Chapter 10
Kitchen Gardening for Nutritional Security Under Changing Climate

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Abstract Climate change is a global phenomenon and posing formidable challenge in all sphere of life. Food system is no exception of it and impact of climate change is observed through direct and indirect influence on parameters related to weather, land, air, water etc. This is continuously making difficult to lead sustainable life; especially considering the situation of food (nutritional) security, poverty and livelihood situation of majority of world population. The nexus between food

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security and climate change is aggravated by poverty, which needs to be challenged by enhancing resilience of food production system. World-wide development practitioners have tried to capture various coping mechanism and adaptation strategies followed by farming community. One such practice is kitchen gardening which enhances resilience of farm-families in climate change regime. In this chapter we will address concept of kitchen gardening, its prominent roles, experiences gathered from the kitchen gardening and way forward for development practitioners, in order to achieve nutritional security in changing climate scenario.

Keywords Kitchen gardening · Climate change · Homestead gardening · Nutritional security

10.1 Introduction

Climate change is very much intertwined with agricultural sectors (including allied sectors), food security and nutrition. Different sectors of agriculture are not only affected by climate change, but they also contribute to it through greenhouse gas emissions through deforestation, methane emissions from livestock rearing and rice farming, the use of biological and synthetic fertilizers etc. Global emissions must be drastically lowered in order to meet the Paris Agreement's goals of limiting global warming to 2 °C. However, by lowering greenhouse gas emissions and boosting carbon absorption in biomass and soils, agriculture can help to combat climate change. The conditions in which agricultural operations are carried out are changing substantially because of climate change, directly, by altering environmental physical properties *viz*. temperature, precipitation frequency, intensity, and distribution, the acidity of the marine environment etc., and indirectly, by altering ecosystems and interspecies relationships, particularly through affecting pollinators, parasites, weeds, illnesses etc. Household members and vulnerable groups in tropical developing nations are already suffering from harmful impacts. Negative impact of climate change on agricultural productivity will worsen in most of the regions beyond 2030. According to new research, global grain production would decline by 17% in 2050 as compared to a scenario where climate change is absent. The FAO estimates that agriculture would need to raise food output by 50% by 2050 owing to population growth and dietary changes (FAO 2017). Effects of climate change on agricultural sectors have economic and social ramifications for households (producer and consumer both) and nations that rely on agricultural output. As a result, climate change has an impact on all dimensions of food security, including food supply, physical and economic accessibility, and nutrient use, as well as the stability of these three variables. These repercussions are particularly severe for the poorest households, which rely on agricultural activities for 70% of their income, and for the least developed nations, whose agricultural sectors account for a large percentage of GDP. Climate change tackling has become a focus area in policy discourse also due to its holistic impact on life on earth. Changes not only in macro scale but

at the very micro level, individual level are advocated. 'Think globally and act locally' has encouraged individuals to think over and reflect upon their own lifestyles at the realm of local to global context.

One such change in agricultural practice is kitchen gardening and current chapter addresses how multidimensional roles of kitchen garden can be a potential tool for enhancing resilience against climate change. In developing countries vegetables are the main source of livelihood for most of communities because vegetables are loaded with several vitamins, carbohydrate, salts and proteins. Now a day's vegetables become an integral part of average household's daily meals because of increasing awareness towards their health (Solankey et al. 2021). Initially this chapter will introduce the concept of kitchen garden and how it is relevant and important in current scenario. Various study reviewed to understand social-cultural-biological-environmental context of kitchen garden and how kitchen garden responses climate change also explained. This chapter has made an attempt to identify possible areas for future course of action.

10.2 Nutritional Security Under Changing Climatic Scenario

Despite tremendous improvements in food security, more than 2 crore people have faced micronutrient deficiencies; the number of chronically malnourished people stands more than 80 crores in India; nearly 25% of children under the age of five is stunted; and 0.34 crore people lost their lives every year as a result of overweight and obesity (FAO 2017). Climate change has multi-faceted impact on food safety (FAO 2016), community hygiene, water quality, food security, woman and child healthiness etc. Effect of climate change on food supply, accessibility, and stability can lead to significant changes in dietary choices and balance, which can have a bad impact on household health. Moreover, for the reason of its health implications, climate change has a detrimental influence on nutrition. Certainly, it can effect on increasing water, food, and vector-borne transmittable diseases, all of that increases nutritional requirements and reduces nutrient absorption. Farmers' health may be directly impacted by climate change, mainly due to excessive heat and a lack of drinking water. As a result, the poorest and most susceptible people have been and will be the first to suffer.

It is important to know various aspects of food safety while investigating the consequences of environmental change on food safety and developing strategies to mitigate these implications. Food security may be characterised in four ways, according to FAO:

- Accessibility of foods
- Availability of food (economical and physical)
- Consumption of food
- Stability in long-term (vulnerability and shocks)

Food Availability indicates the availability of adequate amounts of appropriate-quality food; domestically produced or imported. Accessibility of food indicates the individuals' access to sufficient finances for obtaining healthful diets. The legal, political, economic, and social features of the society in which they exist, entitlements are definite as a set of all product bundles over that a person can develop authority.

Food Utilization is to achieve a state of nutritional well-being in which physiological demands are fulfilled, food must be utilized through sufficient diet, clean water, sanitation, and healthcare.

Food Stability means a population, home, or person should have availability of enough food at all the times to be food secure. They should not be at risk of losing food due to unexpected occurrences (such as a financial or climate disaster) or cyclical occurrences (e.g., occasional food insecurity). As a result, the term "stability" refers to the availability, accessibility, and use aspects of food security.

Climate change has direct influence on food availability by impacting negatively on crop-animal production and health, as well as seafood supplies, particularly in Sub-Saharan Africa as well as South Asia, where the major parts of the global food-insecure present. A reliable supply of food is not just a basic requirement for impoverished agricultural producers; it is often their sole, and sometimes precarious method of making a living and sustaining their existence. The small and marginal farmers with lesser yields will find it more difficult to get food since they will have less money to spend.

Furthermore, decreases in food availability due to climate change will almost certainly result in higher food costs. This would have an effect on both urban and rural communities, as they spend considerably more of their capital on food. Poor landowner farmers, the major parts of them are net food buyer, would also be affected (World Bank 2008). Climate change might effect on how food is consumed. Myers et al. 2014 suggested that there might be negative consequences regarding food quality, nutrition, and food safety. However, the consequences of climate change on food security may be extremely place oriented, with foods growing in areas facing quick climatic change. Vitamin D insufficiency, for example, has been linked to environmental/ecosystem deterioration (Wahlqvist 2013).

Climate-related changes can hurt individuals who are not so poor but are vulnerable, such as, a flood destroys a small farm, a drought hurt a livestock herd, or polluted water causes a kid to get ill. These occurrences have the potential to wipe out decades of hard labour and wealth accumulation, as well as create lasting health harm. Climate change will influence overall socio-economic development thereby future trends in poverty and food insecurity. According to a recent World Bank finding, poverty levels in 2030 are likely based on many climate shocks and policy scenarios. Another investigation concluded, under an excess climate change effect condition, the number of people are in severe poverty rises by 12.2 crore in 2030, and in a prosperous condition, the increase is only1.6 crore. Policy decisions and

focused adjustment methods will choose the future strategies of climate change on poverty (Hallegatte and Rozenberg 2016).

