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Nutrition-sensitive extension approaches: Conceptual perspectives on Nutri-gardens

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Abstract

Nutri-gardens represent a pragmatic, multi-functional extension strategy within nutrition-sensitive agriculture. By ensuring localized access to diverse, nutrient-rich foods, they directly address the dimensions of food security—particularly access and utilization. Evidence demonstrates their efficacy in improving nutritional status, reducing morbidity, empowering women, and enhancing household economic resilience. Therefore, integrating nutri-garden promotion into mainstream agricultural extension policies is recommended as a sustainable approach to combat malnutrition and hidden hunger at the grassroots level.

Keywords: Nutrigarden, nutrition, food security, agricultural extension, malnutrition

Introduction

India occupies a position of 102 out of 123 nations on the 2025 Global Hunger Index, indicating a severe hunger situation within the country. The nation persistently contends with elevated levels of undernutrition, which remains a formidable public health challenge. As per the National Family Health Survey (NFHS), rates of stunting and underweight in children stand at 38.4 per cent and 35.8 per cent, respectively. This undernutrition has profound long-term consequences, manifesting as impairments in cognitive development and physical growth, alongside a compromised immune response to infections. Significantly, it is identified as the fundamental cause for approximately half of all mortality instances in children under the age of five in India.

The issue of food security presents a grave and ongoing concern for the country. Despite holding the status of the world's second-largest food producer, India concurrently hosts the planet's second-largest population of undernourished individuals, estimated at 195.9 million. Scholarly reviews examining the nexus between food security and child malnutrition indicate a direct correlation in middle-income nations. Further research concludes that conditions of undernutrition and stunting are often outcomes of household-level food insecurity. The Food and Agricultural Organization (FAO) conceptualizes food security as a state wherein "all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." This definition is built upon four integral pillars: availability, access, utilization, and stability (Schleifer & Sun, 2020) ^[11]. Consequently, food insecurity can be inferred when one or more of these fundamental components is deficient or compromised.

In response, the Government of India has implemented

substantial policy measures over recent decades aimed at ensuring food security and addressing malnutrition. Key initiatives include the Integrated Child Development Services (ICDS), which provides supplementary nutrition and take-home rations to children, pregnant women, and lactating mothers; the national Mid-Day Meal programme in schools; and the reinforcement of the Public Distribution System (PDS). The legislative cornerstone of these efforts, the National Food Security Act (2013), legally mandates access to adequate quantities of quality food through state-sponsored security programmes.

Notwithstanding these comprehensive efforts, an estimated 195.9 million individuals in India experience hunger daily. This persistent gap underscores the necessity for multi-pronged strategies to address food security amidst continuously growing demand. Historically, policy focus has included enhancing staple crop production; for instance, the National Development Council resolved in its 53rd meeting to increase the production of rice, wheat, and pulses by 10, 8, and 2 million tonnes, respectively, by 2011 under the 11th Five Year Plan (Jha *et al.*, 2020) ^[5]. However, a critical realization has emerged within the scientific community: increasing aggregate food production alone, without addressing qualitative nutritional aspects, is insufficient to eradicate malnutrition. Therefore, there is a pressing imperative to meet the need for nutritive food at the most fundamental level—the household or farm. In this context, localized interventions such as promotion of nutri-gardens are posited to play a vital role in augmenting national food security and enhancing dietary diversity to combat malnutrition.

A nutri-garden is defined as a cultivation method focused on planting and harvesting nutrient-dense crops in close proximity to residences—such as backyards, terraces, or rooftops—to fulfill a family's annual nutritional requirements. In urban settings, this can be adapted as

rooftop, terrace, vertical, or container gardening. In rural areas, backyard cultivation is the predominant model. These gardens contribute to national food security by supplementing food rations and providing direct access to essential nutrients. Crucially, they enhance dietary diversity by ensuring a consistent supply of micronutrient-rich fruits and vegetables sufficient for familial needs. Thus, nutri-gardens present a sustainable, decentralized model for simultaneously improving food security and nutritional diversity at the household or community level.

