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The World Vegetable Center



The World Vegetable Center's Approach to Household Gardening for Nutrition

June 2016

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The World Vegetable Center is an international nonprofit research institute committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of safe vegetables.

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World Vegetable Center
P.O. Box 42
Shanhua, Tainan 74199
TAIWAN

Tel: +886 6 583 7801

Fax: +886 6 583 0009

Email: info@worldveg.org

Web: avrdc.org

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CONTRIBUTORS

This document was written by Pepijn Schreinemachers with contributions from Victor Afari-Sefa, Fenton Beed, Thomas Dubois, Warwick Easdown, Shrinivas Gautam, Peter Hanson, Li-Ju Lin, Greg Luther, Ramakrishnan Madhavan Nair, Maureen Mecozzi, Sanjeet Kumar, Annelie Öberg, Ralph Roothaert, Svein Solberg, Tsvetelina Stoilova, Abdou Tenkouano, Ray-Yu Yang and Marco Wopereis.

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FOREWORD

The World Vegetable Center is committed to alleviating poverty and malnutrition in the developing world through the increased production and consumption of nutritious and health-promoting vegetables. Household gardening is an age-old practice to supply a diverse range of fruit and vegetables to the home, but its potential has yet to be fully exploited.

Targeted interventions to optimize household garden production and consumption practices show great potential to reduce malnutrition. The World Vegetable Center has been involved in household gardening since the 1970s and has accrued a wealth of practical experience from various locations, crops, production systems and target groups.

The approach presented in this document is based on our experience and available evidence. It defines the World Vegetable Center's approach to household gardening, emphasizing three synergistic components of gardening, nutrition and health, and support systems. The document will be an important means of communicating our approach to partners, donors, and collaborators, and it will also facilitate learning as an organization. In that sense, I expect the document to be updated periodically to reflect new experiences and incorporate new evidence of what works, and what doesn't.

This strategy is timely as the international research and development community increasingly recognizes the potential of household gardens to reduce malnutrition in low income countries. There are important gaps in our knowledge about the optimal design of household garden interventions and I therefore hope our approach will advance research and development into this important domain.

Marco Wopereis
Director General
World Vegetable Center

List of acronyms

DALYs	Disability adjusted life years
KGVK	Krishi Gram Vikas Kendra (an NGO in India)
NGO	Nongovernmental organization
SDGs	Sustainable Development Goals
ToT	Training of trainers
WASH	Water, sanitation, hygiene and health



1. INTRODUCTION

Household gardening is the mixed cropping of fruit, vegetables, herbs, spices and other useful plants as a supplementary source of food and income (Midmore *et al.* 1991). It is an age-old practice that is common to rich and poor countries alike. The word 'garden' connotes that the primary purpose is own household food production rather than selling (as opposed to 'fields'), though any surplus can be shared with neighbors or sometimes sold. The garden has a functional relationship to the homestead but also can be located alongside fields, rail tracks, streams, or rivers; hence 'household' rather than 'home' gardens.

For poor people, household garden produce can make a critical

contribution to the household diet and provide several other benefits, particularly for women, but this role is mostly ignored in agricultural research and extension, which tends to focus on field-based commercial food production. This is slowly changing as questions increasingly are being raised about agriculture's contribution to nutrition and health. The relationship between increased food production and better nutrition and health of producing households is less straightforward than often assumed (Turner *et al.* 2013; Webb and Kennedy 2014). For instance, income from the sale of crops often is not used to buy quality food for the household. This has led to a renewed interest in household gardens because they show a more straightforward

pathway from food production to nutritional outcomes, although there is a need for better evidence (Ruel and Alderman 2013; DFID 2014). Most importantly, household gardens contribute to at least eight of the Sustainable Development Goals of the United Nations (see Table 1).

The World Vegetable Center has worked on household gardening since the 1970s (Gershon *et al.* 1988; Midmore *et al.* 1991; Chadha and Oluoch 2003; Keatinge *et al.* 2012; Schreinemachers *et al.* 2015). The Center's research shows that a small garden, if managed well, can produce enough vegetables, and the micronutrients (vitamins and minerals) contained therein, to nourish a family of four year-round (Chadha and Oluoch 2007; Chadha *et al.* 2011).¹ However, the productivity of most existing household gardens is low because of poor soil quality, limited water availability, low quality seed, crop pests and diseases, poor crop management and the destruction of crops by livestock. The experience of the World Vegetable Center shows capacity building and targeted support can address many of these production constraints, but parallel capacity building in nutrition and

health is critical to ensure nutritional impact.

The purpose of this document is to articulate the World Vegetable Center's approach to household gardening based on experience and published evidence of what works. It covers all relevant aspects including intervention design, impact evaluation and the approach to form partnerships to deploy household gardens at scale. It also defines the role of the World Vegetable Center as a research organization in this area and lists the relevant research questions that need to be addressed.



Low dietary diversity is a problem in many low income countries.

¹ Earlier research by the World Vegetable Center focused on a 6 x 6 meter garden design, but the current understanding is that the size of the garden should be adjusted according to household needs, available resources, location and climate. Year-round production is not always possible, especially in dry areas.

Table 1 The contribution of household gardening to the Sustainable Development Goals

SDG	Goal	Household gardens...
1	End poverty in all its forms everywhere	...generate small but significant streams of income, especially for women.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	...supply nutritive food and make food production systems more productive and resilient.
3	Ensure healthy lives and promote well-being for all at all ages	...improve the health of women of reproductive age and young children.
5	Achieve gender equality and empower all women and girls	...give women more choice and control over productive resources.
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all	...spur entrepreneurship, creativity and economic opportunities, particularly for women.
11	Make cities and human settlements inclusive, safe, resilient and sustainable	...contribute to greening of rural and urban settlements and greater resilience to disasters.
12	Ensure sustainable consumption and production patterns	...have minimal food losses and help to close nutrient cycles.
13	Take urgent action to combat climate change and its impacts	...strengthen household-level resilience and adaptive capacity to climate-related hazards and natural disasters.