Ever increasing global population is likely to confront a broad hunger epidemic because of the reduced food supply induced by climate change. This would result in localized increases in food costs. Under the IPCC's A_2 scenario, the danger of hunger in certain emerging nations, such as India, is expected to stay quite high, with a regular rise in the number of people at risk of food hunger. By 2050, an extra13.2 crore people will be under danger; and by 2080, this number might increase to 26.6 crore (Parry et al. 2004). Coastal erosion and inundation are causing loss of cultivated land in low-lying Indian districts, making it worst for food poverty and property loss. In this example, climate change pressures might be alleviated by a variety of management strategies, including better stock improvement and more integrated agricultural ecosystems and improved soil conditions. There are various scientific evidence that climate change might have detrimental consequences on hunger as well as nutrition, endangering present agriculture and food systems (Nelson et al. 2009), as well as lower calorie intake due to income and non-income consequences (Nelson et al. 2009). In addition to that, the poverty nutrition trap is now a severe worry, which indicates that climatic changes may affect our agricultural production and income source, resulting in poor health and nutrition (Brown and Funk 2008). Under-nutrition is believed to be responsible for about 15% of the worldwide illness, thus making it a serious worldwide public health issue. As a result, poor health in the agricultural community might limit the ability to create and implement adequate food production strategies (Greenfacts 2008). One of the important issues is the high rate of malnutrition among the poor and marginalized population, specifically rural children and the huge number of others living below the poverty line in several countries, that reduces their capability of buying food. The high heterogeneity of protein deficient, energy poor and micronutrient deficiencies within countries continues to be a burden (Greenfacts 2008).

Vulnerable groups with existing inadequate dietary intakes (e.g., low-income individuals, migratory workers) and high nutritional density requirements may be at greater risk. It is commonly known that continuous nutritional deficient food in someone's life might be a critical risk health factor for chronic diseases, which is a huge burden in developing countries (Greenfacts 2008). Moreover, poor diet quality and low nutritional value might have been connected with global obesity as well as chronic sickness like heart related disease, hypertension, stroke as well as diabetes. The recent nutrition transition, that is the method through which globalization, urbanization, as well as changes in lifestyle are linked to high calorie obtain, poor diet, and low physical activities, has been the most remarkable illustration of raising nutritional pressures. Meals of people in poor countries are heavy in fat and energy rich (Gupta and Mishra 2014).

Micronutrient deficiency especially Iron deficiency is widespread in humans (Nag et al. 2020). Food availability is not an issue but the distribution and accessibility are. Child nutritional status in India during 2019–2020 is presented in Table 10.1. The states having a good amount of production are the states having maximum children malnourished (Table 10.1). Assam Bihar and Maharashtra are

Table 10.1 Child Nutritional Status in India 2019–2020

States/ National Territories	Children under 5 years who are stunted (%)	Children under 5 years who are wasted (%)	Children under 5 years who are underweight (%)
Andaman & Nicobar Islands	22.5	16	23.7
Andhra Pradesh	31.2	16.1	29.6
Assam	35.3	21.7	32.8
Bihar	42.9	22.9	41
Dadra & Nagar Haveli and Daman & Diu	39.4	21.6	38.7
Goa	25.8	19.1	24
Gujarat	39	25.1	39.7
Himachal Pradesh	30.8	17.4	25.5
Jammu & Kashmir	26.9	19	21
Karnataka	35.4	19.5	32.9
Kerala	23.4	15.8	19.7
Ladakh	30.5	17.5	20.4
Lakshadweep	32	17.4	25.8
Maharashtra	35.2	25.6	36.1
Manipur	23.4	9.9	13.3
Meghalaya	46.5	12.1	26.6
Mizoram	28.9	9.8	12.7
Nagaland	32.7	19.1	26.9
Sikkim	22.3	13.7	13.1
Telangana	33.1	21.7	31.8
Tripura	32.3	18.2	25.6
West Bengal	33.8	20.3	32.2

Source: National Family Health Survey – 5 Database (2020)

the states where all the parameters of child malnutrition are at an alarming stage. Meghalaya (46.5 per cent), Bihar (42.9 per cent), Dadra & Nagar Haveli, and Daman & Diu (39.4 per cent) are the leading states that reported children less than 5 years who are stunted. Likewise, Maharashtra (25.6%), Gujarat (25.1%) and Bihar (22.9%) are the top states where children's are wasted. Bihar (41 per cent), Gujarat (39.7 per cent), Dadra & Nagar Haveli and Daman & Diu (38.7 per cent) are the leading states of underweight children under 5.

Food security might be improved and assured by implementing policies and programmes to boost dietary diversity, as well as deployment of present and advanced technologies for food production, processing, preservation, and delivery. An adequate, safe, and diverse food supply would aid in the prevention of malnutrition. The incorporation of kitchen garden in households can be a possible step in this direction.

10.3 What Is a Kitchen Garden?

A kitchen garden is a type of area surrounding the house where vegetables as well as other herbs are planted for family consumption.

It can be done in little plot near the house for producing a variety of vegetables according to the season and choice of household. A kitchen garden gives a household the opportunity to cultivate its own food. The household can assure that the food it consumes is fresh and seasonal, and that it was cultivated organically (without the use of harmful chemical pesticides or fertilizers). A kitchen garden can supply fruits and vegetables for a family all over the year. If the product surpasses the family's usage, they can sell it and use the proceeds towards additional public places.

10.3.1 Why Make a Kitchen Garden

Vegetables are necessary element of a healthy meal since these provide a range of nutrients that are essential for a variety of bodily activities. Vegetables are necessary for growth, energy, and disease defense. Vegetables are especially beneficial for children, pregnant women, and nursing mothers who are more vulnerable to malnutrition. People need to have a nutritious diet to stay healthy. A nutritious diet consists of a well-balanced combination of grains, bread, legumes, vegetables, herbs, and fruits, among other things.

The purpose for developing a kitchen garden is one or more of the purposes stated below:

- Encourage the growth of nutrient-dense fruits and vegetables.
- Enable individuals to make better dietary choices by providing them with more information.
- Increase the availability of nutritious food options for children and adolescents at doorstep
- Improve food security and availability of nutritious foods, particularly fruits and vegetables.

Kitchen gardens demonstrate how to grow a diverse and nutritious vegetable for use in the kitchen with minimal input and maximum output.

10.4 Role of Kitchen Garden

The very essence of having a kitchen garden in household was to ensure food security of that particular family. Availability of fresh vegetables at one's disposal and that too at any time of the day without going anywhere to purchase; serve as the basic idea behind establishing such low maintenance gardens. Even today this

serves as the prime motto behind kitchen gardens. Along with this, several other roles of kitchen gardens have been realized over time.

10.4.1 Role in Ensuring Food and Nutritional Security

Kitchen gardens are a genuine source of food and nutrition which if maintained properly provide fresh vegetables and fruits throughout year at low cost. Generally, kitchen gardens are established at backyards of houses near the water source and where there is presence of adequate sunlight. Usage of fertilizers and plant protection chemicals are minimum because the motto is not commercial but sustainable farming. Hence use of farm yard manure, natural sources of plant nutrition like biofertilizers and organic pesticides like *neem* oil etc. are more popular in backyard gardens. As a result, the vegetables and fruits which grow have minimum chemical residues, tastes better and are full of nutritional values. Arya et al. (2018) conducted a study in four districts *viz*. Bulandshahr, Muzaffarnagar, Gautam Budh Nagar and Baghpat of Western Uttar Pradesh, India where 160 families who had established kitchen gardens reported average production of vegetables to be 403.4 kg in the year 2011–2012 and 2012–2013. Kitchen gardens provided farm families fresh organic vegetables ensuring food and nutritional security at low cost. Asaduzzaman et al. (2011) reported that homestead gardens, in other words kitchen gardens, of Bangladesh provided 364.56 gm of vegetable/person/day containing 179.83 kcal while the minimum requirement is 200 gm per person/day. Red amaranth produced highest (69,116 kcal) kcal/ m^2 and spinach produced the lowest kcal/m^2 (10,378 kcal) in homestead gardening. Such gardens contributed 10 percent towards achievement of food and nutritional security. Tribal households with kitchen gardens were reported to have additional intake of Iron 32.70% and Ca 110.40% in Seoni district of Madhya Pradesh, India (Rana et al. 2021). Singh et al. (2020) had studied the role of kitchen gardens in improving the nutritional level amongst rural women of Kannauj district, Uttar Pradesh, India. After implementation of planned kitchen gardens in 60 selected families, 44 per cent increase in yield of vegetables was reported and benefit-cost ratio was found to be 6.13. Availability of vegetables per person for consumption increased from 80 gm to 200 gm and improvement in nutritional status was also observed through increase in BMI after six and twelve months trial. Even in Tanzania, the Per Capita Kilo Calorie Intake (PKCI) was reported to be reduced by 3.92% in households where there was absence of kitchen gardens (Sileshi et al. 2022).

