesh also showed a high prevalence of X among children aged 7-16 (Interdepartmental Committee on Nutrition for National Defense, 1965 and 1966).

d) Adults--the instances of xerophthalmia are very rare except in nursing mothers because the vitamin A requirements during lactation are much greater. Night blindness may be found but rarely does blindness occur. Among a few adults, cirrhosis of the liver leads to an impairment of the storage of retinol in the liver and can cause xerophthalmia. Intestinal malabsorption from conditions such as steatorrhea is another cause.

The onset of blindness occurs primarily in the under five group. This differentiates xerophthalmia-caused blindness from many other major causes. In most areas, trachoma does not affect preadolescents (Oomen, 1964(b), p. 2). Cataracts and glaucoma usually occur among adults. Smallpox produces very localized incidence of blindness and is easily identified because of the residual pockmarks. Thus, a high percentage of blindness under the age of 15 usually indicates the presence of xerophthalmia. "In a carefully conducted study in East Java, Indonesia (by J. Ten Doesschate), it was found that in blind children under 5 the cause of blindness was xerophthalmia in 75 percent of the boys and 62 percent of the girls" (Xerophthalmia 2, p. 1). Identification is not always this simple. For example, Ms. Cheryl Bliss has been studying the role of xerophthalmia in "Luapula blindness" in Zambia. The various ways of identifying the causes of blindness in this valley produce very conflicting hypotheses about the cause of

blindness and it is possible that a quite unique syndrome exists outside of any previously known by medical science (personal communication, Ms. Bliss, Cornell).

Geography

In the geography of xerophthalmia, climate plays a role far different from what one would suspect. The humid, rich and green tropics where carotene sources are plentiful, especially in the Far East, often have a high incidence of xerophthalmia. These are the rice-eating areas and the areas with high incidence of gastrointestinal infection. Also, these are the poor and more highly populous areas.

A very high incidence is found in the slums of Manila and Cebu City, Saigon, Dacca and the large cities of Southern India, such as Madras and Hyderabad.

Among the regions of the world the most prevalent and serious problem is found in South and Eastern Asia, the Far East, North Africa, and parts of the Near East. And a less serious problem is found in Central and South America, and North Asia and East Africa. The lowest incidence in the developing world is in West Africa where cooking in red palm oil is common. Few cases are found in the Caribbean.

Seasonality

Seasonality does not refer to the lagged relationships between diseases, nutritional deficiencies and the onset of X. Rather it includes the seasonal patterns of production, consumption, employment, savings and dissavings, rainfall, temperature, diseases, etc. In relation to the effects of seasonal patterns on xerophthalmia (X), the following factors are important:

1. Changes in food production and employment lead to scarcity

of key foodstuffs and the resultant higher prices. Preharvest famine and under- and unemployment are two results (e.g., Mellor, 1970; Oshima).

2. Changes in the rainfall, especially the onset of rainy seasons or monsoonal conditions, often result in diarrhea epidemics.
3. The temperature and humidity cycles can lead to periods in which respiratory and bronchial infections are more predominant.
4. The production of important "protective" horticultural plants may also fluctuate with these climate variations.
5. Increased consumption of calories and proteins may lead to spurts in growth which, in turn, could exacerbate the deficiency of vitamin A and lead to X (Sinha).

The importance of each of these seasonal factors are accentuated on the subsistence sector which depends on agricultural production and employment. Conversely, they are integrated in the cash or industrial sector which has more access to steady employment and also to commodities grown in other climate regions. Other factors, especially the role culture plays in savings and consumption patterns, are important. Two interesting discussions of seasonality are by Oomen and Ten Doesschate, and Sinha and Bang. The latter is based on community data.

The patterns of X vary markedly from one geographic area to another and fluctuate on an annual basis; however, the seasonal patterns of the incidence of X appear to prevail each year (Oomen, 1973). Studies on the effects of season are unavailable for rural populations. Data for urban populations represent a dramatic seasonal effect of X which could be even greater in the rural areas. For example, in Bangalore, South India, "the

seasonal prevalence (of X) in April to July was attributed to the scarcity of green vegetables and milk in that season and to the prevalence of summer diarrhea" (ibid., p. 209). In Hanoi, on the other hand, two distinct seasonal patterns are found. In October-November, a cold season leads to numerous diseases, and in April-July the warm summer season. The quick increases and decreases in the prevalence of X in Hanoi indicated the likely effects of disease. In Bangalore the changes were more gradual and point to the greater importance of vitamin A deficiency.

In Indonesia, the peak period is the dry season when only rice was available and the lowest incidence occurred in the wet seasons when green vegetables and fruits were available. In East Java (Surabaya), July is the peak month, while in West Java (Bandung), May is the peak month. The seasonal variations are more pronounced in Surabaya. It was felt that only the dietary aspect was significantly better during the low X wet season, while diet was only one of the factors explaining the peak incidence in the dry season (ibid., p. 213).

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Appendix 1.

Cost analysis, effectiveness parameters and benefit cost analysis

Cost Analysis

Three programs were being carried out for the prevention and elimination of xerophthalmia. These programs are:

(a) Distribution of massive dosage vitamin A capsules to children age 1-15, every six months,

(b) Fortification of MSG with vitamin A, and

(c) The comprehensive Public Health Intervention (PHI)

The specific cost components of each program will be spelled out first.

(a) Capsule Intervention

There are only two components in the cost of this program, namely the cost of the capsules and the cost of delivery. Should the people be required to pay for the capsules, then this would fall under private cost. But since this is not done in the program, all costs are treated as social costs. The total social cost per distribution per barrio for this program is therefore:

$$C_c = nA + D$$

Where C_c = total social cost per distribution

A = cost per capsule

n = total number of capsules dispensed

D = delivery cost

and $D = P_c + F_c$

where P_c = 1 day salary + travel allowance for 1 physician to train distributor

F_c = incentives for distributors

One distribution is needed every six months which means that two distributions are needed per year. The cost per capsule was ₱0.086.[1/] This calculation is the prorated expense of buying a much larger shipment.