2. THE HOUSEHOLD GARDEN APPROACH OF THE WORLD VEGETABLE CENTER

2.1 Objectives

The World Vegetable Center's household garden intervention aims to improve the nutritional status of people vulnerable to micronutrient malnutrition by increasing the year-round supply of a diverse range of fruit and vegetables from a household-managed garden linked to complementary training in nutrition and health and to necessary support systems.² The Center's household garden intervention has three components:

²In botany, fruit refers to the seed-bearing part of a pollinating plant. Here we distinguish fruit from vegetables based on cultural practices.

Garden production: (a) A diverse range of nutrient-dense fruit and vegetable species, combining traditional and improved varieties, suited to prevailing environmental conditions; (b) garden management based on good agricultural practices to overcome production constraints.

Nutrition and health: (a) Knowledge about the importance of fruit and vegetables for nutrition and health and knowledge about good food practices that enhance the preservation, uptake and utilization of micronutrients; (b) awareness raising about the importance of clean water, sanitation and hygiene for health and alignment of the household garden

intervention with existing programs in this area.

Support systems: (a) Supply of high quality seed by commercial seed suppliers or community-based seed systems; (b) support from community-based groups, such as women's groups, or their establishment where they are absent.

2.2 Targeting

The household garden intervention targets locations where the prevalence of micronutrient malnutrition is high because that is where the potential for impact is the greatest. These locations can be identified from government statistics and data from Demographic and Health Surveys (DHS). Other proxy variables may be useful. For instance, it has been shown that households further away from a market (where food can be sold or bought) have lower dietary diversity (Sibhatu *et al.* 2015), which is in turn associated with lower nutritional status (Arimond and Ruel 2004; Arimond *et al.* 2010). Poorly diversified production systems, both market- and subsistence-oriented, are also negatively associated with dietary diversity (Jones *et al.* 2014; Jones 2015; Sibhatu *et al.* 2015).

Further criteria can be applied to target households within such high-prevalence locations:

- The potential impact is the largest if targeting households with a woman of reproductive age and young children, particularly under 5 years of age, because they are the most vulnerable micronutrient malnutrition (West 2002; Black *et al.* 2008).
- Households owning few durable assets (e.g. land, livestock) can be targeted since low wealth status is strongly associated with child undernutrition (Hong *et al.* 2006; Hong and Mishra 2006).
- The availability of a minimum space for a household garden has been used in some of the Center's projects, though vertical and space-saving gardening techniques can be utilized to grow fruits and vegetables in small spaces.

Within households, the intervention should first and foremost target women in charge of meal preparation, as they usually decide what household members consume and are most likely to be in charge of the household garden. Sensitization of other household members about the potential benefits of household gardening helps to broaden the support base. For instance, men and grandparents may be influence household food decisions and behavioral change communication may need to target them.

2.3 Theory of change

Women of the selected households receive hands-on training in gardening linked to complementary training in nutrition and health. Concurrently, the supply of high quality seed is arranged, by working with private seed companies or by training people in the communities to save their own seed.

According to the theory of change of the intervention (Figure 1), the trained women will have gained knowledge about gardening and a better understanding of how the household garden can improve family nutrition and health. This, together with a one-time supply of minimally required inputs, is expected to motivate the women to establish and maintain their own household gardens. Implementing partners regularly visit the women to re-emphasize the message and provide technical advice.

A well-planned and well-managed garden is expected to supply the household with a diverse range and year-round harvest of fruits and vegetables. Participative selection of crops by local communities in combination with nutrition and health training should give an incentive to consume rather than sell the garden produce. Sales from the household garden could potentially contribute to sustaining the garden as revenues can motivate people to venture into

gardening and may be used to buy inputs. The cash earned could also contribute to nutritional outcomes if it is used to buy meat, dairy or other nutritive foods. However, there is a lack of evidence for such causal relationships. Nevertheless, nutrition rather than income is the main objective of a household garden intervention.

Trained women will have gained knowledge about gardening and a better understanding of how the household garden can improve family nutrition and health.

