Homegardening for food and nutritional security and for biodiversity conservation during the pandemic times

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Abstract. The COVID-19 pandemic and the associated lockdown – often regarded as a “Global Human Confinement Experiment” – has created an unprecedented situation around the globe. While the reduced human presence and mobility, causing declines in visitation rates of protected areas, may generally favour biodiversity conservation in natural ecosystems, the pandemic has caused major disruptions of the food supply chain. Furthermore, the “reverse migration” of labour has led to scarcity of workforce in many localities hitting agricultural operations. The cumulative effect is food insecurity for millions of people in both the developed and developing countries. It is therefore crucial to encourage local food production systems at the household and community levels. Tropical homegardens, which are resilient and sustainable production systems, are important in this respect. Homegardening is a unique farming system, which combines divergent production and service functions around the homesteads and contribute to the supply of fresh food at the household level. Being a decentralized production system, such practices may reduce food wastage along the supply chain. A prominent structural attribute of homegardens is the great diversity of species ranging from creeping herbs to tall trees and livestock, implying the potential for biodiversity conservation. Although land-use systems are challenged as never before in the wake of the pandemic, homegardening may provide a way forward to overcome the looming food insecurity at the household level in the rural areas of many countries.

1. Introduction
The coronavirus is spreading rapidly all over the world. Between December 2019 and March 2020, the pandemic has besieged 186 countries [1]. The consequential enforced confinement and shifts in human mobility patterns are altering all aspects of the society [2]. The large human lockdown and its eventual relaxation, at times referred to as a Global Human Confinement Experiment, has strong feedbacks on the coupled human and natural systems [3]. There are both positive and negative effects of human confinement on a range of natural and managed systems, including wildlife, protected areas and agroecosystems. Among the positive features, due to forced restrictions, pollution levels in many cities around the world have drastically reduced. For example, during lockdown, air quality of Delhi, one of the most air-polluted cities in the world (https://www.numbeo.com/pollution/rankings.jsp), have witnessed notable improvements; i.e., reductions (> 50%) in the concentrations of pollutants such as PM10 and PM2.5 (particulate matter with a diameter of less than 10 and 2.5 μm respectively) in comparison to the pre-lockdown phase have been reported [4]. Indeed, satellite images have shown dramatic improvements in air quality in every nation disturbed by the pandemic, as industry and
transport are shut down. The year 2020 will also very likely see a global decline in greenhouse gas emissions, as well as large reductions in other drivers of global warming, implying favourable effects on biodiversity conservation. Corlett [5] in an editorial in Biological Conservation noted that there are reports, albeit anecdotal, of reduced human pressures on wild species following the pandemic. They posited that in protected areas, declines in visitor numbers caused by travel restrictions and park closures have reduced stresses on sensitive animals and trampling pressure on popular trails. As traffic and other human activities decline, wild species have been venturing into rural, peri-urban and urban areas, including parks and beaches, where they have not been seen for long. Shipping has declined worldwide, in turn, reducing impacts on marine systems as well.

Although the so-called Global Human Confinement Experiment may favour biodiversity conservation in the natural ecosystems, the pandemic has caused major disruptions in agricultural production and food supply chain, which aggravated the already existing severe problems of hunger and malnutrition along with food wastage. Indeed, the “reverse migration” of agricultural labourers during the pandemic has led to disruptions in the agricultural processes in many countries, implying potent challenges to food production. McDonald [6] reported strong indications of internal migration of the agricultural workforce due to COVID-19, which probably has delayed rice planting in northwestern India. Indeed, more than 95% of the rice area in India is dependent on manual labour for crop establishment and the lockdown-triggered huge reverse migration has affected this process especially in the north-western states of Haryana and Punjab, where rice-wheat system is the predominant cropping system. It is well-known that rice-wheat system productivity is primarily driven by timely transplanting of rice and, subsequently, by the timely sowing of the wheat crop in sequence.

