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# GARDENS AND VITAMIN A

## A Review of Recent Literature

by


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| | |
|---|---|
| AVRDC | Asian Vegetable Research and Development Center |
| CI | consumption index |
| DGLV | dark green leafy vegetable |
| FAO | Food and Agriculture Organization |
| FEN | Food Energy Nexus |
| HDM | hierarchical decision model |
| IDRC | International Development Research Centre |
| ISRA | Institut Senegalais de la Recherche Agronomique |
| ISTI | International Science and Technology Institute, Inc. |
| IU | international units |
| IVACG | International Vitamin A Consultative Group |
| LAPIS | Lesotho Agricultural Production and Institutional Support |
| MfM/FfHF | Meals for Millions/Freedom from Hunger Foundation |
| MSG | monosodium glutamate |
| NAS | National Academy of Sciences |
| NCD | National Capital District |
| NRC | U.S. National Research Council |
| NDpCal | net dietary protein-calories |
| NGO | non-governmental organization |
| NRU | Nutrition Rehabilitation Unit |
| NV | nutrient value |
| NY | nutrient yield |
| ONC | overall nutritional completeness |
| PNG | Papua New Guinea |
| PVO | private voluntary organization |
| RCSB | Royal Commonwealth Society for the Blind, U.K. |
| RDA | recommended daily allowance |
| RE | retinol equivalent |
| RDR | Relative Dose Response |
| RNC | relative nutrient cost |
| SCF | Save the Children Federation |
| UNAM | Universidad Nacional Autonomia de Mexico |
| UNICEF | United Nations International Children's Fund |
| UPF | usual pattern of food consumption index |
| USAID | United States Agency for International Development |
| VITAL | Vitamin A Field Support Project |
| WHO | World Health Organization |

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# EXECUTIVE SUMMARY

Inadequate vitamin A status has become an increasingly important issue for development policy in the last decade, with growing evidence of its contribution not only to xerophthalmia and blindness, but to high child mortality rates. Although short-term interventions may sometimes be a necessary temporary strategy, sustainable long-term solutions to vitamin A deficiency rest with increased consumption of provitamin A-rich foods by those vulnerable to deficiency. Home-grown vegetables and fruits and gathered wild foods are important sources of provitamin A. Indigenous gardens have been a part of household production systems since the beginning of agriculture and continue to remain important in terms of food supply, nutrition, and income in both the industrialized and the developing countries.

The major purpose of this document is to identify many of the key issues that should be addressed in future efforts to promote home gardens for vitamin A production. In particular, the document addresses development approaches to gardens, issues related to targeting and evaluation, indigenous sources of provitamin A, food processing and nutritional value, food intake and nutritional status, garden nutrient yields, the impact of gardens on consumption and income, and factors that affect garden impact.

The recommendations developed from this review of the literature are summarized below under the categories of targeting, garden project design, improving garden impact, and evaluation.

**Targeting**

- The first step for identifying target regions with vitamin A deficiency is to use secondary sources such as data from WHO and UNICEF.
- Indirect indicators such as production of provitamin A-rich foods and consumption patterns should be used for assessments of inadequate vitamin A status. Direct assessment indicators have more limited applications because of cost, required sample size, and limitations of technical support.
- Feasibility studies should be conducted prior to implementation of garden interventions to assess production and consumption factors that may influence potential impact of gardens.
- To improve availability of provitamin A-rich foods to infants and young children, garden projects should encourage the involvement of women to ensure their access to garden foods, control over garden income, and education.

**Garden Project Design**

- Local participation in assessments, planning, implementation, and evaluation is essential for making gardens relevant to peoples' needs and sustainable in the long term.
- Policy-makers need to be made aware of the importance of urban gardens and encouraged to support these garden efforts.
- Indigenous sources of provitamin A should be promoted in garden interventions whenever possible.

**Improving Garden Impact**

- Nutrition education components should be included in garden interventions to promote appropriate processing, storage, and cooking techniques that protect the provitamin A content of foods.

- In communities where protein energy malnutrition (PEM) exists, garden interventions should encourage the production and consumption of food sources that contribute fat and/or protein to the diet.
- Existing cultural preferences need to be considered when encouraging provitamin A-rich foods.
- A diversity of provitamin A-rich foods should be grown to meet both subsistence and marketing needs and to reduce gardeners' risk.

**Evaluation**

- Evaluation criteria should be based on feasibility studies to realistically assess the impact of local garden interventions.
- Indirect assessment indicators should be relied upon as much as possible.
- Local communities should be included in designing and carrying out the evaluation of garden interventions.

# I. INTRODUCTION

Vitamin A deficiency and inadequate vitamin A status have become an increasingly important issue for development policy in the last decade, with growing evidence of their contribution not only to xerophthalmia and blindness, but to high child mortality rates as well (Sommer et al. 1983, 1986; Underwood 1990). The three major development interventions to combat such low vitamin A status and deficiency have been vitamin A supplementation, either through injections or capsules, fortification of foods such as sugar and monosodium glutamate (MSG), and promotion of increased consumption of vitamin A-rich foods. Increased consumption often includes nutrition education and/or the establishment and encouragement of household and community gardens.

Although supplementation and fortification have utility as short-term solutions to serious deficiencies, sustainable long-term solutions to vitamin A deficiency rest with increased consumption of vitamin A- and provitamin A-rich foods by those who are vulnerable to deficiency (Indirabai 1986; Latham and Solon 1986; McKigney 1984; Simmersbach 1990; Solon, et al. 1979; Teply 1986). This approach directly addresses the social and environmental causes of vitamin A deficiency. The possibility of improving the availability and consumption of provitamin A based on available resources grows out of the fact that it is present in many foods. Vitamin A can be available in the diet both as provitamin A in carotenoids contained in green, yellow, and orange vegetables and fruit, or as preformed vitamin A (retinoids) in some animal products such as eggs, milk, and liver. There is abundant evidence that most of the vitamin A value in developing countries diets comes from carotene-containing plant sources. In fact, in Africa and Asia, vegetable products constitute 86 percent of the vitamin A intake (McKigney 1983). Thus, home cultivation of vegetables and/or fruits and utilization of wild foods can provide important sources of vitamin A-rich foods.

To fully understand the relationship between gardens and nutrition in order to effectively plan future research and intervention initiatives, the Vitamin A Field Support Project (VITAL), funded by the Agency for International Development, is carrying out an assessment of past and ongoing household and community garden efforts. Directed by the International Science and Technology Institute, VITAL is following a three-phase approach for this assessment: 1) a bibliography of recent literature and a review of recent program implementation experiences; 2) a synthesis of findings from phase one; and 3) a workshop of experts to discuss issues outlined in the first two phases and to make recommendations to VITAL on future initiatives.