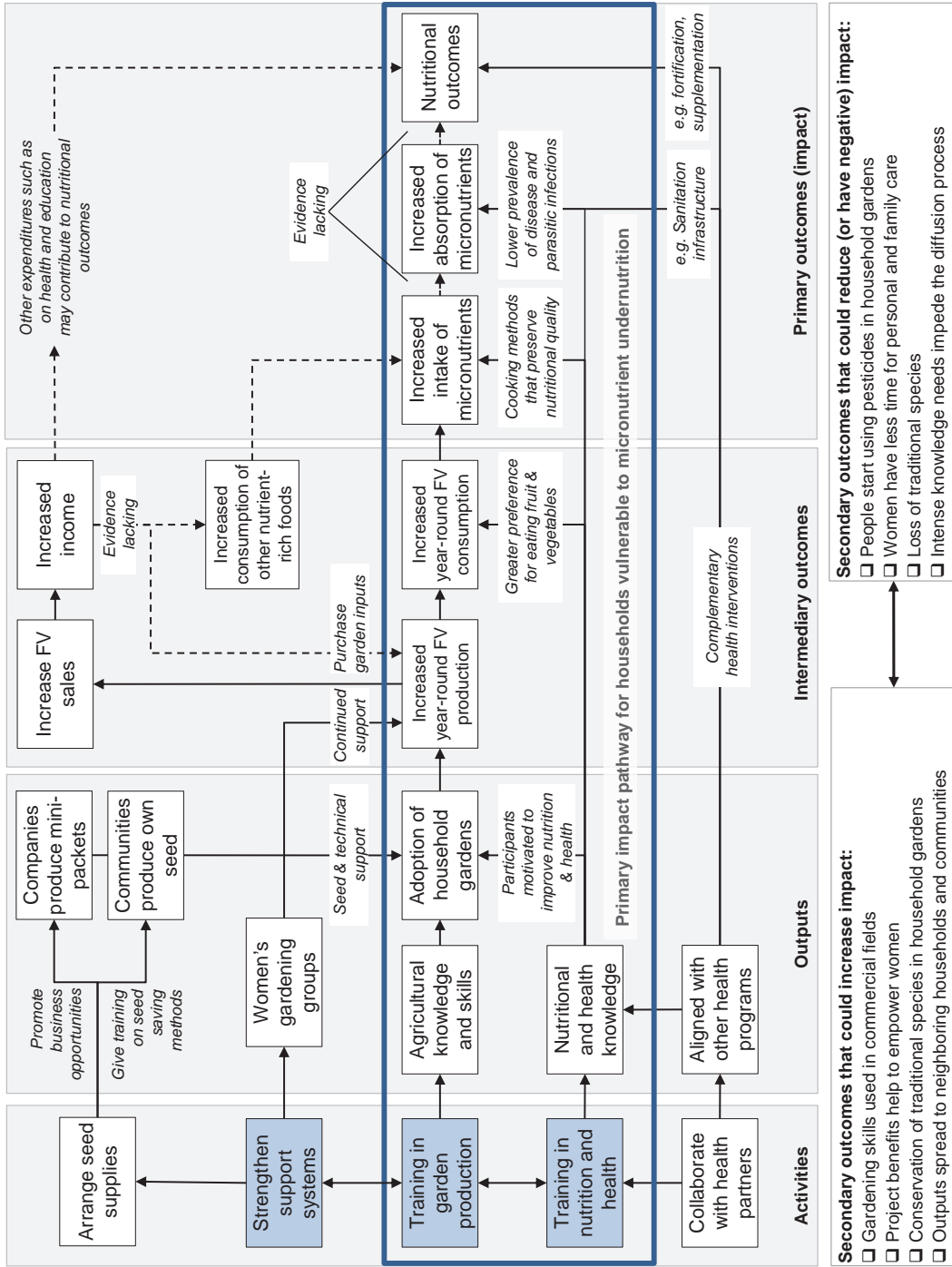


Figure 1 Theory of change of the World Vegetable Center household garden intervention and vegetables

2.4 Knowledge gaps

The theory of change identifies some of the key knowledge gaps surrounding household garden interventions.

Nutritional outcomes: Do household garden interventions improve the nutritional status of those household members most vulnerable to micronutrient deficiencies?

Maintaining agro-biodiversity: Household gardens are often a hotspot of agro-biodiversity (Watson and Eyzaguirre 2002; Alam and Masum 2005; Galluzzi *et al.* 2010). The introduction of improved varieties has the potential to replace traditional varieties and narrow genetic diversity. What is the impact of household garden interventions on local agro-biodiversity and what intervention design can help to safeguard it?

Sale of garden produce: It is unclear if, and under what conditions, the sale of household garden produce contributes to nutritional outcomes or to the sustainability of the household garden. Is there a trade-off, or is it a win-win?

Reliable seed systems: What are the most reliable seed supply systems for household gardens if private seed supplies are unavailable? (see Section 5.1)

Scaling approaches: What are the most effective and efficient models for scaling household garden interventions leading to sustainable impact? (see Section 7.2)

Sustainable pest management: What pest management methods are the most suitable for household gardens in low income countries and how can the use of chemical pesticides be avoided?

Promoting consumption: What methods are the most effective at promoting increased consumption of fruits and vegetables among young children and women of reproductive age?

2.5 User needs and interests

The household garden intervention must build on the development needs articulated by the target population. Communication is important to identify these. This is best done through informal consultations and observation rather than a questionnaire survey. The purpose is to understand vegetable growing practices, gender preferences and types of vegetables for home consumption and selling, current resource constraints and knowledge gaps in garden management, nutrition and health. Examples of such information gathering include:

- Visit existing gardens and talk with their caretakers about the

challenges they encountered and the solutions they tried.

- Talk to women in charge of meal preparation about what fruit and vegetables household members like to eat, where the produce is obtained, how it is prepared, and what they know about the nutritive value of the produce.
- Talk to farmers and agricultural extension workers about which vegetable seeds are locally available and the quality of these.
- Observe methods of sewage disposal and from what source water for household use and irrigation is supplied to the household.
- Talk to school teachers and local health workers about the main health problems in the village, the importance of micronutrient deficiencies, and the likely causes of it.

The project team then discusses with the community members how household gardens could address identified constraints and gaps, and the feasibility of implementation. Local government officers are involved to create awareness about the project, to give them a voice in the project design, and to raise their interest. This exercise is repeated in other communities until a consistent pattern of information emerges.





3. GARDEN PRODUCTION (COMPONENT I)

3.1 Selection of nutrient-dense fruit and vegetable species

Crop species for the garden must be selected through dialogue between project implementers, communities and other stakeholders. The following considerations are relevant:

Select fruits and vegetables containing nutrients that are in short supply, but also select a diverse range of fruits and vegetables, because all have different properties (Table A1, A2).

Select fruits and vegetables liked by the household members, particularly women and children.

Select crops that are hardy, easy to grow, adapted to the local climate

and soil, and tolerant to common pests and diseases. It usually makes sense to select different species for the dry and wet seasons, and to include some perennials.

Quality seed and/or seedlings of the selected crops must be locally available and accessible by the households (see Section 5.1 below).

Include improved varieties but also traditional varieties to maintain agro-biodiversity and cultural heritage.³

New nutritive crop species or varieties can be introduced and tested for acceptability, and this can create enthusiasm for gardening. For instance,

the World Vegetable Center introduced amaranth and vegetable soybean to household gardens in Thailand in the 1980s, which became well accepted (Munger 1988).

