

# Peri-Urban Horticultural Systems and Household Gardens in South Asia

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## Background information

The peri-urban horticultural systems of South Asia are key suppliers of vegetables to urban centres. Their proximity to major markets enables the perishable products to be sold after short distance transport. These systems are thus unaffected by inadequate infrastructure for perishable food transport (roads, cold chain, etc).

Peri-urban agriculture is especially important and diverse in South Asia, with various forms: commercial gardening, home gardens, community gardens, community supported agriculture, vertical farming, rooftop gardening, etc. (Nicholls et al 2020). Peri-urban small-scale farms often grow a diversity of crops over space or time (i.e., in same growing season), which contributes to their overall output. Although peri-urban farms tend to be very small, their economic viability can be very good, and they can be equally or even more productive than commercial, monoculture farms.

## Plant Systems considered in this report

Peri-urban vegetable production is characterized by year-round cultivation of crops, where vegetable crops are rotated according to seasons. In some cases, mixed cropping or inter-cropping is also practiced. Although production is mostly concentrated near the consumption centres (closest cities), surpluses are also transported to other urban areas within a country. These systems in South Asia produce and supply all kinds of vegetables, according to local demand. Leafy vegetables (predominantly spinach, mustard, amaranth and kangkong, and culinary herbs such as fenugreek and coriander), cauliflower, cabbage, radish, carrot, beans and peas, cucurbits, okra and tomato are commonly grown in the peri-urban systems of South Asia (Pushpakumara et al 2012; Sumangla et al 2013). Frequent irrigation is widespread, although involving very variable water quality. Most vegetable growers rely on organic manures, supplemented by inorganic chemical fertilizers.

Home gardens are commonplace in both urban and rural settings across South Asia. Many home gardens also have perennial vegetable trees, especially moringa and fruits such as bananas (including plantain). Leafy vegetables such as amaranth, sessile joyweed, Asian pennywort or culinary herbs grow wild under shade and among the planted trees in home gardens.

Tomato, fresh beans (French bean, lablab), cabbage, cauliflower, amaranth, and bitter gourd can be considered as keystone vegetables in South Asia in peri-urban vegetable production as well as home gardens. Chili pepper is also an important solanaceous vegetable, but is more commonly produced as a field crop grown at a larger scale and away from urban areas, although it is commonly found in home gardens as well.



Field of tomatoes, Coimbatore, India (photo: P Schreinemachers, World Vegetable Center)

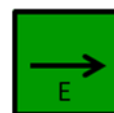


Woman in home garden, Sindhupalchok, Nepal (photo: P Schreinemachers, World Vegetable Center)

| Keystone species    | Family           |
|---------------------|------------------|
| Tomato              | Solanaceae       |
| Fresh beans         | Fabaceae         |
| Cabbage/cauliflower | Brassicaceae     |
| Amaranth            | Leafy vegetables |
| Bitter gourd        | Cucurbitaceae    |

## Vegetables health in South Asia







Home garden:



Peri-urban horticulture:



## Assessment for keystone species in Peri-urban horticulture

| Keystone species     | State of plant health (30-years)   | Evolution of plant health (10-years)   | Health  |
|----------------------|--|--|---|
| Tomato               | Pests and diseases and their management have been well studied and recommendations are available. Because of the development and adoption of technological innovations including disease resistant varieties to manage biotic constraints, the state of plant health has significantly improved. However, emerging diseases (especially viruses) and invasive pests remain a serious threat. | More research has been conducted on emerging plant diseases, shifts in plant pathogens, and disease management strategies including disease resistant varieties. The state of plant health has significantly improved. |    |
| Fresh beans          | Some research has addressed plant health in French bean ( <i>Phaseolus vulgaris</i> ) and hyacinth bean ( <i>Labiab purpureus</i> ). The state of plant health in French bean has improved, but remains a major concern in hyacinth bean.  | More research has been conducted on emerging plant diseases, and the development of disease management strategies. The state of plant health has improved to some extent.  |    |
| Cabbage/ cauliflower | Pests and diseases and their management have been well studied and recommendations made available. The state of plant health has significantly improved, especially for the diseases, but the diamondback moth ( <i>Plutella xylostella</i> ) remains a major threat, especially in the lowlands.  | More research has been conducted on the development of disease management strategies. The state of plant health has significantly improved.  |  |
| Amaranth             | Although amaranth is a short-duration crop, plant health information is available to some extent. Plant health does not seem to be a major issue for the leafy types than the grain types.   | Some research has been conducted on emerging plant diseases, especially viruses. The state of plant health has remained the same.  |  |
| Bitter Gourd         | Plant disease management has been addressed to some extent for this species. Concerns on plant health are increasing despite varietal improvement, which primarily focuses on yield increase.  | More research has been conducted on emerging plant diseases, and disease management strategies, with limited focus on disease resistant varieties. The state of plant health has improved to some extent.              |  |
| All species combined | Satisfactory knowledge on plant health is available on the considered crops. The state of plant health remains a major concern to smallholders in the region.  | The state of plant health has been improving.  |  |

### **State of vegetables health in the past 30 years**

Year-round production is a common phenomenon in peri-urban vegetable production systems in South Asia. The use of irrigation and manure are high. The diversity of crops limits the build-up of pests and pathogens into severe outbreaks. Although the literature on plant health focused on peri-urban vegetable production systems is scanty (Chowdappa 2013), pests and diseases in these systems do not significantly differ from those of other (field) vegetable production systems. Literature on field vegetables thus can be useful.

