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Review

Potential Economic, Social and Environmental Contribution Study of Urban Agriculture Based on Five Key Features Identified through Past Studies

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Abstract: Urban agriculture (UA), for recreational (gardening) and or commercial (farming) purposes, is commonly practised around the world, and uptake is increasing globally. There are many claims regarding UA's social, economic and environmental benefits with scant exploratory research. The overarching objective of this paper is to access the potential economic, social and environmental contribution of UA based on five major features that have previously been shown to be critical to optimising the benefits of UA: area, purpose (gardening or commercial), crop value (mixed, mid to high), mechanisation level (none to partial mechanisation) and market mechanism (retail versus wholesale) based on past studies focusing on Adelaide, Australia and the Kathmandu Valley, Nepal. Including the reviewed 15 past studies that closely reflect the above five features of UA, most UA research has focused on the social benefits and potential cost savings of growing food in cities, with few studies interrogating its economic viability, employment potential or opportunity to reduce greenhouse gas emissions. There is a clear need to study UA using a systems approach to ensure viability, replicability and sustainability. Real-world case studies focusing on diverse settings will help to characterise key features and corrective actions for improving overall sustainability.

Keywords: urban agriculture; area; purpose; mechanisation; market mechanism; crop

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1. Introduction

Urban agriculture (UA) typically has social and economic motives connected to food production [1]. UA, also known as urban farming or urban gardening [1], encompasses a variety of production forms including uncontrolled- and controlled-environment agriculture [2]. The more prevalent approach—uncontrolled-environment UA—includes cultivating crops in the community, individual allotments, farms, gardens on housing areas and rooftops, organisational gardens, market-driven vegetable production, and growing food in public parks [3]. In contrast, controlled-environment agriculture utilises various advanced technologies for high input efficiency, such as vertical farming, ensuring relatively high and year-round production [4]. The variation in forms is mainly due to farming environments ranging from controlled to uncontrolled, methods of growing, crops grown and purpose (social/economic/environmental). These variations in UA are primarily influenced by the nature of the economic activity, location and tenancy, crop, scale and technology, markets and consumers' needs and interests [5].

Hodgson et al. [6] classified UA as the practice of producing food in a city area utilising non-commercial, commercial and hybrid production technologies. The non-commercial UA activities mainly encompass practices conducted in an uncontrolled environment, while commercial and hybrid production involves a combination of both. Hodgson et al. [6] documented eight gardening activities, four market-oriented productions, and one integrated farming activity across different parts of the world. The purposes of UA diverge according to development contexts. UA in developing countries is more oriented towards producing food for household consumption and income [7]. In contrast, UA is focused on lifestyle, health, community development, and innovation motives in the developed world [8]. In a broader context, UA is either advanced for recreation, such as gardening, or as a means of livelihood through commercial farming. UA has broader social, economic and environmental roles leading towards its promotion on a global scale [9]. UA is endorsed as a means of enhancing livelihoods, social connections, leisure, environmental benefits, and cohesion [10]. UA has been considered a means to help reduce greenhouse emissions associated with food production and distribution, at least to some extent [11]. Furthermore, UA has the potential to reduce food insecurity by producing a variety of crops locally, overcoming transport barriers, and providing a source of income [12].

UA is believed to have a crucial role in providing a stable food supply along with jobs and income to enhance urban resilience against external shocks [13]. UA has captured the interest of researchers due to shifting perspectives on food production, consumption and distribution [14]. The major challenges in urban areas are natural disasters, pandemics, scarcity of natural resources, poverty and food security, and in this regard cities need strategies to cope with food supply concerns [15]. However, the social, economic, and environmental impacts vary based on scales, contexts, and approaches [16]; UA may possess greater environmental and other values compared to commercial agriculture [17]. The benefits of UA, especially the environmental and social dimensions, have been significantly underestimated [18], as has the fact that UA can serve multiple roles, including job creation [19,20]. And in general, UA is supposed to reduce food miles and economic pressure through 100–200 million urban farmers that directly supply fresh horticultural commodities to city markets [21]. Greenhouse gas (GHG) emissions from food production and distribution contribute approximately one-quarter of global GHG emissions, constituting a significant global issue [22]. Thus, curbing emissions from the food system is a major challenge that could be facilitated by low carbon emissions, scalable and affordable technologies [22]. The current food distribution system could be significantly improved and there is considerable scope for improving the current distribution system for UA produce through more localised/decentralised markets, ultimately leading to reduced emissions during food distribution [23].