2. Literature Review

Balwinder-Singh [7] hypothesized that labour shortages caused by reverse migration of farm labour will significantly delay the transplanting of rice with a consequent delay in wheat seeding – with cascading effects on system-level productivity in the northwest India. Results of their simulation study suggest that rice productivity losses would be low as compared to that for wheat, with total system productivity loss estimates ranging from 9% to 21%, equivalent to economic losses of USD $674 m to $1.48 billion. The lockdown had already hit the marketing season of wheat in India. Cost of labour is also going to double due to the shortage, affecting agricultural profitability. Delayed rice transplanting and harvesting can also exacerbate winter air pollution with concomitant health risks in northwest India. Technological options such as direct seeded rice, staggered nursery transplanting, farm mechanization for mitigating labour shortage and crop diversification away from rice can help address these challenges but require new approaches to policy and incentives for change. Indications (e.g., record food grain production of over 295 million tonnes in India during 2020-2021) are that by harnessing such technologies the farmers of north-western India were able to resolve the impending crisis to a great extent.

Although field crop production in northwestern India was able to withstand the crisis to some extent, the situation elsewhere and in other sectors is probably different. In particular, the pandemic crisis has adversely impacted the livestock and fisheries sectors. With trucks not plying and the hospitality industry badly hit by the pandemic and the general economic slow-down, these sectors are severely affected. The livestock feed supply system is probably disrupted and the prices of cattle feed and dry fodder have increased; missed opportunities for artificial insemination due to non-availability of frozen semen is yet another bottleneck, which may have lasting impact on the livestock industry. However, on the positive side about 40% of reverse migrated labour may be engaged in the dairy industry.

It is often argued that in the wake of the pandemic, rigorous controls on the sale and consumption of wild species, and implementation of the international health regulations, must be scaled up globally. A complete ban of the trade, farming and consumption of wild species, or a "clamp-down" of wet markets, however, may affect the food security of the low-income rural areas and communities as
these markets sustain the livelihoods of large sections of resource-poor people, who rely on wild foods as a significant source of food security and nutrition.

On the whole, the pandemic is likely to affect the food and nutritional security of vast sections of the society. According to [1], by the end of 2020, globally about 265 million people will face the risks of severe/extreme food insecurity as against 135 million in January 2020. Both developed and developing countries will be affected, but the hotspots of food insecurity will be in the developing countries of South Asia, Sub-Saharan Africa, Latin America, and the Caribbean, and the Pacific region [8]. Obviously, COVID-19 is worsening the already chronic problems of hunger and hidden-hunger in Asia and Africa – the two continents, which have the most people susceptible to both under-nourishment and malnourishment (520 million people in Asia and 243 million in Africa suffer from these maladies [25]. Furthermore, the COVID-19 pandemic is also disrupting access to fresh and nutritious food at affordable prices to large and growing urban populations [8].

It is, therefore, important to strengthen local food production at the household and community levels. Clearly, there is a need to adopt more resilient food production systems, reduce food waste along the supply chain, and strengthen the growth of local agricultural capabilities [8]. Tropical homegardens can play an important role in providing enhanced food supply and increased food diversity. It is a time-tested example of sustainable agroforestry [9]. The homegarden is a farming system, which blends divergent production and service functions on homesteads to supplement supply of fresh food at the household level. They are considered desirable and sustainable land-use systems, which offers easy day-to-day access to fresh vegetables and fruits, providing enriched and balanced diets by supplementing proteins, vitamins, and minerals [10]. As a source of medicinal plants and a locale for socializing and recreation, homegardens are also important to human health and wellbeing, especially in the pandemic times. This paper will examine how homegardens can improve food security, nutritional value, and biological diversity around the family home during and after the pandemic season. However, it may be noted that, as this piece is being written, the pandemic is still accelerating in many countries and hence this article can only be a snapshot of a rapidly changing situation.