3.2 Good agricultural practices

Low productivity of existing gardens is often the result of poor management of soils, water and crops, and poorly performing varieties. The following list of topics for open-field vegetable gardens is to be covered in any household garden training (Villareal *et al.* 1993):

- **Garden location:** Selection of the best location for the household garden should consider easy access to water for irrigation, soil conditions, adequate sunlight and effect of shade, safety, and protection from animals and theft. The garden can be established on land owned by the household or on communal land allocated by a village chief or other local authority and managed by a community group.
- **Garden size:** The optimal size of a garden varies from household to household depending on the availability of space, water, and most importantly, labor. It is better to start small and expand later than to start big and then realize it is too much to handle. The used garden space can be variable, depending on available water.
- **Soil preparation:** The use of raised planting beds is advisable, particularly during the rainy season or in low-lying areas because it protects crops from waterlogging, reduces soil compaction, and makes weeding and other crop management practices easier. Mixing compost into these beds when they are first prepared is recommended. In dryland areas the use of planting pits (also known as zai holes) and grass mulches can improve water use efficiency.
- **Fencing:** Domestic animals—goats, chickens, and cows—wandering freely can trample plants and quickly destroy a garden. It is critical to establish barriers to keep them out.
- **Raising healthy seedlings:** Raising seedlings in nurseries before transplanting into the field reduces the amount of water needed in the first 3-4 weeks, makes observations and control of pests

³ Traditional crops are usually well-adapted to local conditions, well-liked by people, and may be highly nutritious. It is therefore important to maintain these in the garden and allocate space to them, even if these are not always the most productive. In some cases, plants are harvested by foraging in wild terrain, but they could be produced in greater quantity and quality by growing them in the garden.

and diseases easier, and allows for better use of garden space.

- **Soil fertility management:** Best results are obtained by combining organic and mineral fertilizers, with organic fertilizers building soil health and mineral fertilizers addressing lack of nutrients, such as nitrogen. Organic fertilizers can be made from farmyard manure and organic household waste, both of which need composting before they can be used in a garden. Vermicomposting (the use of worms for composting) is also recommended.
- **Seed saving and sowing:** Good quality seed is fundamental for a productive garden, as are the method and time of sowing. Seed saving can be practiced when quality seed cannot be bought (see Section 5.1). Staggered sowing and planting can spread maturation times.
- **Thinning, pruning, staking and trellising:** Thinning may be needed for all crops, but particularly for those that grow long shoots or vines such as tomatoes, cucurbits and beans. Staking and trellising enable plants to grow upwards, thereby optimizing garden space, improving yield quality, and making harvesting easier.
- **Irrigation and drainage:** The location and size of the household garden is largely determined by access to water during the dry season. Household wastewater can be reused in the garden if it does not contain sewage water or excessive amounts of detergents. Mulch can make water use more efficient by reducing evaporation from the soil.
- **Pest and disease management:** Gaining an understanding of what is causing pest or disease problems will often help in finding a solution. A basic understanding of insect pests and beneficial insects is required to make good production decisions. Chemical pesticides are not to be used in a household garden because the risk of pesticide residues to human health is too high, especially if the garden is located near the home. Instead, pests can be controlled by spraying a soap solution or botanical mixtures using neem, lemongrass, chili pepper or garlic. Some pests can be removed by hand. Rotation of crops reduces pathogens in the soil. Diseased plants need to be removed from the garden to prevent further spread. Mulching with straw or grass clippings can help suppress weeds, which compete with crops for essential nutrients and moisture.



Figure 2 Promotion for 5 color vegetables on a mini seed package produced by Lal Teer Seed Company Ltd. in Bangladesh.

4. NUTRITION AND HEALTH TRAINING (COMPONENT II)

4.1 Nutrition

A lack of essential vitamins and minerals (particularly vitamin A, zinc, iron, folic acid, and iodine) often goes unnoticed by people affected and is therefore called ‘hidden hunger’ (Ramakrishnan 2002). Improving human nutrition through gardening first requires people to become aware of the problem, its causes and consequences, and possible solutions. Raising nutritional awareness aims at enhancing understanding of:

- Macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins and minerals) metabolism, their food sources, functions, and related disorders (see Table A1).
- The importance of a balanced diet (dietary diversity), the nutritive value of different food groups (e.g. staples, legumes, fruit, vegetables, animal sources of food), and the association between fruit and vegetable colors and the nutrients they contain (**Figure 2**).
- Good food and nutrition practices, including tips for food storage and processing, food safety, and preserving the nutritive quality in meal preparations.
- Existing misconceptions and possible socio-cultural barriers to increased vegetable consumption

(e.g. superstitions, taboos) about food and nutrition need to be corrected at the same time. Nutritional awareness training should target women in charge of meal preparation, but must also include their husbands and grandmothers to have a major influence on the household's food behavior. After the training, household members should feel motivated to improve family health through household gardening.

4.2 Water, sanitation and hygiene

Healthy eating does not necessarily lead to healthy people in the presence of disease. For instance, diarrhea—a leading cause of death among children—prevents the body from absorbing water and nutrients. Poor sanitation practices such as open defecation can be an important cause of diarrhea. Other common diseases include those caused by parasitic infection (e.g. schistosomiasis, helminthic infection, malaria) and long-term exposure to chemical contaminants in water (e.g. pesticides, lead, arsenic). High disease prevalence can blunt the benefits of fruit and vegetable consumption. The household garden project must therefore work closely with local health workers, nongovernmental organizations (NGOs) and international partners to ensure these issues are concurrently addressed.

The household garden intervention must raise awareness about the importance of water, sanitation, hygiene and health (WASH) among participant women. This can provide a basic understanding of:

Parasitic infections that can be transmitted through contact with water or soil and vector-borne diseases.

The importance of washing fruits and vegetables with clean water to prevent infection.

The importance of sanitation (i.e. safe management and disposal of solid wastes, particularly human excreta, and wastewater in and around the community) and hygiene (e.g. washing hands and disposing safely of household wastewater).



5. SUPPORT SYSTEMS (COMPONENT III)

5.1 Quality seed supplies

A productive garden starts with the use of quality seed, seedlings, saplings or vines. Seed quality refers to a combination of seed purity, high germination, vigor, and absence of diseases. Quality seed is essential but in many locations it is either unavailable or prohibitively expensive. Own seed saving can be a solution but requires specific skills; community-based seed production can be more sustainable.