Based on previous research, the economic, social and environmental outcomes of UA are largely influenced by factors like labour use, scale, level of mechanisation, crop type, market mechanism, distance of production to market, and greenhouse gas emissions during different stages [24]. Operating as a more localised and diverse food production system, UA in principle has the potential to bring production closer to the consumer. This proximity can offer access to affordable and nutrient-rich food, ultimately aiding the mitigation of adverse effects linked with an extensive food supply chain [14]. However, some previous studies have put forth unfounded claims regarding the potential economic, social and environmental benefits of UA, focusing on specialised case studies that might not be applicable to most situations [25]. Conversely, some studies might have a solid foundation but have failed to address the key issues related to employment ability, economic viability or carbon emissions within the context of mechanisation—a factor crucial for viable UA.

Kafle et al. [25] developed an integrated optimisation model to analyse the features of UA based on the trade-offs and synergies between economic, social and environmental objectives focusing on Adelaide (representing a high-income setting) and the Kathmandu Valley, Nepal (representing a low-income setting), concluding that there are five key variables (scale, distance to the consumer, crop type, market mechanism and level of mechanisation) affecting the potential for UA to deliver net benefits to one or more of these objectives.

This study aims to review the key features of UA based on past studies conducted in Adelaide, Australia and the Kathmandu Valley, Nepal and recommend future courses of action for overall sustainability. The fifteen past studies that represent the features of UA, focusing on UA types and purpose, distance, scale, crop type, mechanisation level, and market mechanism based on the framework developed by Kafle et al. [25] have been studied to assess the potential economic, social and environmental benefits which are essential for studying UA as a system approach. The paper then recommends future courses of action to assist UA in becoming more sustainable and scalable based on the learning from divergent development scenarios.

2. Methodology

The approach followed in this study is based on a desktop review of fifteen published UA studies, all compared via the governing features identified by Kafle et al. [25] as presented in Figure 1. These five key features of UA are: distance and scale (area), mechanisation level, market mechanism, purpose, market mechanism, and crop value. Together, these contribute to the potential for the wider replicability, viability and sustainability of UA. Those features are compared with the contribution towards the specific objectives (i.e., economic, social or environmental), and a discussion on the present status is conducted. Finally, recommendations are provided for the improvement of UA practices.

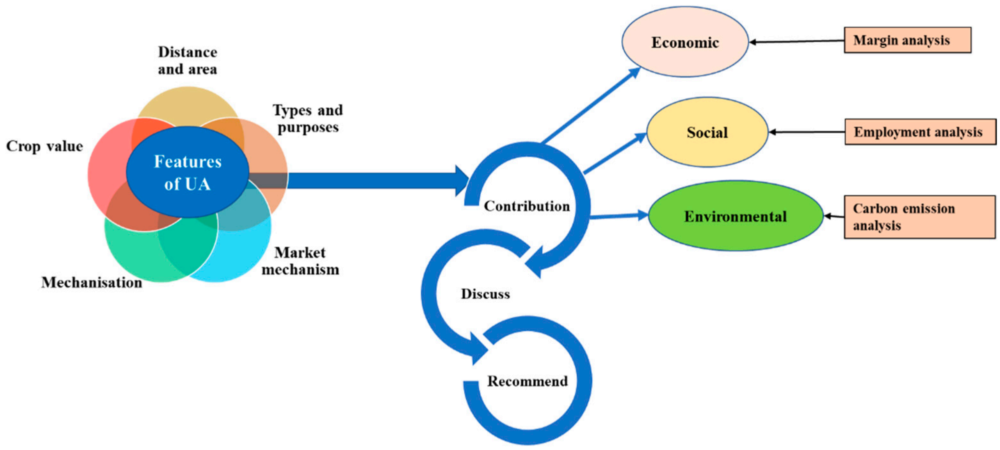

Figure 1. Approach followed for the study.