This report represents the second phase of the assessment, and is based on the first phase, especially the literature review, or bibliography (Soleri et al. 1990). The bibliography builds on the discussion of gardens and nutrition by Brownrigg (1985), focusing on materials written since 1984, and is arranged around the following four topics: 1) gardens and development (both theoretical and applied approaches); 2) garden foods and vitamin A (indigenous sources of vitamin A, food processing and nutritional foods, food intake and vitamin A status); 3) garden nutrient yields (model/maximizing gardens, indigenous gardens); and 4) impact of gardens (consumption impact, income, and savings impact). The synthesis document follows a similar organizational framework in its discussion.

A second major source of information is *The Tip of the Iceberg* (Peduzzi 1990), which summarizes the program implementation experience and lessons learned from both USAID-funded and non-USAID-funded home and community garden efforts.

The major purpose of this synthesis document is to identify many of the key issues that should be addressed in current and future home gardening efforts. In particular, the document addresses issues related to targeting and evaluation, indigenous sources of vitamin A, food processing and nutritional value, food intake and nutritional status, garden nutrient yields, the impact of gardens on consumption and income, and factors that affect garden impact. Finally, the document ends with a number of recommendations that should be considered in future research and intervention. To facilitate the discussion of issues and recommendations, the report begins with an operational definition of household gardens and outlines the various development approaches to gardens.

# II. GARDENS AND DEVELOPMENT

Indigenous gardens have probably been a part of the household production system since the beginning of agriculture. They continue to play an important role in household production, income, and nutrition. In the developing countries, gardens exist in an astonishing diversity from the oases of the Sahara to the forests of Indonesia, from the canal banks of irrigation districts to the vacant lots of large cities. Just as gardens persist with urbanization, they flourish in industrial countries and continue to make significant economic and nutritional contributions, as, for example, in Canada (Omohundro 1985), the United States (Gladwin and Butler 1984), Poland (Kleer and Wos 1988), and Great Britain (Crouch and Ward 1988).

Gardens have been a persistent presence in development projects for at least several decades. In part because gardening components are often integrated into other projects, it is hard to determine exactly what the investment in them has been, though it appears to have been substantial. As Brownrigg noted in her 1985 review of the literature, there have been numerous small garden projects "on the order of US $5,000 to $30,000 (plus staff or volunteer expenses). However, hundreds of larger-scale projects with gardening components have cost in the range of US $3 to $5 million (calculated by 1983 US dollar conversion rates). Successive projects, campaigns, and programs in India, the Philippines, and more recently, Indonesia have cost hundreds of millions over the years" (1985:67).

## II.1 Definitions

Household gardens are mixtures of annual vegetables, fruit and nut trees, grains, condiments, and other crops. They can be found on rooftops; next to houses; as plots in fields; in strips along canals, roads, or railroad tracks; and as contiguous plots in community gardening areas. Frequently community gardens could be most aptly described as contiguous, individual household gardens located within a community gardening area. Functionally they may be communal in the management and distribution of critical productive resources such as land and water (Duggan 1985; Stone et al. 1987; Yoon 1983). Occasionally labor or monetary contributions are also required to support communal efforts such as hiring transport to market (Yoon 1983), or obtaining manure (Duggan 1985).

The following definition of household gardens is used in this paper:

> [A garden is] a supplementary food production system that is under the management and control of household members. In addition to food it may provide herbs, fuel, medicine, fodder, building materials, shade, social or recreational space, and beautification. A household garden can be consumption or market oriented, but at least some of the produce will be consumed by the household. As a supplementary production system the household garden is secondary to both the primary source of household food, whether from field production or purchase, and to household income, whether from sales of field produce, wage labor, migrant remittances, or other sources. A corollary of this is that households do not invest a major portion of their labor or other resources in gardens....
>
> In defining household gardens in the context of development, functional characteristics take precedence over form or cultural norms, because [the] interest is in how the garden is related to systems of household production, nutrition, and economics. This includes relationships both within the household, and those that connect the household to the rest of the world...the household can be considered the elementary unit of production and consumption. (Cleveland and Soleri 1987:259)

The secondary nature of gardens is an important defining criterion because it helps distinguish gardens from field agriculture. Anthropologists and others often refer to primary-staple or cash-crop production that does not involve the use of the plow or irrigation as "horticulture," and the fields in such systems as "gardens," for example, the

Chagga "gardens" (Fernandes, et al. 1985) or Papua New Guinea "gardens" (Crittenden, et al. 1988). These "gardens" do not fit the definition given above and so are not considered in this paper.

The term "indigenous" is used in this paper to refer to locally developed knowledge, practices, skills, and resources. This definition also applies when referring to plants and does not mean that the species originated in the area, but rather that the particular variety or varieties are the product of local human and/or environmental selection and management.

"Development," in this context, is defined as equitable improvement of vitamin A nutritional status that benefits the most vulnerable people in the community, with long-term sustainability beyond the life of the project.

### II.2 Targeting

The complex interactions between gardens and nutrition make it difficult to identify target populations for a project promoting gardens as an intervention for reducing vitamin A deficiency. Targeting garden interventions must include several considerations: 1) the prevalence of vitamin A deficiency among different segments of the population; 2) the viability of promoting indigenous gardens given agroecological and cultural conditions and previous experience with garden techniques; and 3) the potential for garden production to have a nutritional impact.

There are several methods that can be used to determine the existence and magnitude of a vitamin A deficiency problem in the population. The direct indicators include: 1) biochemical indicators such as serum retinol, relative dose response (RDR; Arroyave 1990, personal communication), and breast milk retinol; 2) morphological abnormalities, such as conjunctival impression cytology; and 3) clinical eye manifestations, such as xerophthalmia, including Bitot's spots and corneal destruction. Indirect indicators include: 1) production and availability of dark green leafy vegetables (DGLVs), other provitamin A-rich foods, or preformed vitamin A-rich foods (i.e., eggs and milk); and 2) dietary indicators such as food patterns, consumption of provitamin A-rich foods, and intrafamily distribution of these foods.

Compared with direct indicators, production and dietary indicators have the following advantages: 1) they do not require the technical support necessary for direct assessment; 2) they do not require such a large sample population to accurately measure the prevalence of rare symptoms; 3) they are not as intrusive; 4) they are less expensive; and, most importantly, 5) they provide information of direct use to the long-term intervention strategies of increasing production and consumption through gardens and nutrition education.