3. Discussion

3.1. Homegardens for food and nutritional security and for generation of rural income and employment

The central dogma of tropical homegardening is food production – either directly producing edible fruits, nuts, grains, rhizomes and tubers, leaves, flowers etc. or indirectly promoting (facilitation) higher and/or sustained (continuous) production. Consistent with this, many food and beverage plants ranging from herbs to vegetable and fruit yielding woody perennials abound in the homegardens and they provide a vital share of the food and nutritional requirement of the household. Aspects like what proportion of the household’s food requirements is obtained from the homegardens has attracted some attention. Torquebiau [11], after a review of the early literature on homegardening, reported that homegarden-based dietary supplies account for 3% to 44% of the total calorie and 4 % to 32 % of the protein intake, implying great variability in this respect. Key determinants of the share of homegarden produce in the household’s food intake are the size of the homegardens, the suite of species involved, size of the households and their socioeconomic status. The bottom-line, however, is that homegarden supplies can rarely meet the entire basic staple-food requirements of the household [12]. It may be also noted that, being a component of the whole farming system, homegardens exist in harmony with other production systems involving staple food crops such as rice (Oryza sativa), maize (Zea mays) or cassava (Manihot esculenta).

Many homegarden produces are also remarkable sources of nutrients and minerals. For example, several tree species in the homegardens are rich sources of carbohydrates, vitamin C, riboflavin, iron and vitamin B6. Comparisons involving homegarden-owning target groups with a control group without such gardens showed that there is significantly higher round the year production and
consumption of vitamin-rich fruits and vegetables by the former. This, in turn, reduced iodine, vitamin A and iron deficiencies and made the offsprings of homegardeners less prone to xerophthalmia [12]. By supplying diverse products round the year guaranteeing food diversity to the gardeners, homegardens also aid in food security during “lean” seasons. By following the so-called Rangpur model of gardening (a cropping pattern for year round production systems developed in Rangpur region of Bangladesh), it was possible that farmers in rural Bangladesh were able to fulfil their daily requirement of vegetables in most months of the year, signifying an improvement in food security and malnutrition reduction [13]. Homegardens are thus recognized as the poor farmers’ insurance and safety net in dire food situations, giving additional nutrition and calories [14]. There is growing consensus that homegardening can be a practical approach for improving household nutritional security for at-risk populations, particularly women and children. In view of this, homegardens figure prominently in the government policies relating to food security in countries like Sri Lanka [14].

Aligned to food security is the issue of nutritional quality of food. In general, little or no exogenous inorganic inputs are applied in the homegarden systems; consequently, products from homegardens are supposedly of better quality. Such products also may fetch premium prices in health-food stores in food-quality-conscious societies. Yet another fundamental feature of homegardening is the sharing of the produce within the society. Although a significant portion of the produce is used domestically, products such as fruits, vegetables and medicinal/ornamental plants are also freely distributed within the local communities [15]. This equitable allocation of the farm produce is a noteworthy feature and endows the homegarden system a unique social disposition. Scientific production and utilization of the homestead can also reduce purchase of expensive vegetables from outside sources, earn a small cash income by selling vegetables and fruits and ensure more intakes. Such features make homegardening an ideally suited land management system in the pandemic era when labour scarcity and the general inability to procure costly inputs may adversely affect intensive agriculture production.

3.2. Generation of cash income

While homegardening is generally recognized as a source of subsistence production, it is also important in providing additional cash returns to the growers, as mentioned. This is of special significance in the pandemic era when income sources are generally drying up due to deceleration of economic growth both locally and globally. The income generated by the sale of such products can be used for procuring food items from outside the farm, thus augmenting food security and food diversity. The relative proportion of homegarden commodities sold out as against those domestically consumed, is however, drastically variable both within and between different regions. For instance, in Indonesia it averaged 21.1 % of the total income, but ranged from 6.6 % to 55.7 % depending on the size of the gardens, family needs and species composition [15]. Commercialization (e.g., introduction of high value cash crops) may increase the cash income of the gardeners [16][17]. Homegardens thus have a potential to improve livelihoods considerably, especially when the gardeners take necessary steps to make production more sustainable.