In some countries private seed companies are not aware of the business opportunity in seed mini-packets and prefer to sell seed in larger packs to large- and medium-scale farmers. Demand for mini-

packets can be low because smallholder farmers and gardeners might not be aware of the benefits of using quality seed. The project can give a seed company a guaranteed demand for mini-packets to reduce initial risk while promoting their use in the project villages. Experience from Bangladesh shows that the supply of mini-packets can be a real business opportunity; for instance, Lal Teer Seed Ltd. sold 1.3 million mini-packets in the second year after the company introduced them (Katalyst 2015; see also Figure 2). Where quality seed is only available in large packs, a local association or women's group can collectively buy seed and distribute it to its members. One World Vegetable

Center household garden project in East Africa developed four alternative models of seed supplies for household gardeners as shown in Table 2. The project realized that these models can be combined to supply seed of different vegetables.

Still, household- or community-based seed saving must be considered, particularly to supply seed of traditional vegetables where these are not commercially available. Seed saving involves selecting suitable, healthy plants from which to save seeds, harvesting the fruits or pods at the right time, extracting, cleaning and drying the seed, and packaging and storing it under proper conditions (Sukprakarn *et al.* 2005).

BOX 1: SEED MINI-PACKETS IN INDIA







NGOs working with target communities can be encouraged to see the potential for a sustainable business in producing home garden seed packs where seed companies are reluctant to make the investment.

Through a guaranteed buy-back program in case sales failed, the NGO Krishi Gram Vikas Kendra (KGVK) working with tribal communities in Jharkhand in northeast India was encouraged by the World Vegetable Center to produce a wall poster containing 20 small seed packs of different vegetables suitable for home gardens. In 2012 the initial production batch of 1500 packs quickly sold out. The following year sales increased to more than 5000 packs.



Recognizing the potential, two staff members left to set up their own businesses producing a variety of different packs. Within two years more than 80,000 households had been reached with the seed packs.

Table 2 Alternative models of vegetable seed supplies to household gardens used by a World Vegetable Center project in East Africa.

Model		Advantage	Disadvantage
<p>World Vegetable Center Seed: The Center produces the seed and distributes it to farmers through the implementing partners.</p>		<ul style="list-style-type: none"> • Straightforward and quick to implement • Predictable seed supply • Good and uniform seed quality 	<ul style="list-style-type: none"> • Limited capacity • High cost • Not sustainable (temporary solution)
<p>Quality Declared Seed System (QDS): Specialized and trained farmers receive government foundation seed, a government agency inspects and certifies the seed, farmers sell the seed to households within their own location ¹</p>		<ul style="list-style-type: none"> • Financially sustainable if seed producing farmers are able to make a profit 	<ul style="list-style-type: none"> • Difficult to coordinate • Requires intensive government cooperation • Does not ensure availability of all varieties in all locations in every season
<p>One Seed Company: A seed company contracts farmers to supply seed, produces seed kits and distributes them to households through agro-dealers.</p>		<ul style="list-style-type: none"> • Sustainable as long as contract farmers, the seed company and agro-dealers make profit 	<ul style="list-style-type: none"> • Does not ensure availability of all varieties in all locations
<p>Seed Company Alliance: As above, but several companies involved contributing different varieties.</p>		<ul style="list-style-type: none"> • Sustainable as long as all value chain actors are able to make a profit. • Greater diversity of species and varieties than supplied by a single seed company. 	<ul style="list-style-type: none"> • An alliance between companies might reduce competition and thus increase prices for farmers.

Note: 1 See Rajendran et al. (2016)

5.2 Community-based groups

Community groups, either existing ones or established as part of the intervention, allow participants to share ideas and experiences about the household garden, family health and nutrition, as well as other issues. Community groups can be critical for sustaining household gardens.

In certain settings, such as in South Asia, women's self-help groups make an important contribution to women empowerment by facilitating rural women to engage in social relationships outside their family (see Section 5.2). For Bangladesh, Patalagsa *et al.* (2015) found particularly positive effects of household gardens on women empowerment where women had formed a small group of fellow gardeners in their community.





6. WOMEN EMPOWERMENT

Women empowerment is an important objective in its own right as reflected in the Sustainable Development Goals (SDG5). Empowerment refers to a process of change by which people with a low ability to make choices acquire such ability (Kabeer 2005). Such choices can include where to live, who to marry, how many children to have and freedom of movement, association and expression. Women, and particularly women living in poor rural areas, are often denied many choices. For instance, rural women in Bangladesh usually cannot go to the market to buy or sell food or do paid work outside the homestead. In sub-Saharan Africa, men often dominate income generation from

cash crops such as coffee, sugarcane or cotton, but both men and women engage in vegetable production and women can earn income from selling vegetables.

Previous studies have shown that household gardening interventions can increase women's ability to make choices (Hallman *et al.* 2003; Hillenbrand 2010; Kumar and Quisumbing 2011). A gender analysis of the World Vegetable Center's household gardens in Bangladesh showed that women gained more control over what the household consumed, generated a small but for them valuable amount of cash income, and most importantly, gained respect and self-confidence by being

recognized for their agricultural skills (Patalagsa *et al.* 2015). Such changes were gradual rather than radical.

There are therefore good reasons for household garden interventions to actively promote women empowerment rather than assume that the mere targeting of women will help to empower them. Wherever possible, household garden interventions should not try to maintain the status quo at the expense of women when prevailing norms are discriminatory and resulting practices breach the constitutional rights of women in the target countries.

One subtle way of promoting women empowerment is the creation of women’s gardening groups. Where possible, women could sell some of their garden produce and control the cash. Careful consultation with both men and women is required to change adverse gender norms. Members of women-only groups can build confidence to become members of mixed groups where economic benefits are often greater due to better access to resources, networks and transport (Oxfam International 2013).