Because of the difficulty and expense of collecting data on vitamin A nutritional status, Storms and Quinley urge reliance on secondary data sources such as WHO, UNICEF, and regional or national information bases for targeting and assessment. They state, "If secondary sources give reasonable direct or indirect evidence of significant vitamin A deficiency in the project area, a vitamin A intervention component can be justified." (Storms and Quinley 1989:11). They recommend that targeting be based on reaching those populations that are most vulnerable: pregnant and lactating women, and infants and children (1989:14-15). In addition, cooperation and complementarity with existing programs are also advocated.

Where assessment determines that vitamin A deficiency is severe, short-term, temporary interventions such as supplementation or fortification may be necessary to halt the serious consequences of the deficiency. However, this does not mean that gardens should not also be an intervention. They can be part of a combined approach to addressing the problem, as is recommended by a number of researchers and practitioners (Indirabai 1986; Latham and Solon 1986; McKigney 1983).

When promoting garden interventions for nutritional benefits, it is important to assess the potential impact gardens can have on household nutrition given overall consumption patterns. In communities where PEM is acute due to a shortage of staple foods, garden nutritional impacts may not offset the overall problem. In addition, gardens designed to address seasonal shortages of fruits and vegetables may be designed differently from those intended to provide year-round supplements to existing diets. Thus the complex production-consumption linkages need to be clearly understood in assessing the potential impact of gardens (Frankenberger 1985).

The potential for improving existing gardens or establishing new ones can best be determined through community-based assessments (Cleveland and Soleri 1991:47-62). Informal interviews and participant observation should be used to identify any existing gardens. Existing gardens provide a wealth of information for assessment of production potential and constraints, as well as information about consumption and nutritional impact. Absence of gardens is also informative and where they do not exist, the reasons for their absence should be discussed with diverse community members. As Peduzzi (1990) points out, gardening as a nutritional intervention is not practical if adequate water sources are not available. In addition, a community's familiarity with gardening practices will have considerable influence on the successful implementation of such interventions.

Initial information gathering with informal interviews and participant observation will help assessment field workers identify what specific information is needed in greater detail. A small, stratified random sample representing different household types (i.e., social or economic classes, female-headed, etc.) can then be used to conduct one- to two-page formal interviews covering key questions on production, processing, and consumption. Intrahousehold differences in status and power can be reflected in access to foods and thus nutritional status (Eskelinen 1977). Taste, cultural preferences, and rules about food also affect consumption differences between household members (Shrestha et al. 1989; Tarwotjo et al. 1982). Because women and children are often those most affected by these two aspects of intrahousehold food distribution and consumption, it is important to include questions, in both informal and formal interviews, that specifically address their conditions and needs. The information obtained through these interviews can provide a portion of the baseline data necessary for evaluating the impacts of garden interventions.

## II.3 Development Approaches and Garden Project Implementation

There are several distinct approaches to household gardens in development which shall be described briefly. These approaches can be most usefully distinguished according to whether they are based on models brought in from the outside, or are built on indigenous knowledge. The approach used appears to have a strong influence on the implementation and success of the project.

### II.3.A Industrial Garden Model

Industrialized agriculture from northern temperate regions such as the United States has greatly influenced food systems in the developing countries, including household gardens. It is large-scale, capital intensive, and aims to create optimal growing conditions for monocropping commercial crop varieties using agrochemicals for pest, disease, weed, and soil management; mechanization; and centralized irrigation systems. The production successes of industrial agriculture have made it a powerful cultural model worldwide, and have led in many instances to the displacement of indigenous agriculture. Despite these production successes, this approach has had adverse effects on the environment, on consumer health, and on the poor in both the industrial and developing countries (Cleveland 1990; NRC 1989a).

The industrial agricultural model, in combination with temperate-region row gardens, has dominated the kind of gardens promoted by industrialized nations and extension workers trained in this tradition. Often the goal is increasing production or sales, with minimal attention to the effect on household economics, nutrition, or social well-being (McKigney 1983; Pacey 1978). Garden projects often overlook local gardening practices, promoting commercial seed of temperate "European" vegetables, European-style tools and manufactured agrochemicals (see Brana-Shute 1985 for an example). Purchased inputs may be subsidized by the government or sponsoring agency. This model is often oriented toward local, national or even international markets.

### II.3.B French-Intensive, Bio-Dynamic, Organic Garden Model

Another model that has frequently been imported from the industrial to the developing countries is one based on French-intensive, bio-dynamic, or organic gardens. While very different from the industrial model just described, it also tends to be imposed from the outside, with minimal consideration of local knowledge or resources. Ninez (1985) discusses its unsuccessful application in Lima, Peru.

Variations on this model include the nutrition-maximizing model gardens developed most notably at the Asian Vegetable Research and Development Center (AVRDC) in Taiwan and applied in Thailand and other countries in southeast Asia (AVRDC 1988; Gershon 1985; Yang 1981). Bittenbender refers to these as "intensive fixed models," and notes that projects based on them "lack flexibility" (1985:647). Brownrigg points out that they are a scaled-down version of traditional Asian vegetable fields using beds and rows, and are being promoted in places where quite different mixed gardens are indigenous (Brownrigg 1985:33).

### II.3.C Indigenous Garden Model

Indigenous gardens exist in most parts of the developing world, but are seldom studied, in part because of their genetic, agronomic, and sociocultural complexity (Cleveland and Soleri 1987). They are one component of indigenous food-production systems, and share many basic characteristics with small-scale indigenous agriculture. Yields per unit area often increase with decreasing size of a garden, and labor productivity of gardens can be higher than that of fields. Indigenous gardens are the result of continuing experimentation; they are far from static, and often include recent innovations borrowed from similar gardens in other areas, as well as from industrial gardens. Indigenous gardens provide many other products in addition to food, including medicines, fodder, building and craft materials, flowers, shade, and a place for relaxation and social activities. Key features are the use of local knowledge and resources, locally adapted, genetically diverse crops with many varieties, crop rotation, mixed cropping, and the exploitation of different microenvironments, such as areas with soil that holds water longer. Cultivated areas often resemble natural ecosystems, containing dozens and sometimes over 100 domesticated and nondomesticated species (Alcorn 1984; Grivetti 1978; Soemarwoto and Soemarwoto 1981). Their high level of diversity minimizes pest, disease, and weed problems and reduces risk for gardeners (Cleveland and Soleri 1991:286-293). When they occur, these problems are managed by system adjustments.

Indigenous urban gardens appear to exist in most of the world's cities (Cleveland and Soleri 1985; Gutman 1987; Kleer and Wos 1988; La Rovere 1987; Ninez 1985; Sanyal 1986; Tricaud 1987; Vasey 1982; Villien 1988; Yeung 1987). The contribution of these gardens to the diets and incomes of poor urban households is thought to be significant. In addition, these household gardens provide other benefits to the urban community in which they occur, including fresh produce for urban markets, control of environmental degradation, and urban beautification.