**Tomato:** Damping off (caused by *Pythium* and *Rhizoctonia*), Alternaria leaf blights (*Alternaria alternata* and *A. solani*), gray mold (*Botrytis cinerea*), late blight (*Phytophthora infestans*), southern blight (*Sclerotium rolfsii*) and Fusarium wilt (*Fusarium oxysporum* f. sp. *lycopersici*) are major fungal diseases. Bacterial wilt (*Ralstonia solanacearum*), bacterial spot (*Xanthomonas vesicatoria*), tomato leaf curl (whitefly-transmitted Begomoviruses) and tospoviruses (thrips-transmitted peanut bud necrosis and tomato spotted wilt viruses) also cause severe yield losses (Nagendran et al 2019).

**Fresh beans:** Anthracnose (*Colletotrichum lindemuthianum*), gray mold (*Botrytis cinerea*), leaf spot (*Cercospora canescens*), powdery mildew (*Erysiphe polygoni*), leaf rust (*Uromyces* spp.) and wilts (especially *Fusarium solani*) are the most common fungal diseases (CABI 2019a; Chowdappa 2013; Mishra et al 2019). Severe economic losses can occur if pods are infected by powdery mildew. Common bacterial blight caused by *Xanthomonas campestris* pv. *phaseoli* and yellow mosaic virus also reduce production.

**Cabbage and cauliflower:** Damping off (caused by *Pythium* and *Rhizoctonia*), Alternaria leaf blights (*Alternaria brassicae* and *A. brassicicola*), downy mildew (*Peronospora parasitica*), powdery mildew (*Erysiphe cruciferarum*), and black rot (*Xanthomonas campestris* pv. *campestris*) are some of the major diseases (CABI 2019b; Chowdappa 2013), whereas club root of cabbage

(*Plasmodiophora brassicae*) prevails locally in South Asia (Bhattacharya et al 2014).

**Amaranth:** Some knowledge exists on vegetable amaranth health. Capsicum chlorosis virus (CaCV) transmitted by thrips has been reported from India. Leaf blight (*Rhizoctonia solani*) is a major constraint for amaranth cultivation in the monsoon or under humid conditions (Uppala et al 2010). Damping-off, root rot and aphid transmitted *Cucumber mosaic virus* were also reported from vegetable amaranths (Raj et al 1997). The Papaya Leaf Curl Virus, transmitted by whitefly, and yellow vein net disease caused by the Ageratum Enation Virus have also been reported from grain amaranth.

**Bitter gourd:** Powdery mildew (caused by *Podosphaera xanthii*), downy mildew (*Pseudoperonospora cubensis*), mosaic (caused by three different viruses: Cucumber Mosaic Virus, Papaya Ringspot Virus and Bitter gourd Distortion Mosaic Virus), and leaf curl (caused by three different viruses: Bitter gourd Leaf Curl Betasatellite Virus, Tomato Leaf Curl Palampur Virus and Pepper Leaf Curl Virus) are some of the commonly reported diseases (Ali et al 2010; Raj et al 2010). The Indian Cassava Mosaic Virus associated with yellow mosaic disease of bitter gourd was also reported (Rajinimala and Rabindran 2007).

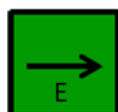
### **Evolution of vegetables health over the recent 10 years**

Although many vegetables in peri-urban systems are produced year-round, the disease risk is relatively high, since vegetable crops are not usually rotated with plant groups that are widely different (such as, e.g., cereals). The incidence of some diseases, especially in the case of insect vector-transmitted virus diseases, will be altered due to climate change (Gautam et al 2013). Priority has been given to developing disease-resistant varieties of commercial crop species such as tomato and to some extent fresh beans and bitter gourd. Other disease management approaches include the use of antagonistic microbes, vegetable grafting, and fungicides.

However, some components in integrated pest management strategies have limited application in peri-urban production systems. For instance, crop rotation for a couple of years (2-3 years for rust disease, and 4-6 years for wilts) is required to reduce the level of inoculum. This is not always feasible in the intensively cultivated peri-urban vegetable production systems in South Asia. Plant health is not a major priority in home gardens for multiple reasons. First, home gardens in south Asia are usually managed at low levels of chemical (fertilizers, pesticides) inputs (but high levels of labour). Second, the agrobiodiversity is so rich in home gardens that it operates as an effective buffer against biotic and abiotic constraints (Kunhamu 2015).