7. SUSTAINABILITY AND SCALING

7.1 Partnerships and long-term commitment

Improvements in home garden management can show quick results in increased garden production and consumption, but sustaining these improvements requires long-term changes in people's habits and beliefs that cannot be achieved overnight. Midmore *et al.* (1991) mentioned that lack of long-term commitment by development agencies and funding organizations is the single most important reason why some garden projects fail. Household garden projects do have the potential to have a sustained impact, if managed well. Kumar and Quisumbing (2011) evaluated the impact of an intervention supplying women with

improved varieties (from the World Vegetable Center) for small-scale vegetable production in Sauria district (near Dhaka, Bangladesh). Ten years after adoption, they found significant improvements in the nutritional status of women and children for early adopters of the varieties. Zimpita *et al.* (2015) also found sustained improvements in vegetable production and consumption 10 years after the completion of a home garden project in a rural village in South Africa.

Strong partnerships with local communities, organizations and private companies are important for

sustaining project benefits beyond the scope of a project, but also for scaling project benefits to a larger number of households (Figure 3). Partners can be separated into three groups:

Implementing/scaling partners: These are the local organizations that actually implement the project, which can be a NGO, government department or a private company.

Research partners: A local university, consultant or private company collaborating in the research design, data collection, analysis, and results writing—depending on capacity.

Enabling/supporting institutions: Government departments, seed companies, agro-dealers, community leaders, and nongovernmental organizations that provide important services to the project. The existence of supportive village headmen or local women’s groups might mean the difference between success and failure of the project.

It is important to identify capacity development needs for each partner at the start of the project. For instance, local seed producers might lack technical capacity or might not see the economic benefit of producing seed mini-packets, or local households might lack capacity in saving seed.

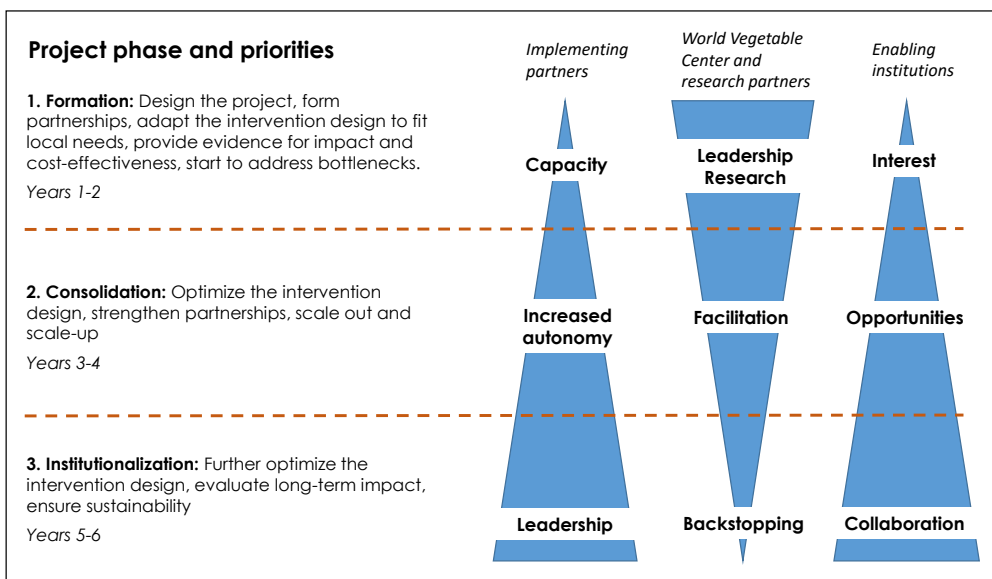


Figure 3 Three phases of a household garden project

Source: Adjusted from Bernet et al. 2006, p. 19.

As an international organization, the World Vegetable Center does not have a permanent role in a household garden project. The Center's role is to design and set up a project based on best-available evidence of what works, to initiate and initially lead local partnerships, to collaborate with local partners to adapt the intervention design to fit local preferences and needs, and to show robust evidence of project outcomes. Leadership is gradually transferred to the local implementing partners and the role of the World Vegetable Center changes to facilitation and backstopping.

7.2 Scaling approaches

Household garden projects have the potential to reach thousands of households as the cost of the intervention per household is relatively low. For instance, Schreinemachers *et al.* (2016) estimated that the average project cost per household garden was US\$ 11 for a World Vegetable Center project in Bangladesh. The Center's household garden projects often use a training of trainers (ToT) approach to strengthen capacity of implementing partners, who then in-turn train the end-users. However, a range of different scaling approaches has been used:

Hub-spokes model. An ongoing household garden project in East Africa divides each project village into informal groups of 20-30 households. The group members select one

person, who is respected, keen to adopt new practices, and willing to train others. This person receives training in seed management, nursery techniques, soil and water management, agronomy, nutrition, hygiene, food processing, marketing and seed production. The project then helps to establish a demonstration garden at a prominent location in the village. These gardens, referred to as 'hubs', provide a space for all households to learn about improved cultivation techniques and improved and traditional crop species and varieties, which they evaluate together. The village-based trainer also receives training on how to train other group members. The group members are encouraged to establish their own household gardens, referred to as 'spokes', and replicate the practices tried in the hub garden that are successful. All group members receive small seed packs of 6-7 vegetables in the first year as well as training in nutrition and health. The hub-spoke model creates a multiplier effect to reach many households. Through the group, households help each other to solve challenges they may encounter in their own garden.

Best practice hubs. In Liberia, an ongoing household garden project uses the best practice hub concept. These are demonstration and training sites managed by the project, which are linked to 5-10 nearby villages. About five lead persons from each

village are trained at the hub. The training covers gardening, nutrition and health. Each trainee is expected to train at least four other households in his or her village and is given five seed packs: one for him/herself and four to share with others.

Direct training of end-users. A household garden project in Bangladesh was implemented by two NGOs, BRAC and Proshika, both of which had existing capacity to implement household garden projects. Women selected for the project received a one-day intensive training on nutrition and garden establishment in groups of 10-15 women per session. The NGO staff visited the women 7-14 days after the training to provide assistance in setting up the garden and answer questions. Women received small seed packs of seven vegetables and vines of sweet potato after the planting beds were near completion. The NGO staff visited the women every week for the first six months of the training and every month for the subsequent six months. Frequent visits leading to high adoption rates were also experienced by a household garden project targeted at women affected by flood damage in the Indian state of Odisha: 90% adopted because of weekly visits by NGO staff who were well known to the community. However, adoption rates fell in the following year when there was less intensive follow-up.