However, indigenous gardens may also be applied as inappropriate models in other contexts. For example, the introduction of the famous *chinampas*, or so-called "floating gardens," from the central valley of Mexico to the east coast of Mexico failed for this reason (Chapin 1988). The introduction of the Indonesian indigenous garden model to West Africa may be another example (Brownrigg 1985:59,77).

Local participation in planning, implementation, and evaluation is essential if project gardens are to be incorporated into households' food systems and persist beyond the life of the project (Brownrigg 1985:100-102; Cleveland and Soleri 1990:49-52). As Brownrigg points out (1985:104-107), imported seeds and tools are expensive, are subject to logistical and phytosanitary obstacles, and, in many cases, are simply not appropriate for local conditions. In such cases the use of locally made tools and locally adapted seeds is more appropriate.

The emphasis on grassroots development based on local knowledge, control, and resources has gained momentum in recent years (Bunch 1982; Chambers 1983; Richards 1985, 1986; Warren, et al. 1989; Werner and Bower 1982). Many recent extension materials reflect this trend by advocating indigenous gardens as the starting place for successful garden projects (Cleveland and Soleri 1991; Dupriez and De Leener 1987; Sommers 1984).

### II.4 Evaluation

While adequate evaluation of indigenous gardens and garden projects is necessary if their success is to be improved and if support for them is to increase, few if any adequate guidelines exist (Arroyave, et al. 1989; Peduzzi 1990; O'Brien-Place 1987). The persistence of project gardens after project completion is the most obvious and crude indicator of success or failure. Beyond this, garden projects have seldom been evaluated in terms of their effect on nutritional status, with a few notable exceptions (e.g., Brun, et al. 1989; Solon, et al. 1979). In part this is due to the nature of gardens themselves. As secondary food production systems, gardens may take many forms and are subject to adjustments in investments of labor, land, and other resources, according to current circumstances. Gardens are complex production systems, characterized by a diversity of inputs and products, often making costs and benefits difficult to assess. And finally, there are many steps between garden production and consumption and the goal of improved nutritional status: processing, storage, intrahousehold distribution, sales/purchases, consumption, absorption, and metabolism. Obstacles at any of these points as well as in inputs to garden production can result in project failure, and so evaluations must discern where those obstacles occurred in order to remedy the problem before abandoning the strategy altogether.

Based on this review of the literature it is obvious that the outcome of an evaluation will be strongly influenced by assumptions about whether goals should be short- or long-term, and narrow (e.g., vitamin A nutritional status of children) or broad (improved overall nutritional status of children or even the whole community). The longer the term and the broader the focus, the greater will be the benefits of gardens in comparison to vitamin A supplementation and fortification. Similarly, when the focus is longer-term and wider, garden projects based on indigenous knowledge may often show greater benefits and sustainability, compared with garden projects based on inappropriate models.

In addition to the nature of gardens, there are programmatic problems that have also hindered garden project evaluations. Lack of time and money have often meant that evaluation has not been possible. Also, as Peduzzi (1990:4,5,10) notes, this often means little investment in preproject feasibility studies or collection of baseline data.

Those evaluation methods that have been developed (Gruen, et al. 1989; O'Brien-Place 1987) or outlined (Arroyave 1989:19-21; Storms and Quinley 1989; Underwood, et al. 1989) are useful in stimulating thinking about evaluation, but may be unrealistic for field application. Collection of the detailed quantitative data suggested by some evaluation guidelines would be more costly than most projects themselves. On the other hand, simply using such indicators as the number of garden project participants or number of training workshops held, overlooks the many details affecting the impact of gardens, and can lead to false conclusions, especially about the success of the project.

The basic approach to evaluation is calculation of efficiencies or output/input (sometimes input/output) ratios. In the most common benefit-cost version this means calculating market value of garden produce and dividing by project and production costs (O'Brien-Place 1987). Nutritional status indicators can also serve as outputs, and can be converted to economic terms (O'Brien-Place 1987:12).

One of the simplest, and therefore most common, criteria is project cost per garden or per household. Brownrigg was able to calculate cost/garden for three projects. The costs per garden for projects in Ilesha, Nigeria, and Benin were $1,659 and $13,837, respectively (1985:74,77). It is important to note that some reasons for the expense of the Benin project were the large expatriate staff, importation of and research on foreign crops and crop varieties, and low acceptance by local people of project crops and gardens. A school garden project in Chile had a total cost per "initial school year" of $6,000 (1985:86). Solon, et al. (1979; see section V.1), calculated the annual cost per household of the public health and horticulture intervention at $9.47/household compared with $0.21/household for capsules and $0.58/household for fortification. However, the low costs calculated for capsule distribution and fortification may significantly underestimate infrastructural and social costs of production and distribution.

Output/input ratios can also be calculated for many of the steps between inputs to gardens and nutritional status and well-being. The comparative advantages of different combinations of these steps in terms of proportional cost to the project, and their importance in furthering the goals of the project, should be intensively discussed in the context of the specific region or site before evaluation procedures are selected. For example, estimation of the nutritional impact of promoting provitamin A-rich local foods by analyzing the active carotenoids in local foods will probably not be worthwhile because 1) such small amounts of provitamin A-rich food supplies the RDA for vitamin A, it will probably be much more cost effective to try to increase this amount to provide a wide margin of safety than to increase the precision of nutrient content assessment; 2) values for many similar foods likely already exist; and 3) the errors and imprecision in these published values may not be greater than variation between meals, households, and communities due to crop variety, growing conditions, processing, and dietary combination.

In the process of choosing evaluation criteria, it is important to take into consideration the important production-consumption linkages and sociocultural variables that were identified in the baseline study prior to project implementation. For example, garden impact on vitamin A can be influenced by seasonal food shortages, child feeding patterns, utilization of wild foods, processing and cooking practices, and access to animal sources of vitamin A. The baseline information will provide guidance as to the appropriate impact measures that should be used in the assessment of gardens.

Despite the lack of information about the impact of gardens in development and the difficulties of targeting and evaluation, there are ways to further analyze gardens' actual and potential contribution to improved nutrition using sources other than project evaluations. The discussion in the remainder of this document is based not only on documentation of garden projects, but also on literature discussing the major components of the pathway between garden production and improved nutritional status, focusing on vitamin A.