Social cost per distribution per barrio

1.	Cost of capsules (₱0.086 x 900)		₱ 77.40
2.	Delivery cost		
	a) one day salary plus travel allowance for one physician to train distributors for each delivery		40.00
	b) incentives for distributors		110.00
	cooperation	₱50.00	
	distributors	60.00	
		Total	₱227.40

Therefore, Total Social Cost Per Year = ₱227.40 x 2 = ₱454.80

(b) Fortification of MSG

Assume that the price of MSG is not increased due to fortification and the marginal cost is subsidized by the government. It follows therefore that private cost is zero and only the total social cost is considered. Economics of scale are involved here and this will be taken into consideration. That is, there is a large fixed cost which can serve many thousands of families. We assume full use of this fixed cost and use as our cost only a prorated portion of that cost. Cost components for this program include:

Nauta Mixer (a new one will be needed every 12.5 years)

Roche Palmitate 250-SD

1/ This cost is based on the reimbursable procurement plan of UNICEF. These 1975 cost figures are the amount the Philippine government would pay UNICEF to purchase, package and ship the drugs and dietary supplements from Copenhagen. Mr. Peter Bailey is thanked for providing us with this information. Conversion from U.S. dollar to peso values is based on $1.00 = ₱7.40.

Silicon Dioxide

Cost of personnel needed to do the mixing

2 workers

1 laboratory technician

Only social costs are required for the vitamin A and other fortification equipment. The basic process suggested is the most expensive one available. A Nauta mixer is used to combine the MSG with the Roche Palmitate 250-S.D. A flow-enhancing agent, silicic acid (silicon dioxide) is added to the vitamin A and MSG during the mixing process. The Nauta mixer handles 11,000 pounds per shift. The material and equipment input requirements for two shifts which will produce daily 10,000 kilograms of MSG or 4,545,000 packages of 2.2 grams MSG per package are:

(1) 1 Nauta mixer = $22,000 Manila CIF. This includes all transportation, insurance, etc. It will be used for 12.5 years and 220 days per year.[1/]

(2) 15,000 IU of vitamin A per 2.1 gram package. When 1 gram of Roche Palmitate 250-SD contains 250,000 IU of retinol palmitate, 250 kg of Roche Palmitate are needed per day.

(3) The Roche Philippines personnel estimate that 5 kilograms of silicic acid are needed per 500 kilograms of MSG so 100 kilograms of silicic acid are required daily.

The total cost of production of 22,000 lbs/day or 10,000 kg/day for 220 working days in a year are:

1/ The Nauta mixer is felt to be more expensive than a tumble mixer which the Roche Manila persons felt could be used. A comparable tumble mixer costs $5000. Mr. Otto of Roche Philippines is thanked for providing us with most of this cost data.

	Year 1
1. Nauta Mixer (Price = US$22,000 or ₱162,800)[1/]	₱ 162,800
needs a new one every 12.5 years	
2. Roche Palmitate 250-SD (yearly)	
needs 55,000 kg[2/]	
at price US$12/kg or ₱88.80/kg[1/]	4,884,000.00
3. Silicic acid (yearly)	
needs 48,400 lbs/year at price US$.65/lb	
or ₱4.81/lb[1/]	232,804.00
4. Personnel needed to do the fortification	
(yearly) 2 workers (₱25/day)	11,000.00
1 laboratory technician (₱25/day)	5,500.00
Total	₱ 5,296,104.00

A barrio with 300 households requiring two 2.4 gram packs of MSG per day needs 1,156.32 lbs of MSG per year, will require only a cost for the first year of ₱1,271.06. For the second year, the cost per barrio will be ₱1,231.99.

(c) Public Health Intervention (PHI)

Private costs of this program would include the following:

C_1 = cement, housing materials and value of time (opportunity cost) needed for toilet construction

---

1/ The conversion rate used was ₱7.40 = US$1.

2/ Tests conducted by Hoffmann-La Roche and Co. in Basley and Nutley show that storage of the MSG fortified with retinol palmitate results in a loss of vitamin A. The biggest loss appears between 0 and 6 months. In the following 8 months, the loss appears smaller. This would lead to a slight increase in the amount of vitamin A placed in each packet and slightly increase the costs laid out above; however the Roche person in charge of this project in the Philippines, Mr. Otto, felt a slight reduction in the amount of MSG placed in each packet would be the more likely result. In either case, the social costs would increase. We feel these studies are conclusive enough to state our fortification costs figures may be underestimated by 5-10%.

C_2 = share in establishing and maintaining Botica sa Baryo

C_3 = value of additional time spent on home gardening over and above that which the household members spend in home gardening before the intervention program. Because the vegetables that the program is encouraging the people to plant do not need very much caring and there was a large gardening time before this program began, this variable is assumed to be zero.

C_4 = value of time needed for preparing, feeding children vitamin rich food, attending nutrition education classes. Because it is very difficult to separate out the program effect from the daily chores of the household without much more detailed time data, this variable will not be included in the computation.

The cost of PHI per household is therefore:

$$C_{PHIi} = \sum_{j=1}^{4} Cj$$

where i = refer to household i

C_{PHIi} = private cost of PHI program per household

C_j = cost component j

The social cost of PHI consists of the summation of all private costs plus the following additional costs:

S_1 = salary for one physician, three FHAs and one horticulturist

S_2 = travel allowance for one physician, three FHAs and one horticulturist

S_3 = TB drugs given out to children with TB

S_4 = subsidized vitamins and other drugs

S_5 = antihelminthics for deworming

S_6 = seeds, cuttings, and fertilizer for home gardening

S_7 = education materials

S_8 = training costs for the FHAs and these include a physician, materials and FHA stipends. Again economy of scale considerations mean we consider that one physician can train 15 FHAs; consequently we prorate the expenses of the physician.

S_9 = water-seal bowl frame

S_{10} = equipments and materials for medical kit. These are normally included in the set-up of a health clinic and will be excluded from the costs of the program. We are considering that this program will be added to an existing program and the cost considerations must include only the marginal costs for the service, supplies and training of the PHI.

S_{11} = opportunity cost of MAW for attending training and helping the health team. This is included as a cost because it is the experience that in places where there are more work opportunities, it is very hard to get volunteers to help the health team. So clearly, a value should be assigned to the time that the MAWs spend in helping the health team.