10.4.2 Role in Generation of Income and Savings

The produce from kitchen gardens is a source of income which generates improved livelihood opportunities, imparts rural development and entrepreneurship (Trinh et al. 2003; Calvet et al. 2012). Mitchell and Hanstad (2004) reported that kitchen garden products can be sold to earn additional income by the households (Eyzaguirre and Linares 2004; Torquebiau 1992; Niñez 1985) either directly or through development of small cottage industry. Disposable income of households have increased through income generated from such activities and the savings generated by consuming home-grown produce. Income generated from sale of kitchen garden produce enabled households of Cambodia, Papua New Guinea and Nepal to save more, use the money for education and other services and also purchase different food items (Iannotti et al. 2009; Vasey 1985). Households in hills of Vietnam earned 22 percent additional income through sale of kitchen garden produce (Trinh et al. 2003). Arya et al. (2018) reported average production of vegetables in 2012–2013 by kitchen gardens of 160 farm families of Western Uttar Pradesh, India was 406.27 kg which saved Rs 8057.50 of each farm family. Kitchen gardens are widely promoted amongst subsistence families of developing countries as a mechanism to avert poverty through additional source of income. It helps resource poor families by making production cost effective (Galhena et al. 2013).

10.4.3 Role as Shock Absorber in Food System and Alternative Source of Livelihood

Kitchen gardens are often less commercial and more subsistence in nature. This very quality indicates that they are not the primary source of livelihood because of their nature of small-scale operation. But these gardens have immense potential to act as alternate sources of livelihood as well as source of ready homemade fresh food. Any situation of food crisis can be averted if vegetables and fruits are available at the disposal. Also, any shortage in income like failure of agricultural crops in farm families due to any natural vagary can be minimized if kitchen gardens have seasonal vegetables, perennial fruits, livestock, flowers or medicinal herbs. Livestock component in kitchen gardens minimize risk due to crop losses and act as an asset to the household (Devendra and Thomas 2002).

10.4.4 Role in Curing Diseases

Plants serve as important source of medicine for humans and livestock and used to prepare biological pesticides. Herbs and medicinal plants are grown in kitchen gardens globally. About 80 per cent people in developing countries use them to treat

various illnesses in cost effective manner (Rao and Rao 2006). Perera and Rajapakse (1991) reported that 30 per cent of 125 plant species of Kandyan kitchen gardens of Sri Lanka were exclusively planted for medicinal uses and about 12 per cent for mixed purposes while in Yucatan, 70 per cent had medicinal uses (Rico-Gray et al. 1991). Medicinal plants are considered important in Bangladesh also (Millat-e-Mustafa et al. 2002) while kitchen gardens in Bukoba, Tanzania have plant species cultivated purely for medicinal purposes (Rugalema et al. 1994). Cinnamon, clove, nutmeg, lime, curry leaf, basil, aloe vera, neem, turmeric are popular medicinal plants in kitchen gardens of Tropical countries.

10.4.5 Role in Improvement of Nutrient Cycle, Ecological Balance and Biodiversity

Kitchen gardens use eco-friendly approaches for food production and conserve biodiversity and natural resources. Kitchen gardens usually have diverse flora and fauna (Galhena et al. 2013). Such gardens are complex agricultural production systems which promote biodiversity conservation. Buchmann (2009) reported that 25 kitchen gardens in Central Cuba contained 182 plant species. Kitchen gardens contain a wide variety of plant species which can be landraces, threatened or rare species or cultivars grown for a set of desirable traits (Watson and Eyzaguirre 2002). Thus, they become ideal sites for in situ conservation of biodiversity and genetic material (Gajaseni and Gajaseni 1999; Trinh et al. 2003). They also serve as habitats for animals and beneficial organisms. These gardens help in nutrient recycling, reduced soil erosion and improved pollination (Pushpakumara et al. 2010).

Humans of the household, animals and plants share a symbiotic relationship with each other within the home gardens. The plants and animals of kitchen garden provide food and other benefits to the family while the later takes care of the former. Plant wastes are used as fodder for the animals and animal manure serves as compost to fertilize plants (Mitchell and Hanstad 2004). Hence nutrient cycling and ecological balance of an area is improved through kitchen garden.

10.4.6 Socio-Cultural and Aesthetic Role

Kitchen gardens are valuable repositories preserving indigenous crops and livestock species and the production techniques of which are also transferred over the generations (Soemarwoto 1984; Blanckaert et al. 2004; Trinh et al. 2003). Interactions circling around home gardens create and reinforce social status and ties within the community. The habit of households having home gardens of exchanging or gifting saplings and plant produce for social, cultural and religious purposes (Soemarwoto 1984; Blanckaert et al. 2004), strengthen social integration and generate social

capital. Beautifully decorated kitchen gardens with colourful seasonal flowers, vegetables, fruits can add to the beauty of a household and impart aesthetic value to the surroundings. Gardening is also a healthy hobby to follow which imparts positive vibes and good aura (https://agriculturegoods.com/).

10.4.7 Role in Empowerment of Women

It is not something new that women not only play the role of care giver of the family, but are also actively involved in food production. Women's role in home gardening varies across cultures, including land preparation, planting, weeding, harvesting of produce (Moreno-Black et al. 1996; Keys and Kaqchikel 1999; Pandey et al. 2007). To women, home gardening imparts social and economic enrichment. A woman of Achuar Indian community in the upper Amazon, maintaining a lush kitchen garden is looked upon as someone having high social status and as agronomically competent woman in society (Descola 1994). Such a woman is considered more committed to family's wellbeing and of high social eminence in Saraguro community of Andes (Finerman and Sackett 2003). For some women, sale of garden products are often the only source of income and livelihood (Marsh 1998). Kitchen gardens serve as important sources of income and in meeting daily food requirements in women-headed families (Rowe 2009).

10.5 Environmental Perspective of Kitchen Garden

10.5.1 Developing Eco-Literacy

Eco-literacy is vital for sustainable human communities and societies by understanding principles of ecosystems (Capra 1997). Eco-literacy helps to understand where food comes from and how it reaches on the table; so, it is foundational aspect of understanding health and sustainability and can have profound effects on the quality of life of individuals and the planet. So eco-literacy should start at an early age for preparing a person as an effective member of sustainable society. An eco-literate person shall develop head, heart, hands, and spirit for organic understanding of world, nature and environment (McBride et al. 2013). Worldwide various school kitchen gardening programme were successfully implemented for multifaceted development of students and deepen their awareness and understanding of food systems, local food movements, and nutrition; developing personal connections to the earth etc. The bunch of activities during planting, caring-nurturing, harvesting and then preparing and sharing foods in classroom may lead to enhanced ecological literacy (Fig. 10.1).