Consideration of the local cultural context is important in the selection of the appropriate training and scaling approach. It is also important that training sessions targeted at women take place at a time that is convenient for them; if women must prepare meals for their household then they might be unable to participate in full-day training sessions. Sometimes a project needs to arrange someone to take care of the children in a separate room while the women participate in the household garden training.

Independent of the approach used, participatory, hands-on and discovery-based learning methods need to be applied since such methods are more effective than classroom-style lectures. This applies to the agriculture, nutrition and health aspects of the intervention, although it is recognized that lectures, talks or presentations are sometimes needed to deliver certain content. Another critical aspect is the need for regular support for households to implement the changes recommended. For instance, technical issues with garden management will need to be solved, and nutrition and health messages will need to be re-emphasized to affect people's beliefs and become part of their daily routine.



8. MONITORING & EVALUATION

8.1 Project monitoring & evaluation

Project monitoring is the day-to-day tracking and documenting of inputs, activities and outputs. It is done continuously throughout the lifecycle of a project to ensure that a project stays within its budget, that resources are spent prudently, to strengthen accountability, and to identify possible bottlenecks in the project implementation. As monitoring is done continuously, it needs to be implemented as a routine operation by project staff.

The World Vegetable Center uses an enterprise resource planning system to monitor project budgets. Using this system, project managers can

keep track of project expenses and assess whether project resources are being used as planned. Another internal system is “VegOne”, which is used to centrally record outputs such as training workshops and seed kit distribution.

In terms of output monitoring, it is critical to record basic biodata of all participants, including their full name and name of the household head, full address and phone number (if available), age, sex and marital status, and previous knowledge and experience in home gardening prior to project implementation, and to track changes during the project lifecycle. Data on the targeting criteria (see Section 2.2) are needed

to confirm that targeted households were reached.

One purpose of monitoring and evaluation is to make project implementation more effective and efficient. Regular face-to-face meetings of project implementers, project beneficiaries and other stakeholders are needed to reflect on experiences from different angles, share ideas and agree on a way forward. Regular consultations contribute to building trust between stakeholders. The meetings can address questions such as: (a) Is the project addressing the true needs of the target population? (b) What are the constraints in project implementation, and what can we do about these? (c) Who were the main beneficiaries and who in the target population was excluded? (d) Is the project on track in meeting its objectives? (e) Is it likely that project outcomes can be sustained after the project? (f) Under what conditions can project outcomes be replicated and scaled out?

8.2 Impact assessment

The impact assessment of a household garden intervention assesses changes in the well-being and nutritional outcomes of the target households that can be attributed to the intervention. The central question is how the outcomes would have changed if target households had not in fact received the intervention.

This requires a valid counterfactual of households that did not receive the intervention but are otherwise very similar to the group of households that did receive it.

A randomized controlled trial is the most robust method for doing this and household garden interventions are usually suitable for applying this method. A list of all villages in the target areas of the project is made and villages are randomly assigned to an intervention or a control group. Households in these villages are then screened for project eligibility (targeting) and all or a subset of eligible households is randomly selected to participate in the project. Randomization at the village rather than the household level is necessary to avoid spillover effects between households in the same village. The alternative is a non-randomized trial, which works the same as the above, except that villages are selected purposively rather than randomly. This method is less robust and results may not be representative for the larger target population.

Independent of the approach taken, quantitative data need to be collected before the intervention is implemented and again one or two years afterwards. Data collection methods must be the same and collection must be done in the same months of the year to control for seasonal variations.

A good impact evaluation should not only quantify impact, but also test the causal relationships in the theory of change. This is done by collecting primary as well as intermediary indicators. Questionnaire-based indicators for household garden interventions typically include:

Dietary diversity: a semi-quantitative measure of the frequency that certain categories of foods are consumed, which has been shown to correlate strongly with biochemical indicators of micronutrient status for adults and children (Arimond and Ruel 2004; Kennedy *et al.* 2007; Arimond *et al.* 2010; Kennedy *et al.* 2010).

Food consumption: a quantitative measure of food intake usually measured using a 24-hour recall period by interviewing the person in charge of meal preparation.

Fruit and vegetable production: the quantity of produce from the household garden in the last 7 days, 1 month, or even the last 12 months.

Income from selling garden produce: this can be captured by adding a question to the production section about how the produce was used (consumed, sold, shared with others).

Biochemical markers are powerful measures of nutritional outcomes and may include serum concentrations of hemoglobin (indicating iron status) and serum retinol (indicating vitamin

A status). However, given they are invasive methods, they must be used sparingly and implemented by qualified health partners. Non-invasive nutrition indicators can include anthropometric indicators as well as clinical signs, both of which must be collected by a trained medical professional. Calorimetric measures based on the skin color of the palm can assess beta-carotene intake but need calibration for each population group (Prince and Frisoli 1993; Stahl *et al.* 1998).

A detailed study protocol must be developed for each impact assessment. There is a standard World Vegetable Center template for this. Studies that involve human subjects may require ethical approval by national authorities, ethical committees of the participating research institutions, or donors.

Quantitative impact evaluation is important, but qualitative research can provide a more in-depth understanding of how the household intervention affects people's livelihoods and social change in the communities. It can complement a quantitative evaluation by identifying possible bottlenecks to impact or unintended outcomes.

8.3 Costs, benefits, and cost-effectiveness

Cost-benefit analysis involves a systematic accounting of project cost



and project benefits expressed in monetary terms. This can be valuable information to project donors as it can help justify their investment, for instance, to foreign taxpayers. The analysis is also relevant to policy-makers who need to decide whether to scale the project to reach a larger population.

Project costs need to include in-kind contributions by all partners and participant households (for instance, for the opportunity cost of the extra time spent on the household garden). The benefits of a household garden include revenues from the sale of fruit and vegetables as well as non-monetary benefits from increased consumption.