Nutrigardens to address nutritional needs

The primary objective underlying the introduction of the nutri-garden concept is to incentivize and enable women to cultivate health-promoting food crops within their domestic spaces. This intervention guarantees a cost-effective, consistent, and readily accessible supply of fresh vegetables, which constitute a foundational element of sound nutrition. These green vegetables are vital sources of vitamins and minerals that play a crucial role in disease prevention. While rural communities typically possess essential productive resources such as land and water, a significant gap exists in their knowledge regarding the nutritional value and scientifically recommended consumption patterns of locally adaptable, nutritious food crops. Consequently, nutri-gardens can be conceptualized as a straightforward yet innovative strategy designed to synergize resource availability with sustainable utilization. This approach simultaneously addresses critical issues including malnutrition, generates supplementary income streams for farming communities—with a particular emphasis on women's economic empowerment—and fosters the adoption of healthier dietary practices.

Conceptually, a nutri-garden represents an advanced iteration of the traditional kitchen garden, where the cultivation of fruits and vegetables serves the dual purpose of direct household consumption and potential income generation. For small and marginal farmer households, these gardens significantly contribute to dietary diversification and yield ancillary benefits, especially for women. The promotion of this concept is strategic for encouraging female engagement in backyard cultivation. A meticulously planned nutri-garden ensures a reliable supply of fresh, nutrient-dense vegetables. This aligns with the dietary guideline issued by an expert committee of the Indian Council of Medical Research (ICMR), which recommends a daily intake of at least 300 grams of vegetables and 100 grams of fresh fruits per individual. Historically, such homestead production systems were integral to traditional agriculture but have witnessed a decline in prominence over time. Presently, there is a resurgent recognition of their critical value. Nutri-gardens are established components of agricultural and food production systems across numerous developing nations and are increasingly endorsed as a viable strategy to mitigate hunger and malnutrition within the context of global food crises (Johnson *et al.*, 2000) [6]. Mitchell and Hanstad (2004) [9] documented that nutri-gardens deliver multiple socio-economic benefits, including enhanced food and nutritional security, the empowerment of women, the promotion of social justice and equity, and the preservation of indigenous knowledge and cultural practices.

A diverse array of vegetables suitable for cultivation can be accommodated in plots ranging from 100 m² to 200 m², even in hilly terrains. Vegetables are rich repositories of nutritionally bioactive compounds, serving as important sources of protective nutrients such as vitamins, minerals, antioxidants, folic acid, and dietary fibre. The distinctive advantages of a nutri-garden include: the provision of fresh produce with high nutritive value; the supply of fruits and vegetables free from toxic chemical residues; a reduction in household expenditure on vegetable purchases; and the superior taste of home-harvested vegetables compared to market-bought alternatives.

Practically, a nutri-garden is typically established in a household backyard with adequate water access. In mountainous regions, proximity to the dwelling is recommended to protect the garden from animal depredation, a prevalent challenge in such areas. A rectangular plot is often preferred over a square configuration. Approximately 200 m² of land is deemed sufficient to provide a year-round supply of vegetables for a standard family of five. The garden's layout and crop allocation can be adapted according to climatic conditions and seasonal variations.

A well-designed and diligently maintained nutri-garden has the capacity to supply adequate nutritious food, including certain staples, for all family members throughout the year. It can fulfil nearly all household requirements for non-staple foods such as fruits, vegetables, legumes, roots, tubers, and spices. Surplus produce sold from the garden can occasionally contribute substantially to family income. Nutritional well-being necessitates consistent access to sufficient, safe, and nutritious food that meets the dietary requirements of all household members year-round. It is critical to note that poor diet and inadequate food intake are not invariably consequences of food scarcity or financial constraints. Essential knowledge regarding nutrition—encompassing appropriate crop selection for backyard cultivation, optimal food choices, and correct food preparation methods in adequate quantities—is a fundamental prerequisite. Nutri-gardens are particularly vital in geographically isolated villages distant from local markets. In hill areas, where fruits and vegetables are often transported over long distances, resulting in high cost and reduced freshness, these gardens directly counter the factors that impede reliable household food supply.