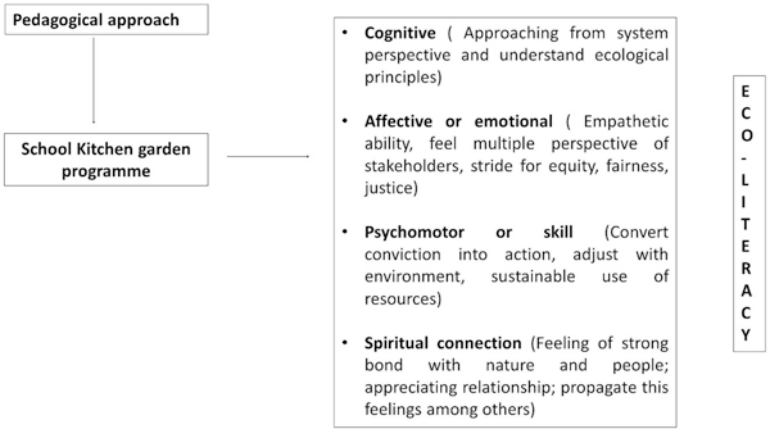

Fig. 10.1 Schematic presentation of developing eco-literacy through school kitchen garden programme

10.5.2 Environmental Behaviour

Kitchen garden or homestead garden has profound influence on individual's lifestyle. Ever-changing climatic scenario also pushes individual to 'think globally and act locally'. So, worldwide mankind is given encouragement to adopt more sustainable lifestyle by institutional bodies, groups, individuals etc. However, experience shows attitude and behaviour change is complex process specially while considering environmental behaviour. The framework suggested by Barr et al. (2001) and Barr and Gilg (2007) to understand environmental behaviour can be modified and used to understand environmental behaviour in kitchen gardening. The suggested model is mentioned below (Fig. 10.2).

10.5.3 Enhancing Resilience Against Direct and Indirect Effects of Shocks

Resilience is primarily viewed as a reactive, defensive mechanism induced by disruptive external changes (Sonnino and Griggs-Trevarthen 2013), and as a crisis-mitigating capacity (Barthel et al. 2013). Global experience highlighted resilience should be seen as proactivity, a potential for learning, as "internally produced and not just externally induced", and as a "dynamic process in which change and reinvention provide the grounds for fundamental reform" (DeVerteuil and Golubchikov 2016). Deriving lessons from Folke et al. (2003), Buchmann (2009) and Jehlička et al. (2019), following schematic representation of resilience through kitchen gardening is shown (Fig. 10.3).

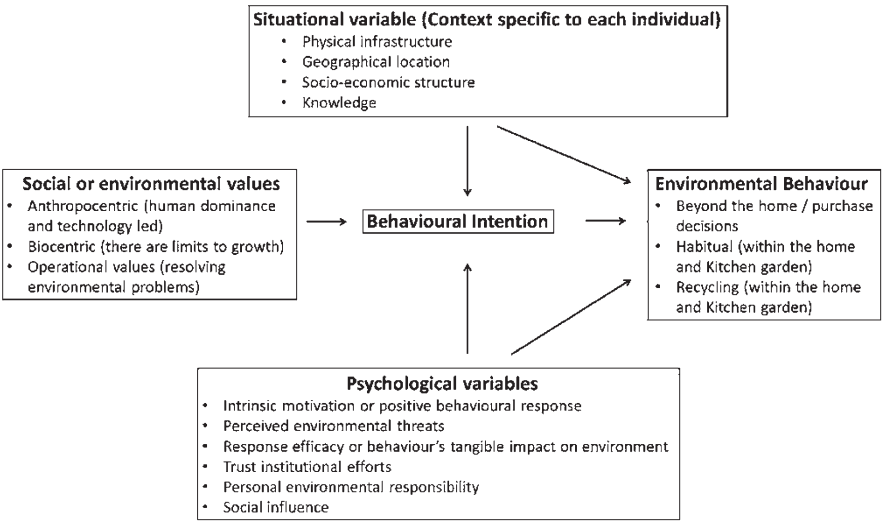

Fig. 10.2 Adapted model for Environmental behaviour in kitchen garden

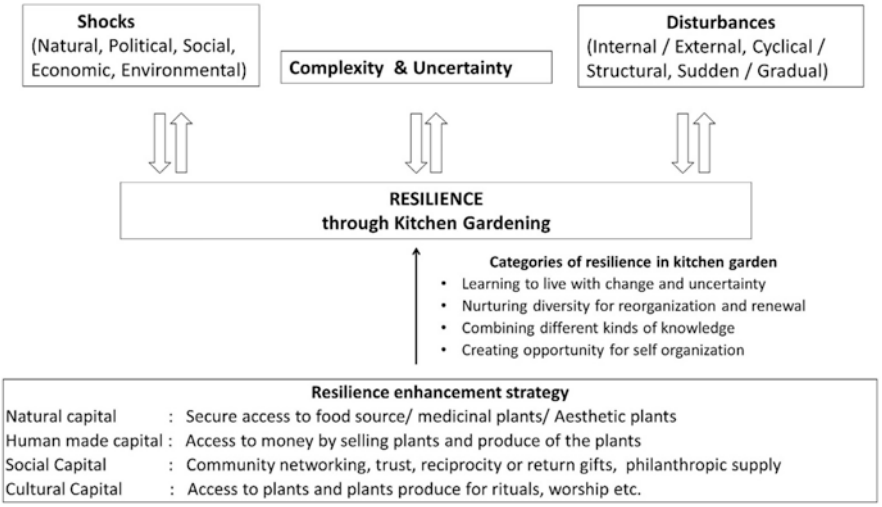

Fig. 10.3 Enhancing resilience through Kitchen Gardening

10.6 Factors Affecting Kitchen Gardening (Table 10.2)

Table 10.2 Factor and their nature of influence in Kitchen gardening

Factors	Nature of influence	Study area	Authors
Practice of school kitchen gardening programme on students and educators	This study reported children's mental, emotional and social health is promoted through activities like kitchen gardening which requires direct contact with nature.	Melbourne primary schools	Maller (2009)
	Practice of school kitchen gardening helps students in enhancing their academic performances, physical activity, language arts, healthful eating habits and acquiring nutritional knowledge.	USA	Graham and Zidenberg-Cherr (2005)
	Kitchen gardening in school involves students in practice and management of activities there by promotes physical activity	Canada	Bell and Dyment (2006)
	Study among second to fifth grade students in USA reported student's knowledge enhanced but no significant difference in attitude. However, after participating in the programme, they reported that they started eating healthier snacks.	USA	Koch et al. (2006)
	School-based Stephanie Alexander kitchen Garden program was designed for introducing children to food education through growing, caring, harvesting, preparing and sharing healthy seasonal food. Hands-on experiences positively influence children's attitude towards environmentally sustainable behaviour.	Australia	Block et al. (2009)
Motivation in volunteering	Engagement in volunteering students in school kitchen garden programme depends on their initial motivation (like desire to be more involved with children, to learn and give back to the community, and to support personal beliefs about the project's contribution to wider societal and environmental issues); benefits by actual volunteering and unexpected benefits. The challenges faced by the volunteers (like managing school community, volunteer workforce, wider community etc) did not come in the way of continuing engagement in the programme.	Australia	Henryks (2011)

(continued)

Table 10.2 (continued)