# III. GARDEN FOODS AND VITAMIN A

Vitamin A can be available in the diet both as provitamin A in the carotenoids contained in green, yellow, and orange vegetables and fruits, or as preformed vitamin A (retinoids) in some animal products such as eggs, milk, butter, and liver. Gardens often include domesticated animals such as poultry, fish, guinea pigs, rabbits, and even goats, and so can be sources of preformed vitamin A as well as provitamin A. However, in this report we focus on crop production, not animals. Absorption of vitamin A, especially carotenoids, requires dietary fat which may also come from garden foods. Gardens may also enhance vitamin A nutrition because they can be critical sources of fat, energy and protein, especially for weaning-age children.

## III.1 Indigenous Sources of Vitamin A

Diets in most developing countries are dominated by plant foods and frequently contain a rich variety of domesticated and nondomesticated indigenous sources of vitamin A and edible oils (Ogle and Grivetti 1985a-d; Ohtsuka, et al. 1985; Oomen and Grubben 1978). Plant foods provide 86% of dietary vitamin A in Africa and Asia, 65% in the Near East, and 53% in Latin America (McKigney 1986:374). The relationship between domesticated and nondomesticated plants used in the diet is important for a number of reasons. First, in some areas this distinction is unclear because "wild" foods are protected, transplanted, and encouraged in gardens and along field perimeters (Becker 1983; Bye 1981; Ogle and Grivetti 1985a-d). For example, a major garden and nutrition project in the 1960s in Ilesha, Nigeria, emphasized traditional vegetables and found that "many Nigerian foods were not as wild as believed...many greens turned out to be semicultivars, which, with a little coaxing were adapted for cultivation in home gardens" (Brownrigg 1985:104).

Second, in some project areas, garden foods are replacing traditional wild foods such as dark green leaves (Brun, et al. 1989; Saenz de Tejada 1989). Habitat destruction and rural-to-urban migration mean that wild foods are no longer available (e.g., Ogle and Grivetti 1985b,c). Many garden projects promote "European" vegetables, that are not adapted to local growing conditions (Brownrigg 1985:104-108; Cleveland and Soleri 1987; Pacey 1978:24; Peduzzi 1990; Shrimpton 1989) and, most importantly, have lower nutritional value than wild foods (Brun, et al. 1989; Saenz de Tejada 1989) or indigenous garden crops (Evenson and Standal 1984; Oomen and Grubben 1978; Shrimpton 1989). This is especially critical for vitamin A consumption when DGLVs are being replaced by crops like cabbage or lettuce, which are extremely low in carotenoids but have higher prestige because of their association with "modernity." For all of these reasons, growing indigenous fruits and vegetables in gardens may be an important strategy for poor households. Program planners are recognizing this. For example, the FAO has incorporated a "traditional plants" component into their vitamin A program, requiring project areas to identify local food plants for use in food production projects (Simmersbach 1990).

Third, it is clear that there are many local plant sources of provitamin A that can be grown in gardens. Yet it is important that recognition of the value of indigenous crops does not lead to their alienation from broadly held household control through seed-stock commercialization (Brownrigg 1985:104; Cleveland and Soleri 1991:293-295). Identifying, understanding and supporting local protection and use of these plants is an obvious first step.

Recognition of the agronomic, nutritional, and culinary advantages of indigenous or traditional crops has resulted in a limited number of locally specific encyclopedic references on these plants, which often include nutritional information (e.g., FAO 1983, 1984, 1986, 1988). Many of these publications focus on trees, not herbaceous annuals. They are useful references for field workers and program planners, and they suggest the many wild and domesticated local plant resources available, only a small portion of which have been formally documented.

### III.2 Food Processing and Nutritional Value

Even when plant foods rich in provitamin A and other nutrients are available, their preparation can either increase or decrease their nutritional benefits significantly. In many developing country diets DGLVs are eaten as a cooked sauce or relish. Sometimes they are dried for storage and future consumption or marketing. Drying is an important food-processing technique because not only does it preserve the harvest for future use, but it can also increase the food's nutritional density and nutrient availability, increasing its value as an ingredient in weaning foods (Cleveland and Soleri 1991:329-332).

High heat and/or exposure to sunlight after harvesting can destroy provitamin A (Akpapunam 1984; Gomez 1981; Maeda and Salunkhe 1981; Simpson 1983). For example, wilting due to exposure to sunlight was found to produce losses of 57% of carotenoids in okra, and 67% in fluted pumpkin leaves, a common West African pot herb (Akpapunam 1984). However, simple measures that reduce oxidation of foods through shortened cooking time, lower temperatures, and shade drying can reduce those losses significantly (Cleveland and Soleri 1990:310-314). For example, sweet potato leaves dried in the shade retain 34% of total carotenoids compared with 10.5% retention with sun drying, and amaranth leaves retain 17.4% with shade drying and 12.4% with sun drying (Maeda and Salunkhe 1981).

Seasonally available orange and yellow fruits such as mangoes are important sources of provitamin A in many areas. Shade drying preserves the seasonal abundance of these fruits for use later in the year and maintains a high beta-carotene content while producing a palatable dried food (Maeda and Salunkhe 1981; Rankins, et al. 1989).

### III.3 Food Intake and Vitamin A Nutritional Status

A relatively small amount of provitamin A-rich garden foods can supply the United States National Research Council (NRC 1989b) RDA for retinol equivalents (RE): from 375-400 ug RE for infants and young children to 800-1,000 ug RE for adults and 1,200-1,300 ug RE for lactating women. This means that just 100-200 g (3-7 oz) of provitamin A-rich food can meet the RDAs for infants and children. FAO/WHO RDAs (FAO/WHO 1988) are somewhat lower than those of the NRC. The limited number of studies that have been done show that consumption of garden foods contributes to improved vitamin A nutritional status. Three levels of evidence support this finding (see Mejia 1986). First, the provitamin A in these foods is absorbed by the body, as shown by increased serum levels of beta-carotene after supplementation with provitamin A-rich foods such as ivygourd leaves (Charoenkiatkul, et al. 1985). Fat in the diet, which the garden can also supply in important amounts--especially in weaning foods--appears to increase absorption (Reddy 1986). Second, carotenoids are successfully transformed into retinol in the body, as evidenced by increased serum vitamin A levels after supplementation with ivygourd leaves (Charoenkiatkul, et al. 1985) or amaranth (Reddy 1986). Finally, consumption of garden foods decreases signs of vitamin A deficiency such as xerophthalmia, including Bitot's spots (Tarwotjo, et al. 1982).