S_1 to S_{10} are direct social costs while S_{11} is an indirect social cost. The total social cost of PHI program is:

$$S_{PHI} = \sum_{i=i}^{n} C_{PHIi} + \sum_{j=1}^{11} S_j$$

where S_{PHI} = total social cost of PHI program per barrio

S_j = cost component j, j = 1, 2, ... 11

i = 1, 2, ... n number of households

In computing the specific costs of each program several assumptions are made. First, we assume the target population of 300 households in each barrio will have 3 children per household. Second, we calculate the costs by assuming meaningful economies of scale would be part of any national health or nutrition program. For instance, this means that the cost of the vitamin A A + E mass dosage capsules is based on a large purchase and more family health aides than are found in this program could be trained for the same fixed costs. Third, the value of time which represents additional or marginal time is included which means the time for gardening was excluded as this was done before the PHI project was introduced but the time for building a new water seal toilet was included. Fourth, our costs are based on the present salary structure and nature of medical technology. For example, new TB chemotherapy which is more cost-effective but unused at present in the Philippines will not be included.

Public Health Intervention

	Year 1	Year 2
I. Private Cost Per Household		
A. Toilet construction (first year only)		
a) cement for flooring ($\frac{1}{2}$ bag)	₱ 7.35	
b) water-seal bowl (labor plus cement)	3.00	
c) housing materials to build house for the waterseal toilet	10.00	
d) value of time (3 days)	24.00	
- this is the opportunity cost for spending time in constructing the toilet instead of doing something else. Minimum wage of ₱8.00/day is used as the basis of computation.		
B. Share in establishing and maintaining Botica sa Baryo	1.00	
It is assumed here that an initial capital of ₱300 is needed for the setting up of Botica sa Baryo and once it is set up, its operation will be maintained through the proceeds from sales.		
Total private cost per household	₱45.35	

These costs are only for the first year of the PHI.

II. Social Cost Per Barrio		
A. Salaries (yearly)		
a) Physician (one day per week, 52 days per year)	1,627.00	1,627.00
- computation based on the present salary of a RHU physician which is ₱9,756 per annum (p.a.)		
b) 3 FHAs (one day per week, 52 days per year)	2,433.60	2,433.60
- computation based on the salary of a RHU midwife which is ₱4,860 p.a.		
c) horticulturist (one week per year)	150.00	150.00

	Year 1	Year 2
B. Travel Allowances (yearly)		
- computed as ₱6.00/day		
a) Physician (52 days per year)	312.00	312.00
b) 3 FHAs (52 days per year)	936.00	936.00
c) horticulturist (6 days per year)	36.00	36.00
C. TB drugs (INH) given out to children with TB	53.75	5.00
Incidence of TB as gathered from the baseline survey is 0.6%. This implies that in a barrio 900 children in the target age group, around 5.4 children will have TB. The cost of supplying 5.4 children with INH for one year is the cost included in this category for the first year. From the second year and after, the cost of treatment will be based on ½ child per year.		
D. Subsidized vitamins and other drugs (yearly)	237.50	237.50
The costs for this category are computed based on the total vitamins and drugs given out free to the sample population during the intervention period. Prices are based on the reimbursable procurement costs from UNICEF.		
E. Antihelminthics for deworming (yearly)	250.00	250.00
F. Seeds, cuttings and fertilizer for home gardens	80.00	40.00
For the first year, cost figure is based on the costs of seeds, fertilizers that the project gives out to the sample population. For the second year and after, only half the amount of the first year is included.		
G. Education materials (biannually)	20.00	
H. Water-seal bowl frame (first year only)	5.00	
I. Training of FHAs (one week every 5 years)		
a) Physician	40.70	
b) Materials	10.00	
c) Stipends for FHAs	144.00	
J. Opportunity cost of MAWs for attending training and helping the health team (yearly)	936.00	936.00
Computation based on an average of 3 MAWs helping the health team for around		

	Year 1	Year 2
6 hours per week. Taking the minimum wage of ₱8.00/day for an eight-hour working day as the value of time, the opportunity cost of 3 MAWs is therefore ₱18.00 per week.		
K. Total private cost per barrio	13,605.00	
Computed by multiplying the total private cost per household by the total number of households in the barrio.		
Total Social Cost	₱20,876.55	₱6,963.00

Table 36 provides a summary of the present value of the private and total societal costs for each program. The present value of the costs for each program are calculated for a 5-year and a 15-year program. Note the smaller differentials between each program's costs over the 15-year period. The costs each year are based on reaching all the children in any area. Equal costs are assumed for each ecological zone. If this is an urban-based delivery system, there will be slight overstatement of the urban area transportation costs. The 15-year costs are the ones which will be used in the determination of the benefit-cost ratios.

The Effectiveness Parameter

The parameter Mj is the effectiveness in eliminating or preventing the various problems associated with xerophthalmia. Thus, we must consider the effectiveness of eliminating the X which exists and of preventing new cases of X. This is not quite the same thing as examining the reduction in xerophthalmia prevalence rates. The reason is that children with X both before and after a program are probably more likely to become blind or die. The available prevalence and change of status data are used to determine Mj.

These programs are designed for a longer period of protection and should not be judged on the basis of an evaluation conducted 6-18 months after the programs began. A more realistic 5 to 15-year period is needed. Given this understanding, the first step will be to determine the effectiveness of each program in preventing blindness and death and in eliminating old cases and preventing new cases of less severe forms of X and the concurrent external effects of these less severe more prevalent C. Table 36 presents the predicted X prevalence rates at the beginning and end of the intervention programs. These rates plus the serum A level and

TABLE 36a THE PREVALENCE OF XEROPHTHALMIA BEFORE AND AFTER THE INTERVENTION PROGRAMS BASED ON THE PREDICTED VALUES OF XEROPHTHALMIA FOR CHILDREN AGED 1-16[1/]

	URBAN SQUATTER			RURAL COASTAL		
	Before	After	Change	Before	After	Change
PHI	.10	.13	+.03	.01	.06	+.05
MSG	.07	.05	-.02	.06	.03	-.03
CAPSULE	.03	.08	+.05	.02	.12	+.10

1/ The predicted values are based on the regression results for each age group as described in Table C5.17. The aggregate values are weighted averages derived from the relative proportion of boys and girls in the 1-6 and 7-16 age groups.

TABLE 36b PRESENT VALUES OF TOTAL SOCIAL BENEFITS

(Values in Pesos)

Zone Discount Rate	Urban Squatter	Rural Coastal
8%	225,041	151,394
15%	68,519	50,440

ocular signs associated with each program are used to determine the Mij rates.