3. Results

The features of UA studied by different authors based on the above-identified five features focusing on diverse development settings are summarised in Table 1. The review of features of UA from past studies was purposively carried out through qualitative verification of UA research for the identification of knowledge gaps on current trends that guide the overall economic, social and environmental sustainability of the UA as a system approach. Thus, the potential qualitative verification of UA's economic, social and environmental contribution has been summarised to compare UA features based on the quantitative verification techniques proposed by Kafle et al. [25]. This comparison aims to explore the current trends of UA research and suggest ways to improve UA practices' overall viability, replicability and sustainability based on the previous modelling study. In this regard, among the several UA studies to date, the selected 15 cases will serve as guiding tools for the further improvement of UA for better economic, social, and environmental sustainability and viability of current practices.

Table 1. Features of the UA studied by different authors for economic, social and environmental outcomes.

S.N.	Location	Type/ Purpose of UA	UA Distance from City Centre (km) and Area (m^2)	Crop Value	Mechanisation	Market Mechanism	Objectives	Further Details	Remarks	Source
1	Adelaide, South Australia, Australia	Home gardening	10–51 km, 4–51	Mixed (combination of high value and low value vegetables) along with fruit trees and poultry	Non-mechanised	Self-consumption and sharing	Economic	Saving money to purchase food	Lacks full cost evaluation, noting only a monthly spending from AUD$0 to AUD$1000 (AUD$30 median).	[26]
2	Florida, USA	Home gardening	0.1–10 km, 2388	Mixed vegetables		Retailing	Economic	0.27 USD (1985 dollars) net return per m^2	Excluded land and labour cost. The dollar values are based on a 1985 study.	[27]
3	Columbus, Ohio, USA	Home gardening	51 km,14					6.50 USD (1985 dollars) net return per m^2		
4	Guelph, Ontario, Canada	Urban gardening	93 km, 0.5–300	Mixed vegetables	NA	Retailing	Economic	−31.28 USD/kg	Compared to market value (4.58 USD). Minimum wage: cost 35.86 USD/kg. Zero wage: cost 10.82 USD/kg. Excluding land cost-with average productivity of 1.43 kg/m^2.	[28]

Table 1. *Cont.*

S.N.	Location	Type/ Purpose of UA	UA Distance from City Centre (km) and Area (m^2)	Crop Value	Mechanisation	Market Mechanism	Objectives	Further Details	Remarks	Source
5	South Australia, Australia	Urban gardening	10–51 km, 4–731 (median 49)	Mixed vegetables	Non-mechanised	Retailing	Economic	−17.17 AUD/m^2/year	Excluded land cost (cost includes setup and growing cost for a month), the setup cost includes 18.91 AUD/m^2 and other cost 0.51 AUD and retail value of 2.25 AUD/m^2.	[29]
6	Adelaide, Australia	Home food garden	0–60 km, 5–160	Mixed (high to low value fruits and vegetables)	NA	Retailing	Economic	10–45 AUD/m^2/year	Net value (cost of water and other inputs excluding land and labour) depending upon crop types.	[30]
7	Low to middle income countries review	Commercial UA (horticulture and livestock)	NA	High value crops	NA	NA	Economic and social	Job creation	Financial gain and Casual, seasonal and permanent jobs	[31]
8	Philadelphia, USA	Market gardening (14 urban farms)	NA, <2020	High value to mixed crops	NA	Retailing	Economic	Profitability	Without labour cost, 6 farms were in profit, 3 in break even and with labour cost only one farm was in profit from high-value crops.	[32]

Table 1. *Cont.*

S.N.	Location	Type/ Purpose of UA	UA Distance from City Centre (km) and Area (m^2)	Crop Value	Mechanisation	Market Mechanism	Objectives	Further Details	Remarks	Source
9	Sydney, Australia	Gardening	within 1 km from built up space, median 10.8	Mixed vegetables	NA	Retailing	Economic	Benefit Cost Ratio (BCR)—0.62	Cost excluded land, per kg cost of production 28.53 USD. Focus was self-provision of food, i.e., cost benefit was saving money to purchase food.	[33]
10	Global scale review (global north and south)	Multifunctional UA	NA	Mixed farming	NA	NA	Social and environmental	Vulnerabilities and externalities minimisation	Environmental impact minimisation (food import embedded environmental impacts).	[34]
11	Rosario, Argentina, case study	Gardening plus commercial	NA, 750,000	Fruit and vegetables	NA	Retailing	Social, environmental	Job creation, reducing food-related emissions	Niche production helped to curb 95% GHG reduction (Initially sourcing food from 400 km away).	[35]
12	Brighton and Hove, UK	Gardening in allotments and rooftops	80 km, 175	Fruits and vegetables	NA	NA	Economic and social	Income and Jobs,	Saving of buying fruits and vegetables EUR 550/year.	[17]