Factors	Nature of influence	Study area	Authors
Pedagogical content knowledge of teachers	Context-specific PCKG2T model was an effective professional learning tool for teacher and indicated extent to which six components (knowledge of Gardening & Kitchen Concepts; understanding of students; understanding of Whnau/ community context; knowledge of relevant curriculum areas; teacher pedagogical knowledge; knowledge of resources) were used during teaching.	New Zealand	Narayan et al. (2020)
Motivation in gardening/ kitchen gardening/ home gardening	The study suggested motivations for gardening are more related with people's way of living, keeping hobby, traditions etc. than to economic reasons. Other reasons were to continue traditional activity and also for physical exercise.	Iberian Peninsula, Europe	Reyes-García et al. (2012)
	The study conducted among 360 households with home gardens in Benin, West Africa and reported that food production (women reported) and medicinal plant production (men reported) were the main motivations of home gardens in Benin.	Benin, West Africa	Gbedomon et al. (2016)
	The study conducted in Omani home-gardens reported top gardening motives were aesthetic, hobby, source for food, physical exercise and protecting environment. The top reasons identified for non-gardening were pavement space, lack of free land, adverse weather, high water bill and lack of knowledge about gardening.	Muscat, Oman	Al-Mayahi et al. (2019)
	Relationship and appreciation for nature, apart from social issues and uses was significant motivation for gardening.	USA	Clayton (2007)
Attitude of women	Majority of the women in the Botswana study reported they were useful to the economy if they grow fruits and vegetables. Moreover, women should establish gardens to tackle food shortage due to unreliable rainfall for field crops.	Mochudi village of Botswana	Subair and Siyana (2003)

(continued)

Table 10.2 (continued)

Factors	Nature of influence	Study area	Authors
Nutritional linkage	CARE's experience in Bangladesh shows if homestead gardens are well planned for year-round production, then it can certainly increase the availability, consumption, and sales of vegetables for land-poor rural households, ultimately resulting into improved nutritional status. However, approach combining homestead production and nutrition education is required for behavioural change. Schoolchildren of grades 7 and 8 proved to be an effective vehicle for raising awareness about benefits (nutritional and economical) of homestead gardening.	Bangladesh	Khan and Begum (2002)
	Market access for rural development (MARD) project reported nutritional knowledge, feeding complementary foods to infants and preservation of foods, and consumption of 16 types of home-produced micronutrient-rich vegetables and fruits, vitamin A–rich plant products etc.	Nepal	Jones et al. (2005)
	Study on household diet diversity in Melghat concluded that increase dietary diversity might be achieved by adopting perennial kitchen garden and also through imparting adequate knowledge.	India	Birdi and Shah (2016)
Environmental behaviour	Environmentalism is related with following behavioural characteristics 1. Alternative agricultural methods like organic production shares goal of environment and food production. The pro environmental attitude which is seen through local food movement, also influences individual to produce and consume in and from kitchen garden. 2. Association of outdoor activities with environmental behaviour 3. Environmental behaviour is associated with recycling and composting activities	USA	Schupp and Sharp (2012)

(continued)

Table 10.2 (continued)

Factors	Nature of influence	Study area	Authors
Gender dimension	Experience gained from the home garden project led by Bioversity International, Nepalese NGO LI-BIRD, and the Swiss Agency for Development cooperation (SDC) a project during 2002–2012, showed that project contributed in driving change in gender norms, such as formal education of girls and the feminization of agriculture. Women from participant households have increased their decision making capacity in their own households and community. The effect was prominent across different caste categories.	Nepal	Elias et al. (2017)
	Classified gardens as men's garden, women's garden, shared garden, and separated garden. They identified gender dimensions in gardening activities and noted men's gardens tended to be "larger, more distant but women's gardens had more biodiversity.	Iberian Peninsula of Europe	Reyes-García et al. (2010)
	British women were more interested than Menin organic gardening	England	Bhatti and Church (2000)
	The way of gardening has profound influence on social relations (class, culture, power, gender etc) and environmental consequences. He argued to explore gendered division of labour in household and its impact on women's gardening activities.	USA	Hondagneu-Sotelo (2010)
Rural-urban continuum	Reciprocity economy (sharing of goods between individual members of a community) was evident in high-poverty rural areas and redistributive economy (reallocation of resources within a collective social unit by formal governmental or charitable units) was found in low-income urban areas. Part of reciprocity economy is made up by home garden produce. They also found that rural areas had three times of gardens as the urban areas.	USA	Morton et al. (2008)

10.7 Case Study on Kitchen Gardening

10.7.1 Designing and Establishment of 200m² Nutri-Garden Model

Indian Council Agricultural Research –Research Complex for Eastern Region (ICAR-RCER), Patna, India has started establishing and standardizing Nutri-garden Model. In October 2019, two nutri-garden models of 100m² and 200m² were established. Figure 10.4 shows the design of a nutri-garden model (rabi). The 100m² model was created for a family of 4–5 members, while the 200 m² model was created for a larger family of 7–8 members. The model was standardized and validated to meet the Indian Council of Medical Research (ICMR) recommendations for vegetable intake (200 g fruit vegetables, 50 g leafy vegetables, and 50 g root vegetables). The 200 m² models were designed with nine fruit vegetables (tomato, brinjal, cabbage, cauliflower, broccoli, dolichos (sem), pea, capsicum, and broad bean) six leafy vegetables (palak, mustard green, coriander, methi, bathua and lafasaag), three root vegetables (carrot, radish, beet) in mind (Table 10.3).

An adult man/woman requires at least 200 g of vegetables per day, whereas people in eastern India consume only 55–85 g/head/day, except potatoes and sweet potatoes. Several studies have found that the problem of malnutrition is worsening due to rural people's lack of nutritional knowledge, resulting in a low intake of balanced foods, including green vegetables. As a result, a scientific model of

Table 10.3 *Rabi* season vegetable crop, plot size, planting space and seed rate for 200 m² Nutri-garden Model

Vegetables (Plot size m)	Seed rate (g)	Spacing (cm)	Plant per plot
Palak (4 × 3)	180	15 × 5	1855
Coriander (4 × 3)	120	30 × 10	437
Mustard green (4 × 3)	35	15 × 5	1832
Radish (4 × 3)	45	20 × 10	785
Methi (3 × 1)	70	15 × 10	815
Beet (4 × 3)	50	20 × 15	430
Carrot (4 × 3)	35	20 × 10	635
Broccoli (4 × 3)	10	45 × 30	45
Tomato (4 × 3)	15	60 × 45	50
Capsucum (3 × 2)	7	60 × 45	18
Cauliflower (4 × 3)	10	45 × 30	45
Brinjal (4 × 3)	15	60 × 45	45
Sem (2 × 3)	150	45 × 30	24
Cabbage (4 × 3)	10	45 × 30	45
BathuaSaag (3 × 1)	2	60 × 45	15
Pea (4 × 3)	300	25 × 15	323
Lafasaag (3 × 1)	5	25 × 15	55

nutri-garden is required to provide fresh and diverse vegetables while also meeting the nutritional needs of ultra-poor farmers (Ferdous et al. 2016). It also aids in the reduction of malnutrition, particularly among children and women, as well as improvement of nutritional issues such as anaemia, which are common among rural residents.

To address these concerns, nutri-garden model was created to make available vegetables at home through year-round vegetable production in the homesteads. This model contributed to household food security through increased nutritious food intake, increased consumption of home-grown vegetables helps in reducing consumption expenditure of poor farm families, and generation of additional income for farmers through the sale of excess vegetables. While nutri-garden has many advantages for developing countries, some key constraints include limited access to agricultural inputs such as availability of quality planting material or seeds, damages from insect pests, diseases, animals, and theft, poor soil fertility etc. Despite its limitations, the nutri-garden model is an environmentally friendly sustainable agricultural practice that can improve food security and economic growth. Farmers were able to meet their daily vegetable requirements by following this model (Fig. 10.4).