## Ecosystem services, as affected by plant disease

Home garden, provisioning and cultural:



Peri-urban horticulture, provisioning and regulating:



Assessment for keystone species in Peri-urban horticulture

| Keystone species in peri-urban horticulture | Provisioning services | Regulating services |
|---|-----------------------|---------------------|
| Tomato                                      |                       |                     |
| Fresh beans                                 |                       |                     |
| Cabbage/cauliflower                         |                       |                     |
| Amaranth                                    |                       |                     |
| Bitter Gourd                                |                       |                     |
| All species combined                        |                       |                     |

## Level of ecosystem services generated by vegetables, as affected by plant disease, in the past 30 years

**Peri-urban horticulture:** Over the last 30 years, disease resistant varieties have been introduced for tomato and French bean. Resistant varieties and root-stocks to overcome virus diseases, late blight, and bacterial wilt diseases limit the reliance on chemical pesticides in tomato. Similarly, resistant varieties against bean rust, wilt, and angular leaf spot reduced the dependence on pesticides in beans. However, the absence of insect-resistant varieties and the poor adoption of IPM practices have led to pesticide overuse, especially in tomato, cabbage and cauliflower, and bitter gourd. Resistant varieties and/or other disease management practices maintained or even increased the provisioning services. However, pesticide overuse adversely impacts regulating services (especially as a cause for declining pollinators and natural enemies of crop pests) in most of these crops. The very high cropping intensity of peri-urban production systems, compared with other (e.g., field) production systems, also adversely affects soil health, which further encourages the use of inorganic fertilizers. An important element is that peri-urban farms have limited access to organic manure (in the absence of farm animals) and are often located in river deltas characterized by heavy clay soils, both contributing to low soil organic matter. Continuous cropping in peri-urban farms also leads to inoculum build-up, and so increases in pathogens and disease incidences, favouring a progressive decline in provisioning services.

**Home gardens** contribute provisioning services in terms of food supply and cultural services including specific ingredients important to the South-Asian food culture (e.g. turmeric, cumin, chili, coriander, curry leaf, cardamom, and fenugreek). Home garden systems have a long cultural tradition in South Asia and there are no reports known to us that such systems are reducing in importance. Home gardens systems usually have a high diversity with many species grown mixed together in limited individual



numbers (Gautam et al 2008). The literature on home gardens focuses on their role in biodiversity conservation, on food provision and their contribution to better nutrition. There are no known scientific studies for South Asia on plant diseases in home gardens, which may suggest that plant diseases are not a key concern in these systems. This may be explained by the small scale of cultivation in home gardens, the short duration of some crops such as leafy vegetables, and the fact that diseased plants can easily be removed with minimal effect on the overall productivity of a home garden. Therefore, on a 5-point scale, both provisioning and cultural services provision can be rated as “Excellent”.

***Evolution of the level of ecosystem services generated by vegetables, as affected by plant disease, over the recent 10 years***

**Peri-urban horticulture:** The area under peri-urban vegetable production is increasing in South Asia, because of the growing population in cities that offer a steady market for the fresh produce. In addition, with growing health concerns and the raising awareness on the nutritional importance of vegetables, vegetable consumption is steadily increasing, stimulating the demand for vegetables. With the advent of innovative breeding tools and biotechnology, several disease resistant varieties are made available by the public and private sectors. The development of the bio-pesticide sector also has generated alternative options for pesticide-free, safer vegetable production. Protected cultivation is also increasing in peri-urban vegetable production. Thus, peri-urban vegetables farmers have adopted recent technological innovations to improve plant health in the recent decade. Hence, both the provisioning services and regulating services are improving in most of the crops.

For home gardens, the effect of plant health on ecosystem services is likely to be small for the same reasons as stated above. Therefore, on a 3-point scale, both provisioning and cultural services provision can be rated as “stable”.

## Complementary information

Peri-urban vegetable production is undergoing continuous changes in South Asia. In fact, peri-urban agriculture is highly flexible by nature, since the periphery of the cities keeps expanding. As a result, this production system faces land and water challenges. Mostly, only a few specialized crops are produced in peri-urban farms. Such lack of diversity and continuous cropping lead to increasing pests and diseases. The use of protective structures (which do not have environmental control) such as poly-net house, low tunnels, etc. in the hot and humid regions of South Asia increases the incidences of diseases. However, there is a lack of literature studying the evolution of pests and diseases and their management practices for different crops in peri-urban production systems systematically across South Asia. This prevents us from generalizing or extrapolating the available information at the ecoregional level. Hence, we are moderately confident that this assessment is accurate.

There is a lack of literature documenting plant health in home garden systems. Some of this may indicate a lack of serious problems; however, it also suggests a bias in agricultural research as home garden systems, despite their importance for food security, receive minimal attention in agricultural research and extension. Considering this lack of published studies, the degree of confidence is best rated as “uncertain”.

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