Cost-effectiveness analysis can be conducted to compare alternative nutritional strategies without the need to value the benefits stream. For instance, this would give the average per capita cost of supplying 1 mg of vitamin A. This can then be compared to the cost of alternative interventions such as vitamin supplementation, fortification or biofortification. Such a comparison can be indicative, but it must be kept in mind that household gardens supply a wide range of nutrients and directly influence some of the causes of micronutrient deficiencies (that is, low food consumption and low diversity of food consumption), whereas the other health interventions address symptoms rather than causes.

BOX 2: IMPACT AND COST-EFFECTIVENESS OF HOUSEHOLD GARDENS IN BANGLADESH

A study was conducted to evaluate the impact and cost-effectiveness of household gardens in Bangladesh. Baseline and follow-up data were collected for 646 intervention and control households and analyzed using a double-difference method. It was found that the intervention significantly ($p < 0.01$) increased vegetable production (+67.2 g/person/year), vegetable consumption, and the micronutrient supply from the garden. Using the disability adjusted life years (DALYs) approach, the study found that the intervention has the potential to close the micronutrient intake gap for calcium, iron and folate by 4-6% and vitamin A by 100%. If these benefits could be scaled to all nutrient-deficient households in Bangladesh then 1.7 million DALYs could be saved. Dividing the average cost per DALY saved by the national per capita income level in Bangladesh suggests a cost-effectiveness of 2.8 for iron, vitamin A, and zinc deficiencies combined (Table 3). The WHO considers a ratio below 3 as “cost-effective” for a health intervention. The true cost-effectiveness is likely to be higher given that other micronutrients are supplied by the home garden as well.

Table 3 Cost-effectiveness of the home garden intervention to address iron, vitamin A and zinc deficiency in Bangladesh

	Iron deficiency	Vitamin A deficiency	Zinc deficiency	All three deficiencies
DALYs lost per year ^a	1,451,710	36,430	224,757	1,712,897
DALYs saved due to intervention ^b	64,976	36,430	21,204	122,610
Cost (US\$) per DALY saved per year ^c	5,772	10,295	17,688	3,059
Cost-effectiveness ^d	5.3	9.4	16.1	2.8

^a Bangladesh data for disability adjusted life years (DALYs) in 2010 taken from IHME (2015). ^b Product of % reduction in nutrient intake gap and DALYs per year. ^c Assumes that: 50% of Bangladesh' 32.3 million households are affected by either micronutrient deficiency; the annual cost per home garden is US\$ 20.9. ^d Cost per DALY saved / Per capita Gross Domestic Product in current 2014 US\$ (The World Bank 2015)

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ANNEXES

Annex 1: Key resources from the World Vegetable Center

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Annex 2: Other relevant resources

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Table A1 Common micronutrient deficiency disorders and fruit and vegetables rich in these micronutrients

Disease	Deficient nutrient	Examples of fruits and vegetables rich in these nutrients	
		Vegetables	Fruits
Anemia	Iron	Leafy vegetables (amaranth, Malabar spinach, lettuce, African nightshade, Jute mallow, vegetable cowpea), beans and peas	Berries, peanuts, sapodilla, jackfruit
Iodine deficiency disorders	Iodine	Onion, okra, asparagus	Guava
Xerophthalmia	Vitamin A	Leafy vegetables (amaranth, African nightshade, Malabar spinach, kale, kang kong), pumpkin, carrot, red peppers	Papaya, mango
Beriberi, ariboflavinosis, folate deficiency	Vitamin B1 (Thiamine), Vitamin B2 (Riboflavin), Vitamin B12 (folate)	Legumes, taro, horseradish leaves, beans and peas, radish, green chili, broccoli, asparagus	Jackfruit, papaya, avocado
Scurvy	Vitamin C	Amaranth, Malabar spinach, cabbage, kale, moringa, tomato, kang kong, bitter gourd, red peppers	Guava, papaya, citrus, jackfruit, passion fruit, mango, pineapple, mangosteen, sapodilla, starfruit, pomegranate

Table A2 Micronutrient content of selected fruits and vegetables (raw, per 100 g)

Crop	Vitamin A (RAE, µg)	Vitamin C (mg)	Iron (mg)	Calcium (mg)	Folate (µg)	Zinc (mg)
Vegetables:						
African eggplant	6	27	1.00	15	23	0.25
African nightshade	403	132	3.89	206	58	0.93
Amaranth leaves	153	36	3.79	305	52	0.66
Bitter melon (fruit)	8	77	0.01	19	72	0.12
Carrots	835	6	0.30	33	19	0.24
Ivy melon (fruit)	117	5	2.06	105	NA	NA
Ivy melon (young shoots)	133	26	0.91	15	NA	NA
Malabar spinach, green	249	49	1.03	25	71	0.38
Malabar spinach, red	189	51	1.02	27	104	0.34
Moringa leaves	146	278	3.27	97	295	0.85
Okra (ladies' fingers)	43	44	1.75	49	27	0.58
Purple eggplant	1	2	0.23	9	22	0.16
Red cherry tomatoes	33	40	0.69	10	5	0.19
Green beans	35	12	1.03	37	33	0.24
Summer squash	10	17	0.35	15	29	0.29
Sweet potato leaves	138	25	0.51	67	1	0.15
Sweet potato roots	709	2	0.61	30	11	0.30
Water spinach (kang kong)	85	9	0.88	44	34	0.21
Yard-long bean	43	19	0.47	50	62	0.37
Fruits:						
Guava	31	228	0.26	18	49	0.23
Mango	54	36	0.16	11	43	0.09
Papaya	47	61	0.25	20	37	0.08
Passion fruit	64	30	1.60	12	14	0.10
Pineapple	3	48	0.29	13	18	0.12
Starfruit (carambola)	3	34	0.09	3	12	0.12

Sources: AVRDC 2014, USDA 2015. NA=Not available.



avrdc.org

World Vegetable Center
Headquarters
PO Box 42
Shanhua, Tainan 74199
Taiwan

T +886 (0) 6 583-7801
F +886 (0) 6 583-0009
E info@worldveg.org