The capsule program eliminated most of the ocular signs and very few ones occur. In the period studied, the ocular signs which were found are of a less serious nature and affect only the conjunctiva. The clinical data were collected 2 months after the capsule was delivered and it is possible that the less than 6-month protection afforded by the capsule may lead to more serious complications by the end of six-months. We assume all blindness and death associated with X will be prevented but that the high prevalence level of less serious X will occur for the final three months of the six-month period. For the first three months, eight percent of the children will still have X. There is the possibility that the capsule delivery system will break down more with time and these Mij rates may be too high. At this time, we assume only 4% and 5% of the capsule children in the squatter and coastal barrios have the possibility of getting X. This means the effectiveness level of Ma and Mnox for the capsule is only about 75%. This represents a 90% reduction for the first three months and a .43% reduction in the amount of X for the final three months.

The MSG fortification promises a much higher level of protection. The large increase in serum A levels after a 10-month period of use mean the higher prevalence of ocular signs which were found after 6 months would have declined by the same period in which the serum A data were collected. MSG fortification affords complete protection against both blindness and death and we assume the effectiveness against morbidity will improve. Still some children would never receive MSG if it were provided only through commercial outlets; thus, 100% effectiveness can never be

obtained. The morbidity level will decline to 1% in both coastal barrios and the squatter areas. This means an effectiveness level against less serious forms of X of about .85 and .83 in these areas, respectively. This is based on the reduction in the initial prevalence levels of X in the MSG areas.

The PHI program is more difficult to evaluate. While it has had the same positive impact on the vitamin A intake of children, and provided significant other health and nutritional benefits, the prevalence of X has increased. About 15% of the children still had ocular signs and a few were of a more severe nature (Table 5.2). Given the availability of medical personnel in each area plus the visit of the FHA's and the work of the MAW's, we assume no deaths associated with X will occur. It is, however, slightly possible that a child may become blind because the serum A levels have decreased and some severe ocular signs occurred. The nutrition education programs which have explained the effects of X-related signs and the importance of consuming leafy vegetables to PHI households should become more effective over time. Nevertheless, there is the possibility that some families will not follow the advice of the MAW's, FHA's and doctors and children will go blind. Others will not be reached at all by the PHI. The X morbidity levels are expected to be slightly lower after the PHI program has run for several more years. Thus, we can assume an effectiveness level against X of only about .50 in each PHI area.

The weighing of the Mij's to produce Mj is based on the net economic value of eliminating each problem in each zone. In the squatter areas, the weights for blindness, death, morbidity and external benefits are .12, .14, .66 and .08, respectively. In the coastal area where the probability of having X was lower, the weights are .06, .09, .33 and .52,

respectively. The weighted Mj's are presented in the last column in Table 37.

The effectiveness parameter Mj is a crucial variable but unfortunately, we are able to estimate it with much less precision than the economic costs and possibly even the economic benefits.

TABLE 37 THE EFFECTIVENESS PARAMETER

EFFECTIVENESS FOR EACH PROBLEM

	morbidity Group A	blindness Group b	death Group d	external benefits Group nox	Overall Effectiveness Mj
Residents of Squatter Areas					
PHI	.50	.98	1.00	.50	.59
MSG	.85	1.00	1.00	.85	.97
CAPSULE	.75	1.00	1.00	.75	.82
Residents of Coastal Barrios					
PHI	.50	.98	1.00	.50	.58
MSG	.83	1.00	1.00	.83	.99
CAPSULE	.75	1.00	1.00	.75	.79

Benefit-cost Analysis

Benefit-cost ratios are a major criteria for project selection. It is always desired that the ratio be greater than one. This criteria presents an incomplete picture in cases in which complex benefits and costs, many of which are intangible, exist. Moreover, most of these analyses limit the scope of their benefits and do not examine many of the secondary effects of their projects. Since the private costs are either very near zero (for two of the programs), it is not useful to present benefit-cost ratios.

The social benefit-cost ratios presented in Table 38 are quite large. Using a discount rate of 8%, these ratios indicate a large benefit to society. The social benefit-cost ratios (BCR) are more important for socio-economic decision-making. In the squatter areas, they clearly indicate the superiority of the capsule program on the basis of costs and benefits related to X as all three programs have BCR's above 1, indicating net economic gains to society from any of these programs. In the coastal areas, the private earning of each cohort are much lower than in the squatter areas and the BCR's are much lower. In fact, the BCR for the PHI is below 1.

In both zones, the capsule program has a higher BCR than the MSG fortification. These differences get much smaller as the discount rate increases from 8% to 15%. Similarly, the increase in the discount rate lowers the BCR of the PHI in both zones.

TABLE 38 SOCIAL BENEFIT-COST RATIOS

Treatment Group	Benefits		Costs		Mij	Benefit-Cost Ratio		Level of Effectiveness Needed for Benefit-Cost Ratio to Equal 1	
	8%	15%	8%	15%		8%	15%	8%	15%
URBAN SQUATTER	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PHI	225041	151394	98078	80448	.59	1.35	1.11	.44	.53
MSG	225041	151394	11439	8333	.97	19.1	17.6	.05	.06
CAPSULE	225041	151394	4203	3059	.82	43.9	40.6	.02	.02
RURAL COASTAL									
PHI	151394	50444	98078	80448	.58	0.89	0.36	.65	never
MSG	151394	50444	11439	8333	.99	13.1	6.0	.08	.17
CAPSULE	151394	50444	4203	3059	.79	28.5	13.0	.03	.06

The Effectiveness Parameter M

It is most useful to examine how small the effectiveness parameter would have to be for the benefits of the program to equal the costs. For the PHI, Mj would have to equal .53 in the squatters area which is only somewhat smaller than the actual estimated effectiveness level of .59. In one case of the rural coastal barrios at the high discount rate, the PHI costs are greater than the benefits and no adjustments are possible. The effectiveness levels of the fortification and capsule programs would have to be very low. They would have to be .5 to .17 for the fortification and .2 to .06 for the capsule for the costs to equal the benefits.

Other Considerations: Unmeasured and Intangible Benefits

The BCR's for the PHI have been very low. Additional nutritional and health benefits will accrue to children and areas covered by the PHI. The present private and social benefits have not included the benefits which accrue for the elimination of TB and other diseases, the increases in nutritional status, the immunization of children and even the less tangible development of barangay organizations. Community participation in the treatment of community health problems was an important element in the PHI and must not be neglected. This is one of the major differences between the PHI and other health programs. Are these additional unmeasured benefits greater than the unmeasured costs? The best approach may be to consider if the ₱30000 difference between the PHI costs-benefits in the coastal barrios are worth these additional tangible and intangible benefits.