Table 1. *Cont.*

S.N.	Location	Type/ Purpose of UA	UA Distance from City Centre (km) and Area (m^2)	Crop Value	Mechanisation	Market Mechanism	Objectives	Further Details	Remarks	Source
13	Kumasi, Ghana	Commercial UA	0–2.8 km, 1000–2000	Leafy vegetables, cabbage and onion	NA	NA	Economic	400–800 USD net income/year/farm	Sustainable intensification of high-value crops.	[21]
14	Borough of Sutton, UK	Community farming	25 km, 260,000	Fruit and vegetables	NA	retailing and wholesaling	Environmental	Reduction potentiality of 882-ton CO_2 equivalent based on life cycle assessment/year from 26 ha.	High-yield crop selection for the local market	[36]
15	Greater Bandung, West Java, Indonesia	Gardening plus commercial	Urban agglomeration with faming in intra urban (inner city) and peri urban	Mixed vegetable dominated by high and low value with small livestock	NA	Retailing and wholesaling	Economic	Gross income of 29,202,111 Rp/person/year from commercial UA,11,872,941 Rp/person/year from semi commercial	Subsistence contributed—1.2%, semicommerical—48% and commercial—75.5% in household income	[37]

Note: S.N. means serial number, and NA means not investigated in the study.

The 15 UA studies focused on different types, areas, and objectives; however, the major thrust, irrespective of developmental context, was on the economic contribution made by the UA practices. This ranged from households saving money on purchasing food to earning profit from growing and selling crops. Almost all the studies neglected land costs, while most considered labour costs in some way. Even when only the labour cost was taken into account, it is important to note that the UA practice in the studies resulted in a net loss. The only viable scenario was observed when the cost of land and labour, excluding other inputs, was not considered, particularly with the intensification of high-value crops. The area under production seems to be governed by the purpose (UA is mainly concentrated in a small area for gardening, while farming is carried out in a relatively larger area with the adoption of multiple technologies for growing high-value crops). The concept of the mechanisation for labour use efficiency has not been introduced in the UA farming system, with direct distribution (i.e., retailing) as the most common marketing mechanism for UA produce.

Limited research has been conducted into job creation/employment opportunities as a potential social benefit of UA. However, several studies addressed a combination of economic or environmental objectives under gardening and/or commercial UA practices. Overall, there is a lack of in-depth analysis of employment opportunities especially focusing on job creation through UA practices.

Some of the studies appear to assume that the environmental benefits arise from a shortened supply chain and non-mechanised production but have not rigorously studied emissions generated in the new supply chain (such as, for example, storage of produce and type of vehicle, frequency and distance for distribution to market), nor whether a UA distribution system generates more or less emissions. The majority of studies have not quantified emissions from the production and distribution of UA produce, rather estimated the carbon reduction potential of localised farming. There is still a lack of comprehensive measures to study the combined potential contribution of UA for the intended benefits with a very shallow focus on crop type, type of farming, labour use efficiency, and market mechanism for overall sustainability.

4. Discussion

The prime aim of this review is to identify the gaps related to economic, social and environmental aspects of UA and recommend a sustainable course of action for studying UA as an interrelated and interdependent system through the five governing features of UA identified through past studies by Kafle et al. [25]. In this regard, the most significant gap identified by this study in the economic analysis of UA practices was the lack of a consistent and comprehensive cost accounting framework. Previous viability studies have generally neglected land and labour costs. In some cases, the UA practices seem unviable even without accounting for labour costs. For the viability of UA, a full and consistent cost accounting framework is necessary [16]. The cost items, particularly land cost in an urban environment and labour cost, especially for the high wage setting, have been shown to be key influences on the core viability of UA [23]. There are various ways to improve labour use efficiency for the profitability and viability of UA, and the introduction of scale-appropriate mechanisation may be one of the most feasible options [23]. The purpose of UA is highly influenced by the availability of land and price of land. If the land is freely available, commercial forms of UA become more viable. However, where land must be bought or leased, UA is squeezed into relatively smaller areas, i.e., backyards or rooftops [24]. In a study carried out by Kafle et al. [24], comparing the economic viability of UA in Adelaide, Australia, and the Kathmandu Valley, Nepal, land and labour costs were the prime threats to viability in the Australian case, while only land cost posed a threat to viability in Nepal, for all scales and distances considered. The distance and scale of farming from the city centre is an important component that influences land costs and, hence, the overall viability of UA, with relatively higher land costs near the city centre and lower costs in the outer areas [24]. The economic viability studies from around the world reveal a limited and inconsistent cost accounting framework that should be broadened and unified to give a clearer picture of the economic viability of UA.