Empirical evidence confirms the positive impact of nutri-gardens in reinforcing food security among rural populations. Research indicates they can nearly double vegetable intake while enhancing both the availability and access dimensions—two pivotal pillars of the food security framework (Ranawat, 2017) [10]. Various agricultural research institutions have identified and released biofortified target crops rich in specific micronutrients. Examples include Vitamin A-enriched carrots, spinach, and pumpkin; Vitamin C-enriched bitter melon, bathua, mustard, and tomato; and iron- and calcium-enriched spinach and bathua, alongside protein-enriched beans and garden peas. The regular consumption of these nutrient-dense crops can lead to measurable improvements in human health and nutritional status. In the long term, scaling up the production of micronutrient-rich foods and improving dietary diversity will substantially reduce the prevalence of micronutrient

deficiencies. In the immediate term, incorporating such crops into daily diets can help rectify micronutrient gaps by enhancing the daily adequacy of individual micronutrient intake (Bouis *et al.*, 2011) ^[1].

Health benefits of fresh vegetables grown in nutri gardens

Bulb vegetables, including onion, garlic, and shallots, are significant dietary sources of sulfur-containing compounds, such as thiosulphinates. These bioactive constituents have been associated with a reduced risk of various chronic diseases (Kubec *et al.*, 2000) ^[8]. Furthermore, onion serves as a prebiotic, stimulating the growth of beneficial gut bacteria and enhancing calcium absorption, a mechanism pertinent to the prevention of osteoporosis (Scholz-Ahren *et al.*, 2001) ^[12]. Additionally, onion and garlic provide notable quantities of essential minerals including calcium, manganese, and potassium. They also possess the capacity to bioaccumulate selenium, primarily in the forms of selenocysteine and selenoproteins.

Vegetables classified within the Solanaceae family, such as potato, tomato, brinjal (eggplant), and chilli, offer distinct nutritional profiles. Potatoes contain high-quality protein due to a favorable composition of essential amino acids, notably lysine, and provide a moderate amount of vitamin C. Chillies are abundant in vitamins, minerals, and specific phytochemicals that demonstrate therapeutic potential in managing conditions like gastric ulcers, toothaches, and osteo- and rheumatoid arthritis. Eggplant has been identified as effective in ameliorating high blood cholesterol levels.

Crops belonging to the Brassicaceae or cruciferous family, such as broccoli, cabbage, brussels sprouts, and radish, are rich in glucosinolates. These compounds are recognized for their chemopreventive properties, offering protection against several cancers, including those of the lung, prostate, and breast. The enzymatic hydrolysis of glucosinolates, initiated by physical disruption of the plant tissue through chopping, chewing, and digestion, yields biologically active metabolites, such as isothiocyanates and indoles, which can inhibit the transformation of normal cells into cancerous cells.

Vegetables of the Chenopodiaceae family, exemplified by spinach, are characterized by succulent leaves and stems consumed as greens. They are a dense source of critical nutrients, particularly iron, folic acid, and dietary fibre. Beyond their nutritional value, these vegetables exhibit substantial medicinal properties, demonstrating anti-viral, anti-fungal, anti-inflammatory, anti-allergic, and anti-septic activities.

Epidemiological research substantiates that regular, frequent consumption of vegetables and fruits is effective in mitigating the risk of multiple cancers, including those affecting the stomach, oesophagus, pancreas, bladder, and cervix. It is estimated that approximately 20 percent of the most common cancers could be prevented through diets abundant in these foods. Fruits and vegetables are concentrated sources of essential nutrients, but a key component of their protective effect is attributed to phytochemicals. These compounds function as potent antioxidants, capable of modifying metabolic pathways, facilitating the detoxification of carcinogens, and influencing processes that may reverse tumor cell

abnormalities (Wargovich, 2000) ^[18]. Their consumption is also correlated with positive outcomes in obesity prevention (Tohill *et al.*, 2004) ^[16].