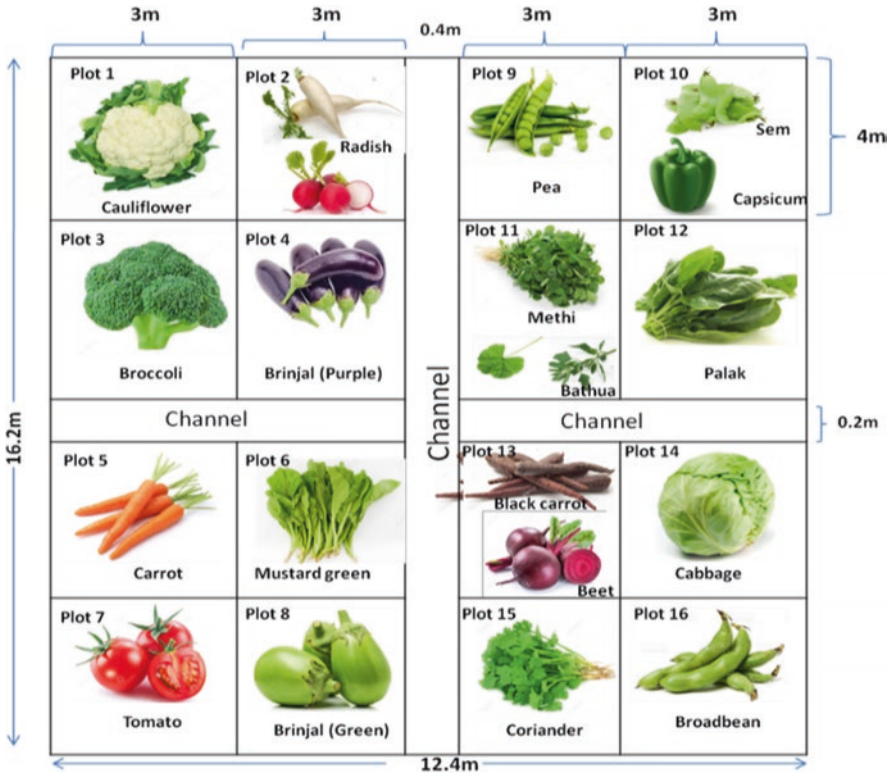

Fig. 10.4 200 m^2Nutri-garden Model (Shubha et al. 2019)

10.7.2 Kitchen Gardening in Uttarakhand, India

Kitchen gardens and their remunerative aspect has been explored through case study conducted under DST-SARTHI project "Ensuring sustainable livelihood security" during 2016–2018 in Lower Shivalik Hills of Uttarakhand, India. Vegetable crops find an important place in kitchen gardens of India. Farmers aiming to maximize their income from relatively small landholding and uses their resources to high profit crops like vegetables. It was found that the whole family is engaged in intensive but small-scale horticulture.

A number of improved vegetable seeds were demonstrated for kitchen garden at farmers' field to improve nutritional security and enhancing farm income in Lower Shivalik Hills of Uttarakhand. Farmers used the seed in the backyard or free space in their house. Farmers of this region grew these vegetables without any inorganic fertilizer. The field data has been collected during Rabi 2017 from demonstrated field at Narsan, Laksar and Gaindikhata blocks of Haridwar district of Lower Shivalik Hills and it accounted average saving of Rs.120.00 per week per family from kitchen garden (Tables 10.4, 10.5 and Fig. 10.5).

Further to promote vegetable cultivation, in Rabi 2017, the following vegetables were demonstrated at farmers' field. The economic analysis was based on primary date collected from farmer's field through personal interview followed by focus group discussion and revealed kitchen gardens not only provide nutritional security of farmers, but additionally provide a handsome return also (Table 10.6).

Table 10.4 Details of kitchen gardening

Crop	Variety	No of demonstration
Palak	All green	100
Fenugreek	PEB	100
Radish	Pusa Chetki	100
Carrot	Pusa Rudhira	100
Garden pea	Pusa Pragati	100
Mustard sag	Pusa sag 1	100

Table 10.5 Economic analysis of kitchen gardening

Before	After	
Expenditure on purchasing vegetable (Rs/ week)	Expenditure on purchasing vegetable per week (Rs/week)	Saving (Rs/per week)
300.00	180.00	120.00

Source: Authors calculation

Fig. 10.5 Kitchen gardening through distributed seeds

Table 10.6 Details of vegetable demonstrations

Crop	Variety	Seed rate (acre)	Area (acre)	Yield (q/acre)	Cost of cultivation (acre)	Gross income (Rs/acre)	Net return (Rs)
Brinjal	Pusa Shyamla	42 gm	0.75	15–18	600–700	14,400–18,000	13,800–17,300
Palak	All green	1.67–2 kg	1	9–12	600–700	6000	5400
Fenugreek	PEB	1.67 kg	1	9–12	600–700	6000	5400
Carrot	Pusa Rudhira	5–6 kg	0.67	120	600–700	30,000	29,400
Garden pea	Pusa Pragati	100 kg	0.5	54–60	600–700	108,000	107,400
Mustard sag	Pusa sag- 1	3–4 kg	0.17	9–12	600–700	7200	6600

Source: Authors calculation based on field data during 2016–2018 under DST SARTHI project "Ensuring Sustainable Livelihood Security" in Lower Shivalik Hills of Uttarakhand

10.8 Constraints Faced During Kitchen Gardening Practices

Constraints or barriers impedes in developing intention to participate in kitchen gardening, in actual participation in kitchen gardening as well as it decreases the effectiveness of kitchen gardening among the practitioners. Study across globes found constraints or barriers in kitchen gardening that can be taken into consideration in time of intervention planning by the development practitioners (Table 10.7).

Table 10.7 Constraints of Kitchen gardening

Author	Constraints of kitchen garden
Sethy et al. (2010)	Following constraints were identified in kitchen garden of Burdwan District, West Bengal, India. Input constraints (unavailability of quality planting materials of fruits and HYVs seeds of vegetables); technical constraints (lack of knowledge about improved varieties, seed rate and sowing time); socio-cultural constraints (fear of theft of the farm produce); post harvest constraints (difficulties in selling for small amount of surplus produce); general constraints (high monkey menace)
Lake et al. (2011)	The study conducted in edible gardens of Eastbourne residents, New Zealand reported perceived barriers (which factored into the intention to participate) and actual barriers (plays after the intention was formed) existed in edible gardening. Perceived barriers (having sufficient time, practical skills, physical ability, access to edible gardeners for support, knowledge of good types to grow, lack of wind, sufficient space, and sun to participate) differentiated between individuals intending to garden and those who did not intend to garden. Some of the barriers also acted as actual barriers which differentiated participants to non-participants in gardening. These are sufficient time, knowledge of growing of food, practical skills, space and sun.
Kortright and Wakefield (2011)	They identified most important barrier in gardening is gardening skills, however other barriers mentioned by the participants of the study are space, lack of sun, and soil quality etc.

10.9 Conclusion

Climate change has made formidable challenges in every sphere of human life, food system is also one of them. Effect of climate change in food production-distribution-consumption has made all the value chain actors to reorient or bring changes in their usual activities. Kitchen gardening is one such practice which enhances households' resilience. The importance of eco-literacy through incorporation of suitable kitchen gardening programme, suitable competency-based skilling during volunteering etc. have immense role in developing ecological stewardship as well as imbibing sustainable lifestyle from the very early age. The practice of kitchen gardening is not new, but to enhance effectiveness of kitchen gardening simultaneous efforts in nutritional education, development and demonstration of suitable kitchen garden options; strategy to focus women from poor household etcare very much important to escape from Poverty-Nutrition Trap (PNT).