Secondary Effects

This analysis has been based on partial equilibrium analysis. Changes in the relative prices of the various production factors have been ignored because they represent only a transfer effect.

The visibility of the PHI is important as this program is more likely to be associated with concurrent social changes. Demographers and other social scientists often argue that the low visibility and lack of social change involved with the malarial eradication and other mass public health campaigns for the past 3-5 decades did not lead to shift in social attitudes necessary for concomitant fertility declines. The high visibility of the PHI may be an important aspect of the functioning of this program.

The goal is the selection of the program which will be most meaningful to the Philippines. The benefit-cost ratio and the other important Filipino development priorities such as participation of local people in the implementation of the program and the development of "home gardens" have been discussed. The BCR can be viewed as a tool which converts the goal of maximization of economic benefit into a constraint that the BCR be greater than or equal to one. Then the broader developmental goals can be examined.

All three programs have BCR's greater than one in the squatter areas, even with the more conservative 15% discount rate. The BCR for the PHI in the coastal areas is well below one. There are a number of important considerations. First for a minimal marginal cost, the PHI program could distribute capsules which would clearly enhance its effectiveness in eliminating old X and preventing new X. Second, the PHI is providing significant other benefits. There was meaningful popular participation in the program though interest did wane at times and there were meaningful relative improvements in the level of diseases, parasites, and nutritional status and a reduction in third degree malnutrition, associated with the PHI treatment compared to the other programs. It is hard to disregard a program with these multiple benefits, especially when the PHI is contrasted with the simpler fortification and capsule program which can only provide vitamin A.

If budget constraints are severe, both the capsule and the MSG fortification are attractive programs. It is important to note that MSG could also be fortified with other items. In the case of the Philippines, iron and iodine would be prime candidates. At the same time, other items could be fortified which would increase the effectiveness of a fortification program. It is, in fact, very wise to fortify several items to insure that a minimal level of protection is provided to each child.

The capsule program has very attractive high BCR's, but its effectiveness level is low. Moreover, it requires a superb delivery system and this is too demanding on manpower and other resources to provide just a capsule as the benefit. It may be much more advantageous to use the capsule as an element of other programs and to provide it as part of the curative process in health centers.

Appendix 2

PUBLIC HEALTH INTERVENTION

Policies on the Delivery

A. Over-all Policies/Guidelines

1. The four barrios will receive the same program of intervention

2. The PHI will be delivered by an intervention team consisting of:

   a) one physician

   b) 3 interviewers who assume the roles of multipurpose health worker

   c) one horticulture expert

3. The intervention team will visit each barrio only once a week and will spend a minimum of eight hours per visit.

B. Priority Setting

1. The four barrios will have the same priority rank and will receive PHI of equal intensity.

2. PHI is primarily delivered to the 300 numbered and listed houses.

3. Sample families will have the highest priority rank in the delivery

4. Families within the geographic limits of the barrio but do not belong to the 300 numbered and listed houses are classified under the lowest priority rank and will receive only unstructured health care.

C. Strategy

1. Initial Delivery

a) The initial delivery will be in the form of a massive, segmental (project by project) approach.

b) The following projects are delivered initially:

1. Deworming project
2. Immunization project
3. TB Control project

c) The initial delivery will conform with the priority setting. The initial projects will be delivered to 50% of the total target population and one-half of these should be sample children.

d) Each of the initial projects will be alloted four barrio visits or a total of 32 hours.

e) The Medical Auxiliary Workers Training Program will be started during the initial delivery. Training will be supervised by the team physician and training is described in the MAW Training Manual.

f) The Botica sa Baryo is included in the initial delivery. The initial capital of ₱200.00 will be loaned by CIM-CU to the community and will be repaid from profits generated by the operation of the Botica sa Baryo.

The Botica sa Baryo will be managed and controlled by the Botica sa Baryo Committee of the Barrio Council composed of the following:

1. Barrio Captain as Chairman
2. Barrio Secretary
3. Barrio Treasurer
4. Barrio Auditor
5. CIM-CU Physician

The operation of the Botica sa Baryo and the functions of the Committee are described in the Botica sa Baryo Manual.

2. Subsequent Delivery

a) The subsequent delivery will be programmed in the context of the Service Model.

<u>The Service Model</u>

1. The delivery of PHI to targetted families

The targetted families will conform with the priority setting namely:

1st priority - sample families

2nd priority - families from the 300 numbered and listed houses

3rd priority - families from within the barrio but without house numbers

2. The team physician will have the following work pattern and time distribution.

50% (4 hours) - morbidity clinic

25% (2 hours) - M.A.W. training

25% (2 hours) - Lecture to groups in the community

3. The three Family Health Aides will devote 100% of their time delivering PHI to targetted families with

the following work pattern and time distribution:

50% - 1st priority family

30% - 2nd priority family

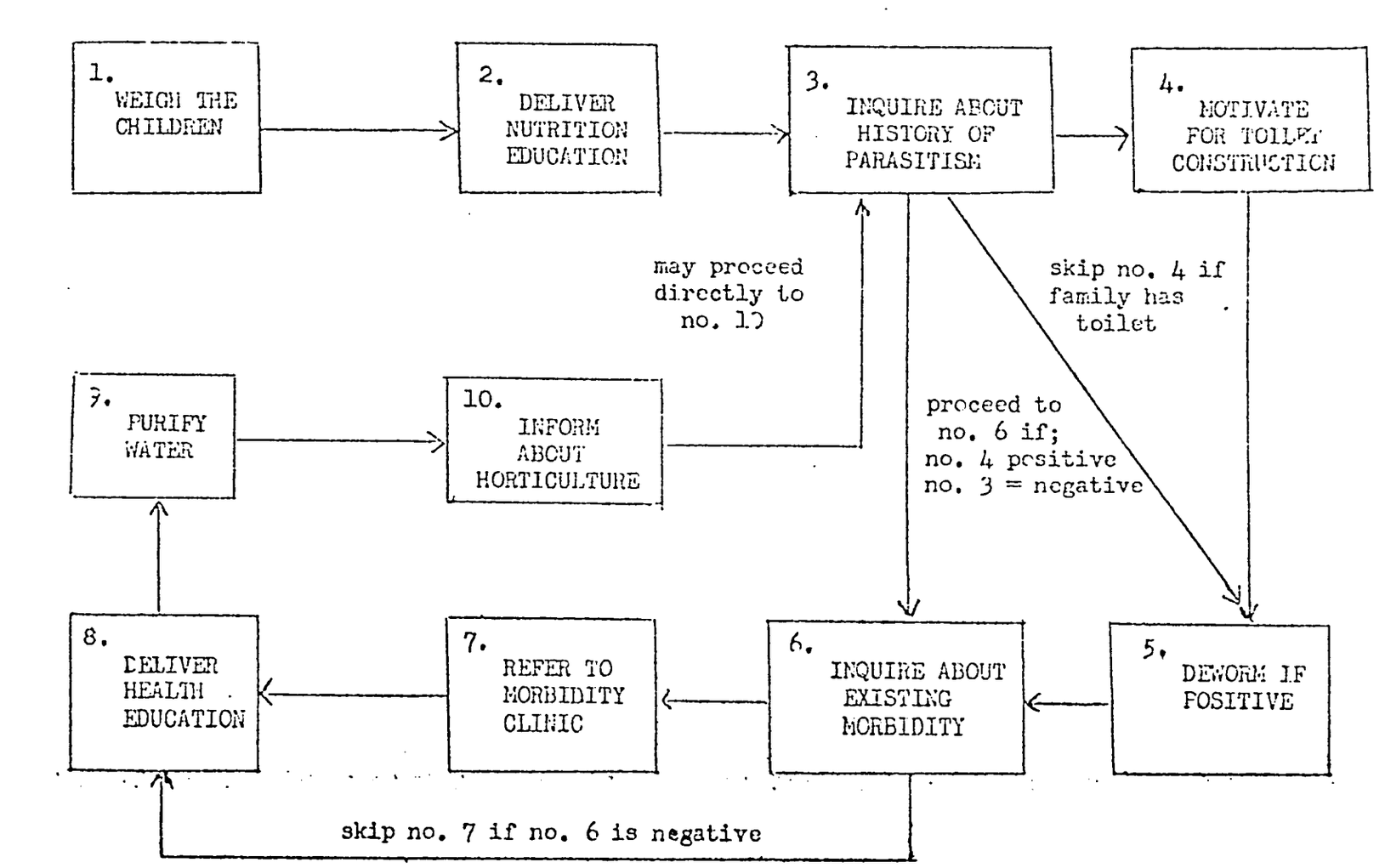
20% - 3rd priority family

4. Each Family Health Aide will devote a maximum of two hours per family during the delivery of PHI.

APPENDIX II

INTENSIVE FAMILY CARE

METHODOLOGY FLOW CHART



Guidelines for Intensive Family Care

No. 1 Weigh the Children

Weights:

A. There are children in the household

Steps:

a. Obtain ages of children

b. Weigh the children and assess their nutritional status using table of standard weights.

1. Family with infants (birth to 2 yrs.) and underweight children - deliver nutritional education (No. 2), etc.

2. Family without infants but with underweight children - start directly with part III of No. 2 (Nutrition Education)

3. Family without infants and with normal weight children - starts with part III of No. 2, etc. stressing ill effects of improper health practices.

c. Motivate for Family Planning

B. There are no children in the family

Steps: a) go to 8 - deliver health education

b) go to 9 - purify water

c) go to 10 - inform about horticulture

No. 2 Deliver Nutrition Education

I. Infant Feeding

A. Breast Feeding (Encourage all mothers to breast feed)

1. importance (complete, convenient, safe, cheap)
2. breast care
3. duration and schedule
4. burping

B. Bottle Feeding (Only for mothers who cannot breas_ feed)

1. hygiene measures:

   - clean bottle)) prevent GIT disorders (kalibang)
   - boiled water)

2. formula

   - use evaporated milk - dilution based on age
   - emphasize disadvatages of condensed milk at high dilution

C. Supplementary Feeding - *starts at four months of age (small amount of vegetables, meat soups, mashed vegetables, etc.)

1. Dilis powder or mongo powder
2. Preparation

   Mashing and straining:

   a. Vegetables c. Rice
   b. Fruits d. Tubers

Principles:

1. Commonly used foods
2. Hygiene
3. Balance meal
4. Palatability

II Weaning

- gradual
- milk must be part of children's diet
- protein-rich foods (mongo, dilis, etc.) that are inexpensive and readily available

III Weight - Index of growth and development

1. Visual: (Charts)

   To compare normal and retarded development

2. Importance:

   a. Weight in direct proportion to and nutritional practices

      if weight is low - not getting enough of right foods

      or stationary - disease process going like parasitism

   b. Weight reflects growth and developmental status of child.

   c. Serial weighing - adequate gauge in determining growth pattern.

IV Malnutrition

A. Visual (Cases)

B. Types (Bring pictures to illustrate)

1. Marasmus
2. Kwashiorkor
3. Vitamin A deficiency - night blindness

C. Effects

1. physical and mental (brain) retardation

physical - thin, presence of pigmentation, edema, etc.

mental - slow comprehension

irritability

decrease work efficiency

2. susceptibility to infection - drain in money

Solution: Balance foods (Protein, carbohydrates, fat) and Vegetables

Motivate for home gardening to produce basic f

No. 3 Inquire about history of Parasitism

No. 4 Motivation for Toilet Construction

A. If the children are positive for parasites (by history or stool examination)

Steps: 1. Explain the presence of parasitism as due to lack of a santiary toilet - demonstrate how a child gets the parasite (simplified parasite cycle of life)

2. Mention the other excreta transmitted diseases and describe them,

3. Inquire whether any member of the family has been sick with these diseases.

if YES: Point out the presence of these diseases in the family as due to the lack of a sanitary toilet. Also point out tha this can be due to lack of blind drainage or improper garbage disposal.

if NO: Inquire whether any member of the family has ever been sick of diarrhea - if yes - then attribute this disease to lack of blind drainage or improper excreta disposal.

4. Teach and encourage the family to:
   a. build a sanitary toilet
   b. construct a blind drainage
   c. dispose garbage properly

B. If the children are negative for parasites:

Steps: 1. Inquire about incidence of diarrhea and other diseases.