Fruits constitute a vital source of dietary micronutrients, encompassing a wide spectrum of vitamins and minerals. Increased intake of fruits and vegetables has been consistently linked to the prevention of major non-communicable diseases, including cardiovascular disorders, type-2 diabetes, and various cancers (Ganry, 2006) ^[2]. Specific fruits such as mango, papaya, citrus, guava, and grapes are notably rich in vitamins A, B, and C, and are also laden with minerals including calcium (Ca), magnesium (Mg), iron (Fe), and potassium (K). The citrus group, in particular, contains ample quantities of vitamin C (Kazi *et al.*, 2015) ^[7].

Impact of demonstration of nutrigarden in farm families

A two-year longitudinal study was conducted from 2018 to 2020 across three villages—Gidnahalli, Marinayakanahalli, and Neralemaradahalli—in the Chikkaballapur district of Karnataka, India. The study cohort comprised 30 farm families (5, 15, and 10 from each respective village), who were randomly selected and subsequently categorized into three groups based on family size: Large (6-8 members), Medium (4-6 members), and Small (2-4 members). The total participant pool numbered 180 individuals, consisting of 97 males and 83 females.

The intervention protocol commenced with an initial awareness program focused on health and nutrition. Baseline data on nutritional status, incorporating socio-economic indicators and dietary habits, were collected using a structured questionnaire. Dietary intake was specifically assessed via the 24-hour dietary recall method administered over seven consecutive days prior to the nutri-garden implementation. Following a cross-sectional design, the intervention was tailored based on resource availability (land and water), familial nutritional requirements, and the expressed willingness of farm women to maintain cultivation across seasons. The Krishi Vigyan Kendra (KVK) in Chintamani distributed comprehensive vegetable seed kits alongside an informational folder. Each kit contained seeds for 10 vegetable types (categorized as 4 green leafy vegetables, 3 roots and tubers, and 3 other vegetables), perennial plants (drumstick, curry leaves, chakramuni), medicinal herbs (Brahmi, Ashwagandha, Madhunashini, Amruthaballi, Stevia), superfoods (grain amaranth and chia seeds) for bund cultivation, and fruit plants (papaya, sapota, guava, lemon, pomelo, pomegranate, jamun) selected for their richness in Vitamins A, B, and C, and minerals such as iron, calcium, phosphorus, and zinc. The accompanying folder provided details on the significance of nutri-gardens and scientifically designed layout plans for year-round cultivation.

Systematic monitoring was undertaken throughout the cultivation period. Data tabulated during each harvest season included yield quantities, detailed food consumption patterns, and calculated nutrient intake. Statistical analysis of the collected data employed calculations of percentage, percent adequacy, and percent increase. Subsequently, a field day program was organized in each village to reinforce awareness regarding nutritional importance, disseminate findings on family health upliftment, and provide further

nutrition education.

The implemented nutri-gardens operated throughout the year, cultivating a diverse array of produce including green leafy vegetables, roots and tubers, and other vegetables such as okra, beetroot, carrot, bottle gourd, beans, chilli, tomato, brinjal, onion, ridge gourd, radish, cabbage, spinach, amaranthus, and fenugreek leaves. On average, each farm family procured 55.7 kg of vegetables for consumption from their garden.

Nutritional status was evaluated using a multi-method approach encompassing anthropometry, dietary assessment, biochemical analysis, and vital statistics. Anthropometric assessment, involving quantitative body measurements to evaluate growth, development, and health, included height and weight to compute Body Mass Index (BMI). Participants were classified into BMI categories: underweight, normal, overweight, Obese Grade I, and Obese Grade II. Pre- and post- intervention assessments of all 180 subjects revealed a baseline where the majority were malnourished: 36.11% underweight, 11.12% overweight, 14.44% Obese Grade I, and 23.33% Obese Grade II, culminating in 85% of the population classified outside the normal range. This prevalence indicated improper dietary patterns, with only 15% initially in the normal BMI category. Following the introduction of the nutri-garden and concomitant awareness initiatives on dietary management, a 19% increase was observed in the population normalized to a healthy BMI; post-intervention, 34% of subjects belonged to the normal category, signifying a positive intervention effect.

A supplementary morbidity assessment of 30 farm women via questionnaire identified major health conditions as shoulder pain (90%), toothache (80%), acidity (76.66%), backache (70%), and eye strain (63.33%). Minor conditions included fever, breathlessness, cold, and cough. Post-intervention, all reported morbidity parameters demonstrated an approximate reduction of 10 to 15%.