References

Al-Mayahi A, Al-Ismaily S, Gibreel T, Kacimov A, Al-Maktoumi A (2019) Home gardening in Muscat, Oman: Gardeners' practices, perceptions and motivations. Urban For Urban Green 38:286–294

Arya S, Prakash S, Joshi S, Tripathi KM, Singh V (2018) Household food security through kitchen gardening in rural areas of Western Uttar Pradesh, India. Int J Curr Microbiol App Sci 7(2):468–474

Asaduzzaman MD, Naseem A, Singla R (2011) Benefit-cost assessment of different homestead vegetable gardening on improving household food and nutrition security in rural Bangladesh. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24–26, 2011

Barr S, Gilg AW (2007) A conceptual framework for understanding and analyzing attitudes towards environmental behaviour. Geografiska Annaler Ser B Human Geogr 89(4):361–379

Barr S, Gilg AW, Ford NJ (2001) A conceptual framework for understanding and analysing attitudes towards household waste-management. Environ Plan A33(11):2025–2048

Barthel S, Parker J, Ernstson H (2013) Food and green space in cities: a resilience lens on gardens and urban environmental movements. Urban Stud 50(1):1–18

Bell AC, Dyment JE (2006) Grounds for action: promoting physical activity through school greening in Canada. Evergreen, Toronto

Bhatti M, Church A (2000) 'I never promised you a rose garden': Gender, leisure and homemaking. Leisure Stud 19(3):183–197

Birdi TJ, Shah SU (2016) Implementing perennial kitchen garden model to improve diet diversity in Melghat, India. Glob J Health Sci 8(4):10

Blanckaert I, Swennen RL, Paredes Flores M, Rosas López R, Lira SR (2004) Floristic composition, plant uses and management practices in home gardens of San Rafael Coxcatlán. Valle de Tehuacán-Cuicatlán, México. J Arid Environ 57:39–62

Block K, Gibbs L, Johnson B, Staiger P, Townsend M, Macfarlane S, Gold L (2009) Evaluation of the Stephanie Alexander kitchen garden program - final report to the Stephanie Alexander kitchen garden foundation, McCaughey Centre, September 2009, http://www.kitchengardenfoundation.org.au/about-the-program/proving-it-works

Brown ME, Funk CC (2008) Climate: food security under climate change. Science 319(5863):580–581

Buchmann C (2009) Cuban home gardens and their role in social–ecological resilience. Hum Ecol 37(6):705–721

Calvet ML, Gómez BE, Reyes GV (2012) Beyond food production: home gardens' ecosystem services. A case study in Vall Fosca, Catalan Pyrenees, northeastern Spain. Ecol Econ 74:153–160

Capra F (1997) The web of life: a new scientific understanding of living systems. Anchor Books, New York

Clayton S (2007) Domesticated nature: motivations for gardening and perceptions of environmental impact. J Environ Psychol 27(3):215–224

Descola P (1994) In the society of nature: a native ecology in Amazonia. Cambridge University Press, New York

Devendra C, Thomas D (2002) Smallholder farming systems in Asia. Agr Syst 71:17–25

DeVerteuil G, Golubchikov O (2016) Can resilience be redeemed? Resilience as a metaphor for change, not against change. City 20(1):143–151

Elias M, Gauchan D, Gotor E, Sthapit B (2017) Promoting gender equality, Social Inclusion and Biodiversity Conservation in Nepal's Home Gardens

Eyzaguirre PB, Linares OF (2004) Home gardens and agrobiodiversity

FAO (2016) The state of food and agriculture. Climate Change, Agriculture and Food Security. SOFA, Rome

FAO (2017) Food and agriculture organization of the United Nations Rome.

Ferdous Z, Datta A, Anal AK, Anwar M, Khan AMR (2016) Development of home garden model for year round production and consumption for improving resource-poor household food security in Bangladesh. NJAS-WAGEN J LIFE SC 78:103–110

Finerman R, Sackett R (2003) Using home gardens to decipher health and healing in the Andes. Med Anthropol Q 17(4):459–482

Folke C, Colding J, Berkes F (2003) Synthesis: building resilience and adaptive capacity in social–ecological systems. In: Berkes F, Colding J, Folke C (eds) Navigating social– ecological systems: building resilience for complexity and change. Cambridge University Press, Cambridge, pp 352–387

Gajaseni J, Gajaseni N (1999) Ecological rationalities of the traditional homegarden system in the Chao Phraya Basin, Thailand. Agrofor Syst 46:3–23
Galhena DH, Fred R, Maredia KM (2013) Home gardens: a promising approach to enhance household food security and wellbeing. Agric Food Sec 2(8):1–13
Gbedomon RC, Salako VK, Chadare FJ, Kakaï RG, Assogbadjo AE (2016) Gendered motivation for home gardening and maintenance of agrobiodiversity: a case study in Benin, West Africa. Ann Sci Agron 20(2):91–104
Graham H, Zidenberg-Cherr S (2005) California teachers perceive school gardens as an effective nutritional tool to promote healthful eating habits. J Am Diet Assoc 105(11):1797–1800
Greenfacts (2008). http://www.greenfacts.org/en/agriculture-iaastd/index.htm#5
Gupta A, Mishra DK (2014) Food consumption pattern in rural India: a regional perspective. J Econ Soc Dev X(1):1–16
Hallegatte S, Rozenberg J (2016) Climate change through a poverty lens. Nat Clim Chang 7:250–256
Henryks J (2011) Changing the menu: rediscovering ingredients for a successful volunteer experience in school kitchen gardens. Local Environ 16(6):569–583
Hondagneu-Sotelo P (2010) Cultivating questions for a sociology of gardens. J Contemp Ethnogr 39(5):498–516
Iannotti L, Cunningham K, Ruel M (2009) Improving diet quality and micronutrient nutrition: homestead food production in Bangladesh. Discussion Paper 00928, International Food Policy Research Institute, Washington DC, USA
Jehlička P, Daněk P, Vávra J (2019) Rethinking resilience: home gardening, food sharing and everyday resistance. Can J Dev Studies/Revue canadienned'études du développement 40(4):511–527
Jones KM, Specio SE, Shrestha P, Brown KH, Allen LH (2005) Nutrition knowledge and practices, and consumption of vitamin A–rich plants by rural Nepali participants and nonparticipants in a kitchen-garden program. Food Nutr Bull 26(2):198–208
Keys E, Kaqchikel G (1999) Women, children, and multiple roles of gardens among the Maya of Highland Guatemala. Yearbook, conference of Latin Americanist geographers. Austin: Paper presented at Conference of Latin Americanist Geographers
Khan MI and Begum S (2002) Addressing nutritional problems with homestead gardening: CARE's experience in Bangladesh. Alleviating Malnutrition through Agriculture in Bangladesh: Biofortification and Diversification as Sustainable Solutions P.61
Koch S, Waliczek TM, Zajicek JM (2006) The effect of a summer garden program on the nutritional knowledge, attitudes, and behaviors of children. Hort Technology 16(4):620–625
Kortright R, Wakefield S (2011) Edible backyards: a qualitative study of household food growing and its contributions to food security. Agric Human Values 28(1):39–53
Lake B, Milfont TL, Gavin M (2011) The relative influence of psycho-social factors on urban edible gardening. NZ J Psychol 40(3):50–59
Maller CJ (2009) Promoting children's mental, emotional and social health through contact with nature: a model. Health Educ 109(6):522–543
Marsh R (1998) Building on traditional gardening to improve household food security. Food Nutr Agr 22:4–14
McBride BB, Brewer CA, Berkowitz AR, Borrie WT (2013) Environmental literacy, ecological literacy, ecoliteracy: what do we mean and how did we get here? Ecosphere 4(5):1–20
Millat-e-Mustafa M, Teklehaimanot Z, Haruni AKO (2002) Traditional uses of perennial homestead garden plants in Bangladesh. For Trees Livelihoods 12:235–256
Mitchell R, Hanstad T (2004) Small homegarden plots and sustainable livelihoods for the poor. LSP Working Paper 11, Rome, Italy
Moreno-Black G, Somansang P, Thamathawan S (1996) Cultivating continuity and creating change: woman's home garden practices in northeastern Thailand. Agr Hum Val 13(3):3–11
Morton LW, Bitto EA, Oakland MJ, Sand M (2008) Accessing food resources: rural and urban patterns of giving and getting food. Agric Human Values 25:107–119