Employment generation: In the COVID-19 era, employment opportunities are generally shrinking, which in turn, is a principal driver of the reverse migration of the workforce. In this context, tropical homegardens offer enormous potential for generating rural employment. Homegardens are essentially owner-operated smallholder systems, which use “free” family labour or low-cost hired labour, usually with more working days per worker, as well as more hours per working day, as compared to commercial, large-scale plantations. It involves establishing diverse agricultural subsystems such as vegetable production, dairying, apiculture, fishponds and the production of a diverse range of products, clearly signifying scope for creating on-farm and off-farm jobs and marketing opportunities. With the Global Human Confinement during the pandemic, it is also probable that family labour availability will be higher. Indeed, family labour may satisfy most of the labour requirements of the smaller homegardens. Mendez [18] reported that homegardens used on average 32.6 h family \(^{-1}\) week \(^{-1}\) with women contributing to roughly half (48%). In many places, women play a vital role in the design
and management of these land use systems including the introduction of species. For example, many  
endeavours such as vegetable cultivation (selection and preparation of seeds, seedlings and cuttings, as  
well as their planting), harvesting fruits, nuts, vegetables and medicinal plants, firewood collection and  
animal rearing, especially in the smaller gardens, are the exclusive domains of women, with or without  
support from the male members of the family. The role for women in homegardening is also crucial  
due to their wide knowledge of horticulture, which is usually transmitted from female-to-female [19].  

3.3. Homegarden species diversity

A characteristic feature of tropical homegardens is the great diversity of herbs, shrubs, vines, trees,  
other perennials, which may be a consequence of the interplay of several socioeconomic and  
biophysical processes. Indeed, many landraces and cultivars, rare and endangered species are  
frequently encountered in the homegardens [20]. Such land use systems also act as refuges for  
wildlife. Homegardens thus may serve as important links to other agricultural and natural landscapes,  
providing a diverse landscape mosaic. Structural characteristics of homegardens such as size of the  
garden are a major determinant of species richness. For Kerala homegardens, Kumar [21] reported  
that species richness on total homegarden area basis increased as the size of the gardens increased, but  
the number of species per unit area declined. Regarding the effects of the pandemic on homegarden  
species richness, it is hypothesized that the human confinement during the pandemic times, may lead  
to increased family labour availability facilitating more intensive managerial interventions in the  
homegardens including species introductions and better management. As a result, plant species  
richness of homegardens may probably increase; however, experimental evidences are lacking in this  
respect. Furthermore, wild species (including predatory birds and animals) from natural ecosystems  
may also venture into adjacent managed systems, implying augmentation of species diversity in the  
homegardens.  

3.4. Nontimber forest products (NTFPs):

Homegardens are major avenues for the production of nontimber commodities such as medicinal and  
aromatic plants, ornamentals, bamboos, gums, resins, chemical extractives and green leaf manure.  
Several medicinal plant species are either intentionally cultivated or occur spontaneously in the  
homegardens. For example, in the Catalanian homegardens, about 250 medicinal plants with curative,  
palliative, symptomatic, and/or other medicinal properties were reportedly present [22]. Likewise,  
herbal formula could be an alternative approach for prevention of COVID-19 in high-risk population  
in several traditional healthcare systems; e.g., Ayurveda [23] and Chinese traditional medicines [24].  
While the medicinal plant resources of homesteads in many areas are generally declining, because of  
over-exploitation and the shifting land use dynamics, the human confinement during the pandemic  
times may lead to increased introduction and better management of medicinal species in the  
homegardens, assuming that herbal remedies can bolster the immunological responses.  

4. Conclusions

Integrated smallholder systems with tree crops such as tropical homegardens are widespread in the  
tropics and they play an important role in providing food and nutritional security to millions of people  
in the developing countries. Homegardens are traditional land use systems, with potential for  
maintaining species diversity in the managed ecosystems and to provide a range of food products such  
as fruits and vegetables, medicinal plants and other products. The traditional homegardens mostly  
represent smallholder production systems of the subsistence or “non-commercial” type. The rapid  
social and economic changes in many parts of the world, however, may encourage commercialization  
of the homegarden system. During the pandemic era, homegardening can play a vital role in  
promoting food and nutritional security, besides providing medicinal herbs, especially for the resource  
poor people in the rural areas. However, experimental data to support such claims are not readily  
available.
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