However, the positive impact of consumption of adequate amounts of provitamin A-rich garden foods can be inhibited by other nutritional deficiencies (PEM) (Mejia 1986). There is growing evidence that there is a synergistic effect between vitamin A nutrition and protein energy malnutrition (Mejia 1986). Protein deficiency affects intestinal absorption, the release of vitamin A from the liver, and its transport in the blood. So even with adequate vitamin A intake, the lack of sufficient protein will result in vitamin A deficiency (Mejia 1986). Synergistic relationships have also been discovered between vitamin A and infectious diseases: vitamin A deficiency may increase mortality associated with infectious disease (e.g., Sommer, et al. 1983, 1986), and infectious disease and PEM may increase the risk of developing vitamin A deficiency (e.g., Charoenkiatkul, et al. 1985; Sommer, et al. 1987).

In cases where PEM may inhibit vitamin A absorption, gardens should be designed in such a way as to contribute to overall improvement in nutritional status. This will improve the likelihood that garden interventions will have a positive impact on vitamin A nutritional status.

# IV. GARDEN NUTRIENT YIELDS

The data on garden nutrient yields must be reviewed from the perspective of gardens in development, not simply gardens as production units. A finding reiterated in most garden project literature is the importance of local sustainability as reflected in community participation, appropriateness of technologies, and resource requirements of gardens (Brownrigg 1985; Cleveland and Soleri 1987; Cleveland and Soleri 1991; Sommers 1984). Taking sustainability into account tends to divide the literature on nutrient yields into two categories: model/maximizing gardens and indigenous gardens. Within these categories nutrient yield from gardens is often affected by crops and crop varieties, seasonality, and production techniques.

## IV.1 Model/Maximizing Gardens

Model, or maximizing, gardens are designed to produce the most of a nutrient or nutrients. Published studies of these gardens demonstrate the capacity for nutrient production, but often do not consider sustainability, especially in a developing country context.

Several studies (AVRDC 1988; Gershon 1985; Kailasapathy 1988; Yang 1981) demonstrate that, in theory, there is no impediment to producing large amounts of nutrients including provitamin A from small gardens. For example, the home gardens designed by the AVRDC were reported to produce between 82 and 125% of the vitamin A RDAs for a family of five from a 13.5-square-meter growing area (AVRDC 1988:10,37).

Some model gardens have been designed for institutional settings such as schools or clinics (Kailasapathy 1988). These gardens are often in situ sources of supplements for target populations who are not necessarily growing the gardens themselves. However, distinguishing between gardens for institutions or for households is important if the gardens are meant to serve as resources for encouraging households to garden. This was recognized in the Ilesha project in Nigeria where the demonstration garden at the project health center was "deliberately scaled to the size of typical home gardens, so that mothers would not be overwhelmed by a large 'institutional' garden. It was a demonstration garden where the women could learn a model they could easily replicate" (Brownrigg 1985:74).

## IV.2 Indigenous Gardens

Research on nutrient production from indigenous, nonproject gardens is extremely limited. Those few studies that do exist show that even without an intentional focus on provitamin A-rich plants, gardens in both industrialized and developing countries can produce significant quantities of vitamin A, as well as other nutrients. For example, in Poland, pensioned households produced 21-34% of their vitamin A RDAs in household gardens (Kleer and Wos 1988). In Newfoundland, gardens provided gardeners with 42% of their vitamin A RDAs (Omohundro 1985). In rural Java, vitamin A deficiencies were found to be less common among low-income households because their diets were significantly supplemented by garden-grown dark green leafy vegetables (Stoler 1978, 1979).

The findings discussed in the previous sections show that gardens have the potential to provide a significant amount of foods that can improve vitamin A nutritional status. In the next section the actual impact of gardens is discussed.

# V. THE IMPACT OF GARDENS

Gardens can affect household nutritional status directly through consumption of garden produce, or indirectly through increased income or savings from marketing garden produce. A review of the sociocultural determinants of the intra- and interhousehold distribution of resources, including produce and income from gardens, while beyond the scope of this paper, is extremely important when considering the impact of gardens.

Attention to intrahousehold distribution of benefits from gardens and other development projects includes looking at their effect on women. Brownrigg (1985:115-119) believes that gardening should not be considered a women's issue, because this draws attention away from women's important role in staple crop production, and because in many communities gardening is not associated with women. However, in many communities gardening is a woman's activity, and can make important contributions to her income, nutrition, and social status (Brun, et al. 1989; Immink, et al. 1981; Kumar 1978). Several authors make the point that it is important to guard or encourage women's access to the productive resources needed for gardening, and their control over garden production (Duggan 1985; Milimo 1985; Nath 1985). For example, Eskilinen (1977:45-48) believes that income from selling garden produce gives the Dogon gardeners (all men) in the communities she surveyed access to fruits, vegetables, and animal products, which are not a part of the staple diet. For this reason she advocates allocation of gardening land and water resources to women to improve their nutritional status and that of their children.

## V.1 Consumption

Several studies have found a positive correlation between indigenous, nonproject gardens and consumption of garden foods providing significant amounts of vitamin A RDAs (Bye 1981; Ensing and Sangers 1986; Immink, et al. 1981; Kumar 1978; Stoler 1978, 1979). Other research has found that these gardens improved household nutrition but there is no specific reference to vitamin A in the published reports (Bindon 1986; Dewey 1981; Ohtsuka, et al. 1985; Shack 1988; Shack, et al. 1990; Stone, et al. 1987; Tricaud 1987; Vasey 1982).

A study in Bangladesh found a lack of vitamin A deficiencies among children in households with indigenous gardens compared with children from nongardening households (Cohen, et al. 1985). However, the study did not clarify whether this relationship is a consequence of the gardens themselves or whether the gardens represent the households' socioeconomic level, which in turn affects children's nutritional status. More attention to the gardens themselves would help determine if they are strategies beyond the reach of the poor or not and would thus shed light on the meaning of the relationship that Cohen and his colleagues found between gardens and symptoms of vitamin A deficiency.

Studies done in Indonesia suggest that provitamin A production and consumption do not necessarily rise with increasing economic status (Abdoellah and Marten 1986; Stoler 1978, 1979). These researchers found that there appears to be more vitamin A deficiency among the middle as compared to the lowest (poorest) economic class. They suggest that this is due to the fact that the poor lack sufficient staple food (rice) and thus have a greater reliance on DGLVs from their gardens to supplement their diets.

Project gardens have also been reported to have a positive effect on vitamin A nutritional status of gardening households (Indirabai 1986; Latham and Solon 1986; Patil 1987; Solon, et al. 1979). The well-documented Cebu City project in the Philippines found that a horticulture and public health intervention provided a significant increase in serum vitamin A levels among the most deficient children participating in the study (Solon, et al. 1979) and provided other nutritional benefits that supplementation and fortification interventions did not. However, supplementation and fortification were less expensive and their coverage more comprehensive (see section II.4). Even so, the study's authors suggest that an evaluation based on less than two years of intervention is insufficient to determine the efficacy of gardens, and they support the continued promotion of gardens, even when other interventions are also being used. Studies of garden projects such as this one do not address the extent of indigenous gardening existing independently of the project or the kinds of gardens being promoted, both of which have a great influence on the cost and sustainability of the intervention strategy. In addition, the total infrastructural and social costs of fortification and distribution may be underestimated.