2. Explain that water becomes contaminated with bacteria when:
   - there are no toilets
   - improper drainage system
   - improper garbage disposal

3. Then teach and encourage the family to:
   a. build a sanitary toilet
   b. construct a blind drainage system
   c. dispose garbage properly

No. 5 Deworm if Positive

No. 6 Inquire about existing morbidity

No. 7 Refer to Morbidity Clinic

No. 8 Deliver Health Education

Topics:

I. Introduction to Communicable Disease Control

A. Briefing of respondents on general results of stool and blood examination of sample children.

B. Information regarding the avoidance and control of certain diseases which easily occur in children and even adults, stressing the importance of knowledge of these diseases.

C. Illustration and discussion of the Communicable Diseases transmitted by the 4 F's:

1. Food
2. Fingers
3. Flies
4. Feces

D. Driving home in minds of Audience the necessity of cleanliness on the four F's.

II. Discussion of Four Common Communicable Diseases Namely:

1. Dysentery (Dysenteria)
2. Cholera (El Tor)
3. Typhoid (Typhus)
4. Intestinal Parasitism (Bitok)

III. Discussion of the general evolution of the specific disease process:

1. Ex. Dysentery:

1. child plays in ground, thus makes hand dirty
2. child eats fruits without washing
3. in evening, child has minimal diarrhea

4. or if day child's appetite not affected therefore, eats more unclean foods
5. so child diarrhea recurs and becomes worst. Also there is accompanying abdominal pain and fever.

2. Discuss also other diseases patterned after dysentery.

IV. A. Sources and Causes of Communicable Diseases through:

1. Water contamination
2. Food, Flies, Fingers, and Feces

B. Control by:

1. Water chlorination
2. Construction of toilets
3. Construction of proper drainage
4. Sanitary disposal of garbage
5. Environmental sanitation

No. 9 Purify Water

Steps:

1. Inquire about the source of water
2. Inquire about diarrhea
3. Mention the water-borne diseases - cholera, typhoid, and dysentery
4. Explain that water-borne diseases are due to water contaminated with bacteria (reinforce with environmental sanitation)
5. Mention chlorination as a method of eliminating these bacteria found in water
6. Teach how to chlorinate water
7. Encourage the practice of water chlorination.

No. 10 Inform about Horticulture

I. Discuss the importance of Horticulture

A. Its relation to good nutrition

1. essential nutrients derived from home garden products

2. freshness

3. economic reason - affords savings

II. Mechanics of Horticulture Program

A. For households with existing home gardens:

1. Check the size and locations of home gardens - campaign for more and bigger home gardens

2. Find out varieties of garden plants - promote the raising of malunggay, agbate, gay, etc.

3. Five technical advices:

a. how to make and prepare a seed box or seed bed with subsequent sowing of seeds.

b. preparation of plots for transplanting

c. encourage the proper use of locally available fertilizer i.e., horse, cow or carabao manure, chicken dungs.

d. care for growing plants including chemical treatment, weeding if possible.

B. Households without Existing Home Garden (with available space)

1. Find out the reasons for the absence of home gardens

a. presence of stray animals - let the owner of such animals tie the animals or encourage the farmer to fence with available materials such as kagingking, salirap, etc.

b. lack of personnel

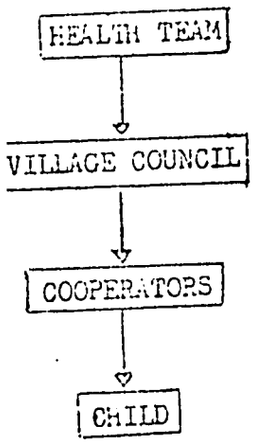
C. Households without available space for home Gardens -

Encourage use of seed boxes, cans for such purpose.

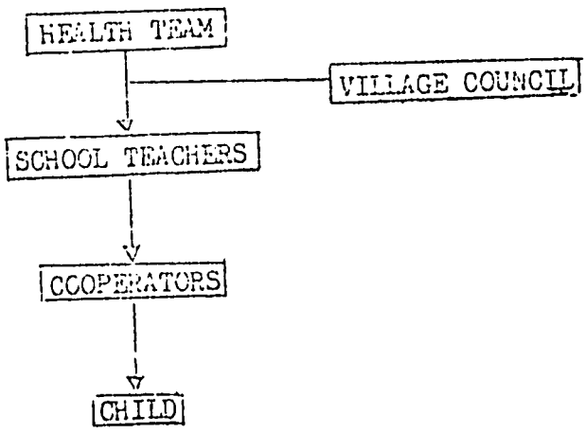
Appendix 3

CAPSULE DISTRIBUTION STRATEGIES

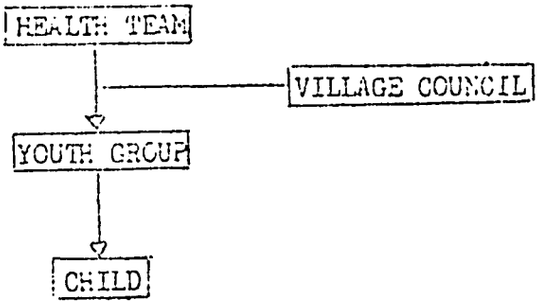
STRATEGY I BARANGAY OR VILLAGE COUNCIL



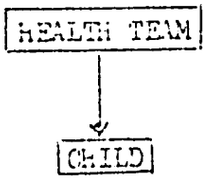
STRATEGY II SCHOOL TEACHERS



STRATEGY III YOUTH GROUPS



STRATEGY IV HEALTH TEAM



Appendix 4

Persons and officials involved in the Project:

FIRST YEAR

A. CORNELL UNIVERSITY

1. Dr. Michael C. Latham - Co-Associate
2. Dr. Barry Popkin - Co-Associate

B. CEBU INSTITUTE OF MEDICINE

1. Dr. Jacinto Veles - President, CIM
2. Dr. Constancio Camomot - Dean, CIM
3. Dr. Ibarra T. Panopio - Consultant Pathologist
4. Dr. Jesus Ravanes - Consultant Ophthalmologist
5. Miss Erlinda Pestaño - Consultant Nutritionist
6. Mr. Gustavo Sasis - Consultant Horticulturist
7. Mrs. Lydia Adlawan - Medical Technologist
8. Mr. Clemente Historillo - Medical Technologist
9. Miss Manette Jabonero - Medical Technologist
10. Miss Veronica Vocal - Clerk-Typist
11. Mr. Nicasio Setrina - Driver