Analysis of food consumption patterns prior to the intervention indicated low intake of essential food groups—such as pumpkin, papaya, green leafy vegetables, roots, tubers, and other vegetables—largely due to reliance on monotype cropping. The adoption of nutri-gardens positively impacted these patterns. Supporting this, Sunwar *et al.* (2006) ^[15] documented that nutri-gardens reduced vegetable procurement costs by nearly ₹7,500 and the consumption of chemical-free produce enhanced overall health. The nutrient intake of farm women is considered reflective of the entire family's nutritional uptake.

Vijayalakshmi *et al.* (2012) ^[17] emphasized the role of nutri-gardens in women's empowerment. A comparative analysis of nutrient intake before and after the demonstration revealed significant increases: protein by 21.82%, dietary fibre by 13.83%, iron by 14.29%, and vitamin C by 15%. This marked improvement serves as a clear indicator of enhanced familial health status. Furthermore, the combined intervention of nutri-gardens and nutrition education reduced the consumption of junk food and street food among the families.

Corroborating these findings, an adjacent study by Sumner *et al.* (2010) ^[14] indicated that augmenting local food diversity yielded substantial health benefits and ameliorated many minor health issues within farming communities.

Women's empowerment through household food and nutritional security: A case study from high hills of Uttarakhand

The presented case illustrates a transformative journey towards household food and nutritional security. Similar to numerous farm families in the state of Uttarakhand, Mrs. Pooja Karki initially engaged in traditional subsistence agriculture. This system yielded food supplies adequate for only three to four months annually, necessitating market dependence for sustenance during the remaining eight to nine months of the year.

A pivotal change occurred in 2018 following her engagement with scientists from the ICAR- Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS) in Almora. Through structured training, she acquired skills in multiple domains: scientific vegetable cultivation, mushroom production, vermicomposting, apiculture (honey bee rearing), and protected cultivation techniques for vegetable seedling production. Despite a formal education limited to the 8th standard, Mrs. Karki demonstrated pronounced enthusiasm for acquiring knowledge on nutrition-sensitive agricultural practices aimed at enhancing dietary quality.

Applying this knowledge, she established an intensive nutri-garden on a 200 m² plot adjacent to her home—an area deemed sufficient to meet her family's daily nutrient requirements. She cultivated over sixteen varieties of vegetables alongside micronutrient-rich fruit plants. Exhibiting significant initiative, she managed these nutrition-farming and allied activities largely independently. The initial harvest season yielded a vegetable surplus exceeding domestic consumption needs. This surplus enabled market sales in local venues, generating supplementary income. Furthermore, she diversified into producing vegetable seedlings within poly-tunnels erected in her garden, subsequently supplying these seedlings of improved varieties to other women farmers.

Her success transformed her farm into a site for farmer-to-farmer learning, attracting visits from neighboring villagers interested in replicating her model for achieving food and nutritional security. Consequently, Mrs. Karki's household now experiences year-round food abundance. Her achievements have earned her respect within the community, establishing her as a successful farmer and a leader who mentors other women. Her work serves as a motivational model, inspiring farmers both within her village and in surrounding areas.

Conceptual Significance in Combating Micronutrient Deficiencies

The relevance of such interventions is increasingly recognized within the context of global efforts to mitigate micronutrient deficiencies, often termed "hidden hunger." These deficiencies are endemic in regions characterized by low dietary diversity, particularly where populations rely heavily on cereal-based staples or practice monoculture agricultural systems. The inability to incorporate adequate fruits and vegetables into diets precipitates severe health consequences, including blindness, physical disability, elevated maternal and infant mortality, compromised immune function, and chronic fatigue.

Standard recommended strategies to address these

deficiencies include food fortification, nutrient supplementation, and dietary diversification. Among these, the promotion of nutri-gardens emerges as a critical, sustainable, and empowering strategy for dietary diversification. By facilitating direct household access to a variety of micronutrient-dense fruits and vegetables, nutri-gardens constitute a foundational approach to directly combat hidden hunger at the community and household level.

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