Consumption of garden produce is affected by cultural preferences and rules about food that influence the diet created from available foods. In parts of Asia, for example, DGLVs are considered taboo for small children, or said to be distasteful to them (Cohen, et al. 1985; Shreshtha, et al. 1989). Therefore, even though provitamin A-rich foods are abundant, they are not consumed by those who may need them, due to dietary practices.

### V.2 Savings and Income

In addition to having a direct impact on improved nutritional status through consumption of produce, gardens can also affect nutritional status indirectly by saving money otherwise spent on food, and by providing household income through the sale of garden produce.

Consumption of garden produce constitutes savings for the household which would have to either purchase those foods or forego the nutrients that they offer. For poor households, even small savings are important. In southern Mexico, Dewey (1981) found that fruits and vegetables produced in household gardens for home consumption would not have otherwise been available to household members because of the expense of those foods. In many urban areas household gardens for home consumption appear to be a response to inadequate incomes for meeting food needs (Gutman 1987; Ninez 1985; Sanyal 1986; Tricaud 1987). Over a five-month growing season, gardens in Lima, Peru, produced an average savings of 4% of the gardener's annual earnings (calculated from Ninez 1985). Savings from garden production have also been found to be important in industrialized countries (e.g., Crouch and Ward 1988; Gladwin and Butler 1984).

If the money from the sale of garden produce is spent on nutritious food or medical care for those in the household most in need, nutritional status can be improved. However, investment of garden income in food or health care does not necessarily occur, as was the case in a garden project in Senegal (Brun, et al. 1989). As with the effects of gardens through consumption, little strong evidence exists for the indirect effects of garden income or savings on nutrition. The income or savings produced by gardens may also be invested in goods or activities that enhance social status, for example, of women, as occurred in Senegal (Brun, et al. 1989). This enhanced status may provide greater decision-making power and access to improved support services, which can also contribute to better health and well-being.

### V.3 Factors Affecting Successful Impact of Gardens

From the previous discussion, it is apparent that a number of factors may influence the impact that gardening can have on the nutritional status of households once an area has been targeted as vitamin A deficient. These factors can be separated into those related to production and those related to consumption. All of these should be investigated thoroughly in feasibility studies prior to intervention to provide input into project design and selection of appropriate evaluation criteria.

Production factors that may influence the adoption of garden interventions include access to water, access to land, access to inputs such as seeds and tools, household experience with gardens, access to labor, and access to extension information. Garden interventions are not likely to succeed if access to water and land are major constraints. The availability of these resources may determine whether the intervention should be oriented toward the community or individual households. Furthermore, access to inputs and extension may determine whether indigenous crops are emphasized exclusively, rather than introduced crops. In situations where communities experience seasonal labor bottlenecks, interventions may be designed to promote gardening during slack periods.

Consumption factors that may influence the nutritional impact of gardens include the prevalence of PEM, beliefs regarding weaning practice and taste preferences, intrahousehold distribution, processing, storage and preparation techniques, the seasonality of foods consumed, and use of wild foods.

As stated previously, in communities where PEM is prevalent, gardens designed to enhance vitamin A status may show little impact. This may call for a change in focus such that gardens are designed to contribute to overall improvement in nutritional status. Cultural beliefs will influence the selection of provitamin A-rich foods that are acceptable for weaning foods and local dishes, as well as the distribution of these foods within the households. The nutritional impact of gardens will also be strongly influenced by processing, storage, and cooking techniques. Inappropriate drying and cooking techniques can result in significant losses in carotenoids. Thus a good nutritional education component should accompany garden interventions to ensure that the gains in vitamin A access obtained through gardens are not lost through postharvest activities. If access to provitamin A-rich foods is seasonal, then gardens should be targeted to seasonal gaps to derive maximum benefits. Finally, in communities where wild foods are an important source of provitamin A, care must be taken not to displace these food sources through garden interventions or other development activities. The complementarity of wild foods and garden vegetables should be stressed through nutrition education programs introduced in conjunction with garden interventions.

# VI. RECOMMENDATIONS

The following recommendations are based on the findings of this review of the literature. The recommendations are organized under the following categories: Targeting, Garden Project Design, Improving Garden Impact, and Evaluation.

## VI.1 Targeting

Targeting recommendations include the selection of indicators used for identifying target populations for interventions to improve vitamin A nutritional status; feasibility studies to determine the viability of promoting indigenous gardens given agroecological and cultural settings; assessments to determine potential for garden production to have a nutritional impact; and identification of garden participants.

### VI.1a Indicators of Vitamin A Deficiency

Secondary sources such as WHO and UNICEF should be used in the first step for identifying target regions with vitamin A deficiency. Once a region is identified, indirect indicators such as production of provitamin A-rich foods and consumption patterns can be assessed through informal and formal interviews within communities to determine the nature of the problem and the potential for garden interventions. Because direct indicators such as biochemical indicators (serum retinol), morphological abnormalities, and clinical eye manifestations (e.g., xerophthalmia) are expensive to collect, require large sample populations, and call for technical support that often is not available, the use of indirect indicators should be considered first.

### VI.1b Feasibility Studies for Determining the Viability of Gardens

Feasibility studies should be conducted prior to the implementation of garden interventions to: 1) determine whether garden interventions are likely to succeed given current production and consumption practices; 2) provide input into project design; and 3) select appropriate evaluation criteria. These studies should consider both production and consumption factors that may influence the potential impact of gardens. For example, garden interventions are not likely to succeed if access to water and land are major constraints, or if purchased inputs which are beyond the means of target households are promoted. In addition, consumption patterns may restrict the varieties of provitamin A-rich foods that can be promoted through gardens.

### VI.1c Assessments of Nutritional Impact of Proposed Garden Interventions

Assessments should be made of the potential impact gardens can have on household nutrition given overall consumption patterns. This can be done in conjunction with the feasibility study or as a separate assessment. In communities where protein energy malnutrition is acute, garden nutritional impacts may not offset the overall problem. These assessments will help to determine the appropriate design of the intervention as well as the criteria for evaluation. For example, gardens designed to address seasonal shortages may be different from those intended to provide year-round supplements to existing diets.