Myers SS, Zanobetti A, Kloog I, Huybers P, Leakey ADB, Bloom AJ, Carlisle E, Dietterich LH, Fitzgerald G, Hasegawa T, Holbrook NM (2014) Increasing CO2 threatens human nutrition. Nature 510(7503):139–142

Nag A, Ray P, Rakshit R (2020) Reflection on iron: strategy for nutritional security in human. Natl Acad Sci Lett 43:395–398. https://doi.org/10.1007/s40009-019-00847-5

Narayan E, Birdsall S, Lee K (2020) Developing a context specific PCK model for kitchen-garden learning programmes. ASIA-PAC J Teach Edu 48(2):112–131

Nelson GC, Rosegrant MW, Koo J, Robertson R, Sulser T, Zhu T, Ringler C, Palazzo A, Batka M, Magalhaes M Lee D (2009) Climate change: impact on agriculture and costs of adaptation. Food Policy Report, International Food Policy Research Institute, Washington, DC

NFHS-5 (2020) National family health survey −5 Database http://rchiips.org/NFHS/NFHS-5_FCTS/NFHS-5%20State%20Factsheet%20Compendium_Phase-I.pdf

Niñez VK (1985) Working at half-potential: constructive analysis of home garden programme in the Lima slums with suggestions for an alternative approach. Food Nutr Bull 7(3):6–13

Pandey CB, Rai RB, Singh L, Singh AK (2007) Home gardens of Andaman and Nicobar, India. Agr Syst 92:1–22

Parry ML, Rosenzweig C, Iglesias A, Livermore M, Fischer G (2004) Effects of climate change on global food production under SRES emissions and socio-economic scenarios. Glob Environ Change 14(1):53–67

Perera AH, Rajapakse RMN (1991) A baseline study of Kandyan forest gardens of Sri Lanka: structure, composition and utilization. For Ecol Manag 45:269–280

Pushpakumara DKNG, Wijesekara A, Hunter DG (2010) Kandyan home gardens: a promising land management system in Sri Lanka. In: Bélair C, Ichikawa K, BYL W, Mulongoy KJ (eds) Sustainable use of biological diversity in socio-ecological production landscapes. Background to the 'Satoyama initiative for the benefit of biodiversity and human Well-being'. The Secretariat of the Convention on Biological Diversity, Montreal

Rana GK, Singh NK, Deshmukh KK, Mishra SP, Saini KPS (2021) Kitchen garden: an ideal approach to enhance household nutritional security in rural areas of Seoni district (MP). Pharma Innov J 10(5):254–258

Rao MR, Rajeswara Rao BR (2006) Medicinal plants in tropical homegardens. In Tropical Homegardens: A Time-tested Example of Sustainable Agroforestry. Edited by Kumar BM, Nair PKR. Springer Science, Dordrecht,The Netherlands

Reyes-García V, Vila S, Aceituno-Mata L, Calvet-mir L, Garnatje T, Jesch A et al (2010) Gendered homegardens: a study in three mountain areas of the Iberian Peninsula. Econ Bot 64(3):235–247

Reyes-García V, Aceituno L, Vila S, Calvet-Mir L, Garnatje T, Jesch A, Lastra JJ, Parada M, Rigat M, Vallès J, Pardo-De-Santayana M (2012) Home gardens in three mountain regions of the Iberian Peninsula: description, motivation for gardening, and gross financial benefits. J Sustain Agric 36(2):249–270

Rico-Gray V, Chemas A, Mandujano S (1991) Use of tropical deciduous forest species by the Yucatecan Maya. Agrofor Syst 14:149–161

Rowe WC (2009) "kitchen gardens" in Tajikistan: the economic and cultural importance of small-scale private property in a post-soviet society. Hum Ecol 37(6):691–703

Rugalema GH, Okting'ati A, Johnsen FH (1994) Thehomegarden agroforestry system of Bukoba district, Northwestern Tanzania. 1. Farming system analysis. Agrofor Syst 26:53–64

Schupp JL, Sharp JS (2012) Exploring the social bases of home gardening. Agric Human Values 29(1):93–105

Sethy S, Sarkar S, Kumar M (2010) Constraints in adoption of improved techniques of kitchen gardening. Ind Res J Ext Edu 10(2):89–92

Shubha K, Koley TK, Mukherjee A, Kumar U (2019) Nutri-garden: a promising approach to enhance rural household food and nutritional security. Food and Sci Rep 1(A):1–4

Sileshi M, Sieber S, Friedrichs K, Rybak C, Feyisa BW, Lana MA (2022) Adoption and impact of kitchen garden on food and nutritional security of farming households in Tanzania. Ecol Food Nutr:1–18

Singh P, Kanaujia VK, Dubey SK, Pandey S (2020) Backyard kitchen garden as the viable tool for nutritional security of rural families: a study from Kannauj district (U.P.). J Commun Mobilizat Sustain Dev 15(3):643–648

Soemarwoto O (1984) The Javanese rural ecosystem. In an introduction to human ecology research on agricultural Systems in Southeast Asia. Edited by Rambo AT, Sajise PE. University of Philippines, Los Banos, The Philippines

Solankey SS, Kumari M, Kumar M, Silvana N (2021) The role of research for vegetable production under a changing climate future trends and goals. In: Solankey SS et al (eds) Advances in research on vegetable production under a changing climate Vol. 1. Springer, Cham., ISBN 978-3-030-63497-1, pp 1–12

Sonnino R, Griggs-Trevarthen C (2013) A resilient social economy? Insights from the community food sector in the UK. Entrepreneurship Reg Dev 25(3–4):272–292

Subair SK, Siyana M (2003) Attitude T oward backyard gardening in Botswana. In proceedings of the 19th Conference of the Association for International Agricultural and Extension Education. pp 612–622

Torquebiau E (1992) Are tropical agroforestry homegarden sustainable? Agric Ecosyst Environ 41:189–207

Trinh LN, Watson JW, Hue NN, De NN, Minh NV, Chu P, Sthapit BR, Eyzaguirre PB (2003) Agrobiodiversity conservation and development in Vietnamese home gardens. Agric Ecosyst Environ 97:317–344

Vasey DE (1985) Household gardens and their niche in Port Moresby, Papua New Guinea. Food Nutr Bull 7(3):37–43

Wahlqvist ML (2013) Vitamin D status and food security in North-East Asia. Asia Pac J Clin Nutr 22(1):1–5

Watson JW, Eyzaguirre PB (2002) Homegardens and in-situ conservation of plant genetic resources in farming systems. Paper presented at 2nd International Home Garden Workshop, Witzenhausen, Germany

World Bank (2008) World development report 2008: agriculture for development. Washington D.C.