C. VITAMIN A STAFF

1. Dr. Florentino S. Solon - Project Director
2. Dr. Tomas L. Fernandez - Deputy Director
3. Dr. Jeremias U. Murillo - Co-Investigator
4. Dr. Asuncion V. Arong - Research Physician
5. Dr. Joseph D. Graciosa - Research Physician
6. Dr. Exequiel D. Pilones - Research Physician
7. Mrs. Mercedes A. Solon - Research Assistant
8. Miss Milagros P. Naputo - Research Assistant
9. Mrs. Victoria L. de la Peña - Research Assistant
10. Mrs. Ruperta A. Caballes - Medical Technologist
11. Miss Guillerma Lampayan - Medical Technologist
12. Miss Adiel A. Macavinta - Clerk-Typist
13. Miss Marcelina Chan - Clerk-Typist
14. Mr. Pedro Mellas - Clerk-Driver
15. Mrs. Celsa C. Pono - Health Educator
16. Miss Carmen Logroño - Interviewer
17. Mrs. Josefina Padilla - Interviewer
18. Mr. Bienvenido Holganza - Interviewer
19. Mrs. Mirasol Abaquita - Interviewer
20. Miss Anita Densing - Interviewer
21. Miss Lorna Fortuna - Interviewer
22. Miss Ma. Lisa Gorres - Interviewer
23. Miss Luzviminda de Guzman - Interviewer
24. Mrs. Florenda C. Labuga - Interviewer

SECOND YEAR

A. CORNELL UNIVERSITY

1. Dr. Michael C. Latham - Co-Associate
2. Dr. Barry Popkin - Co-Associate

B. CEBU INSTITUTE OF MEDICINE

1. Dr. Jacinto Velez - President, CIM
2. Dr. Constancio Camomot - Dean, CIM
3. Dr. Ibarra T. Panopio - Consultant Pathologist
4. Dr. Jesus Ravanes - Consultant Ophthalmologist
5. Mr. Gustavo Sasis* - Consultant Horticulturist
6. Mrs. Lydia Adlawan - Medical Technologist
7. Mr. Clemente Historillo - Medical Technologist
8. Miss Nanette Jabonero - Medical Technologist
9. Mr. Nicasio Setrina - Driver

C. VITAMIN A STAFF

1. Dr. Florentino S. Solon - Project Director
2. Dr. Tomas L. Fernandez - Deputy Director
3. Dr. Joseph D. Graciosa - Research Physician
4. Dr. Asuncion V. Arong - Research Physician
5. Dr. Exequiel D. Pilones - Research Physician
6. Miss Milagros P. Naputo - Research Assistant
7. Mrs. Victoria de la Peña - Research Assistant
8. Mrs. Ruperta Caballes - Medical Technologist
9. Miss Guillerma Lampayan - Medical Technologist
10. Mrs. Marietta Ebo - Research Aide
11. Mr. Bernard Lanutan - Research Aide
12. Miss Godina T. Sa-a - Clerk-Typist
13. Mr. Pedro Nellas* - Clerk-Driver
14. Mrs. Celsa Pono - Health Educator
15. Mrs. Carmen Logroño - Interviewer/Family Health Aide
16. Mrs. Josefina Padilla - Interviewer/FHA
17. Mr. Bienvenido Holganza - Interviewer/FHA

*First six months only.

THIRD YEAR

A. CORNELL UNIVERSITY

1.	Dr. Michael C. Latham	- Co-Associate
2.	Dr. Barry Popkin	- Co-Associate
3.	Miss Amanda Te	- Research Assistant
4.	Mrs. Susan Ybañez-Gonzalo	- Research Assistant
5.	Mr. Eduardo Reyes	- Programmer
6.	Mrs. Leticia Buela-Dizon	- Secretary, AA

B. CEBU INSTITUTE OF MEDICINE

1.	Dr. Jacinto Velez	- President, CIM
2.	Dr. Jose V. Paradela	- Dean, CIM
3.	Dr. Ibarra T. Panopio	- Consultant Pathologist
4.	Dr. Jesus Ravanes	- Consultant Ophthalmologi
5.	Mrs. Lydia Adlawan	- Medical Technologist
6.	Mr. Clemente Historillo	- Medical Technologist
7.	Miss Nanette Jabonero	- Medical Technologist
8.	Mr. Nicasio Setrina	- Driver

C. VITAMIN A STAFF

1.	Dr. Florentino S. Solon	- Project Director
2.	Dr. Tomas L. Fernandez	- Deputy Director
3.	Dr. Yolanda Cabaron	- Research Physician
4.	Dr. Joseph D. Graciosa	- Research Physician
5.	Dr. Exequiel D. Pilones	- Research Physician
6.	Miss Milagros P. Naputo	- Research Assistant
7.	Mrs. Victoria B. de la Peña	- Research Assistant
8.	Mrs. Ruperta Caballes	- Medical Technologist
9.	Miss Guillerma Lampayan	- Medical Technologist
10.	Miss Charito Miranda	- Medical Technologist
11.	Mrs. Marietta Ebo	- Research Aide
12.	Mr. Bernard Lanutan	- Research Aide
13.	Miss Godiva T. Sa-a	- Clerk-Typist
14.	Mrs. Celsa Pono	- Health Educator
15.	Mrs. Carmen Logroño	- Interviewer/FHA
16.	Mrs. Josefina Padilla	- Interviewer/FHA
17.	Mr. Bienvenido Holganza	- Interviewer/FHA
18.	Miss Rosario Cabigon	- Medical Technologist
19.	Miss Aurora Saniel	- Medical Technologist
20.	Mrs. Emiliana Canque	- Interviewer
21.	Mrs. Josefa Chan	- Interviewer
22.	Miss Terencia Magallon	- Interviewer
23.	Miss Pacita Rosafa	- Interviewer
24.	Mrs. Nenita Sotto	- Interviewer
25.	Mrs. Purita Titong	- Interviewer
26.	Mr. Natalio Villahermosa, Jr.	- Interviewer
27.	Miss Fe Villarico	- Interviewer
28.	Miss Rosario P. Soriaga	- Training Coordinator
29.	Mr. Cesar Bugtai	- Horticulture Assistant
30.	Mr. Nonoy Ceniza	- Horticulture Assistant
31.	Mr. Generoso Pena	- Science Aide

Appendix 5

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