### VI.1d Selection of Garden Participants

Garden projects should encourage the involvement of women to ensure their access to garden foods and/or control over garden income. This may increase the likelihood that the groups in the community most vulnerable to vitamin A deficiency (infants, children, and women of reproductive age) benefit from garden interventions.

## VI.2 Garden Project Design

Garden project design recommendations include enlisting local participation in, and control of, interventions, pursuing appropriate strategies for rural and urban settings, and promoting indigenous sources of vitamin A.

### VI.2a Local Participation and Control

Local participation in, and control of, garden projects is essential for making gardens relevant to people's needs and for long-term sustainability. Assessment, planning, implementation, and evaluation should be a cooperative venture between local people and project workers who act as consultants. A two-way communication system can be established where policy-makers and project workers become educated about indigenous knowledge and practices, and local people become educated about outside information and points of view relevant to gardens and nutrition.

### VI.2b Design Strategies for Rural and Urban Settings

Gardens are important economic and nutritional strategies for poor households in both rural and urban areas. In rural areas, gardens are often an important part of indigenous agricultural systems, and project design should build upon these local systems. In urban areas, gardens are still very much a part of the long-term strategy of the urban poor, even though government authorities may deny their importance. Policy-makers need to: 1) be made aware of the importance of urban gardens; 2) support local NGOs in their efforts to provide urban gardeners better access to land, water, and other productive resources; 3) test soil and water for contaminants in areas where gardens are planted; 4) identify and promote crops and crop practices that diminish uptake of toxins; and 5) establish community- based extension services for urban households that include a strong nutrition-education component.

### VI.2c Promoting Indigenous Sources of Vitamin A

Many indigenous food crops and wild plants are rich sources of provitamin A and have traditionally supplied that nutrient in local diets. These indigenous plants are adapted to the local environment and require a minimum of inputs and management for production. In many areas, indigenous plant foods are being lost from the diet and/or are being replaced by introduced crops that have lower provitamin A content. In some cases, newly introduced crops may have higher social status but not necessarily higher nutritional value than indigenous plant foods.

A number of steps can be taken to encourage the promotion of indigenous sources of vitamin A in garden interventions. First, policy-makers and project and extension workers can be educated in the value of indigenous plant foods as part of garden project activities. Second, a bibliography and reference center of documents describing indigenous sources of provitamin A in vitamin A-deficient countries should be created as a resource for project and government workers. Documentation should be collected from organizations already involved in research on wild and domesticated indigenous food plants (e.g., FAO; National Bureau of Plant Genetic Resources, New Delhi; Jardin Botanico, UNAM, Mexico City; Institute for Natural Resources, Africa). Third, garden projects should cooperate with community-based agroforestry and environmental programs to try to protect habitats of wild, provitamin A-rich foods. Fourth, nutrition education can emphasize the complementarity of indigenous, provitamin A-rich foods, and newly introduced provitamin A-rich foods.

## VI.3 Improving Garden Impact

Recommendations dealing with garden impact include nutrition education programs oriented toward processing, storage, and cooking techniques to reduce losses of provitamin A; promotion of foods that contribute fat and protein to the diet in conjunction with provitamin A-rich foods; selection of provitamin A-rich foods that conform to cultural norms; and promotion of a diversity of sources of provitamin A-rich foods that are both locally marketed and locally consumed.

### VI.3a Nutrition Education Programs Oriented Toward Processing, Storage, and Cooking Techniques

Some indigenous processing, storage, and cooking methods may destroy a large proportion of the provitamin A content of foods. For example, high heat and/or exposure to sunlight can destroy provitamin A. However, simple measures that reduce oxidation of nutrients through shortened cooking time, lower temperatures, and shade drying can reduce losses significantly. Nutrition education components should be included in garden projects to promote appropriate postharvest techniques that ensure provitamin A retention in foods. These techniques should build upon indigenous practices as much as possible.

### VI.3b Promotion of Foods that Contribute Fat, Energy, and Protein in Conjunction with Provitamin A-Rich Foods

Severe PEM can impair provitamin A absorption and metabolism. In addition, the lack of dietary fat consumed with provitamin A-rich foods tends to decrease the absorption of provitamin A. In communities where such conditions exist, garden interventions should encourage the production and consumption of food sources that contribute fat, energy, and protein to the diet (e.g., nuts, seeds, beans, dried leaves), especially for weaning infants and young children.

### VI.3c Selection of Provitamin A-Rich Foods that Conform to Cultural Norms

Food taboos and dietary habits should be carefully considered when deciding which provitamin A-rich foods to promote in garden interventions. Indigenous sources of provitamin A-rich foods that are already acceptable should be promoted first.

### VI.3d Promotion of a Diversity of Sources of Provitamin A-Rich Foods

Many households in developing countries plant gardens to increase their income for purchase of food and other items not locally available, and for savings. As marketing of produce increases, consumption of garden crops may decrease, adversely affecting nutritional status. To ensure that sources of provitamin A-rich foods are available to these households, a diversity of crops should be encouraged such that some are marketed and some are grown primarily for subsistence. Garden diversity also reduces economic risk for gardeners.

## VI.4 Evaluation

Evaluation of indigenous gardens and current garden projects is necessary in order to judge if and how gardens are to play a greater role in interventions to improve vitamin A nutritional status. Evaluation recommendations include establishment of realistic evaluation criteria that are based on feasibility studies prior to garden interventions; reliance on indirect indicators as much as possible for impact assessments to be cost effective and relevant to the local community in which the project took place; and involvement of the local community in designing and carrying out the evaluation.

### VI.4a Establishment of Realistic Evaluation Criteria Based on Feasibility Studies

Feasibility studies consider the production and consumption factors that may influence the potential impact of gardens. Taking these factors into account, evaluation criteria should be adjusted to realistically assess the impact of garden interventions. For example, garden interventions should be evaluated differently in communities with limited experience with gardens than in communities with extensive experience. Likewise, garden nutritional impact should be evaluated in terms of the extent of PEM that existed in communities prior to the interventions.

### VI.4b Reliance on Indirect Indicators of Vitamin A Deficiency for Impact Assessment

Indirect indicators of vitamin A deficiency, such as production of provitamin A-rich foods and consumption patterns, are much less expensive to measure and require a smaller sample size than assessment of direct indicators. In addition, indirect indicators may be more relevant to the community in which the project intervention took place. Given that there is usually a limited technical support staff available in developing countries to accurately assess direct indicators, indirect indicators should be relied upon as much as possible.

### VI.4c Local Community Involvement in Evaluation

The local community should be involved in designing and carrying out the evaluation of garden interventions. Evaluation criteria judged relevant by the community will form the basis of future decisions by community members for adopting proposed interventions. Such criteria can be elicited in the feasibility studies prior to project implementation.

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