The nature and extent of employment in UA are largely influenced by labour use efficiency through mechanisation [24]. UA has been studied in relation to its potential for employment, considering seasonal and permanent employment ability [38,39]. The economic and social benefits and impacts of UA, especially from the job creation and income generation perspective, are important and those aspects are, in turn, heavily influenced by the purpose, distribution and market mechanism. And the benefits and impacts from UA practices are ultimately influenced by labour costs—high labour cost favours mechanisation for better economic viability but reduces employment opportunities during production activities [24]. In a past study compiled by Kafle et al. [24], a full-time employment equivalent (FTE) was used as a proxy measure for participation in the food system. As more person hours are involved in food production, labour cost increases, which undermines economic viability in the absence of volunteer labour. However, greater person hours may still be positive in terms of social outcomes in some circumstances. No study has explicitly explored the employment and job creation aspects of UA, particularly in terms of the broader social benefits it may provide in developed or developing contexts. The analysis of the employment potential of UA practices through increased participation in the food system based on the five key features is an opportunity for further research.

UA has several claimed benefits related to environmental aspects, a major one being carbon emission reduction. There is little exploratory research quantifying carbon emissions from UA food production and distribution practices, nor explicit comparison to the larger scale non-UA food supply system. Nicholls et al. [17] highlighted UA's higher environmental benefits when compared to commercial agriculture, and Anzunre et al. [18] on the other hand, have argued that the environmental and social benefits of UA have been greatly underestimated. The environmental and social objectives shown by Kafle et al. [25] to have a direct relationship in the UA system, with higher participation through a direct distribution mechanism thus reducing the amount of emissions during distribution. Importantly, whilst small-scale mechanisation could be competitive with commercial food production in terms of production-related emissions, the distribution mechanism in UA potentially has a major impact on the overall emissions in the food supply when performed with small vehicles [24]. If the food distribution from UA mostly takes place through small petrol-operated vehicles like cars, then depending on the distance to market, those vehicles may contribute very significantly to the food-related emissions [25]. Carefully designed distribution mechanisms are critical for both social and environmental benefits to occur, as claimed.

The fifteen representative UA studies to fulfil the aim of investigating UA as an integration of economic, social and environmental systems suggest that different authors have investigated different types of UA, focusing on different parts of the world for different purposes. A major focus has been on economic aspects, albeit with a highly inconsistent approach to examining the viability or contribution of UA to reducing food costs. A lot has been said about social and environmental benefits, but not a lot of rigorous study has been devoted to quantifying these benefits and explicitly defining what these mean in a scalable UA system. For example, if a key social benefit comes from greater time being spent participating in the food system, then the time spent should be accounted for in some way. Similarly, if a key environmental benefit comes from carbon emission reduction potential, then this should be quantified and, where possible, compared with large-scale food production.

Recognising UA as an interconnected and integrated part of the food system is important, and the economic, social and environmental contribution analysis ultimately helps to identify pathways for viability, sustainability and replicability [40]. The overall economic, social and environmental impacts and benefits from UA at a broader level are largely governed by the area, distance of production and distribution, purpose (either gardening or farming), level of mechanisation (non-mechanised, garden tiller, and cultivator) and market mechanism (direct vs. wholesale) which are integral parts of a UA system. It is important to analyse the current UA practices for sustainability assessment and identification of opportunities for improvement [25]. In this regard, the past modelling approach has helped shed light on the suitability of particular UA systems to particular outcomes, such as smaller-scale approaches being more suited to non-economic benefits, and trade-offs such as mechanisation (for viability) versus non-mechanisation (for greater labour participation).

Based on the current analysis of the fifteen research studies carried out by various scholars, there is a lack of consistency in understanding how UA contributes to the wider economic, social and environmental benefits that have been claimed. Ideally, there should be more studies of UA adopting a common approach to quantifying economic, social and environmental benefits using a shared theoretical framework. This would enable more justifiable and consistent claims regarding the cost and benefits of UA case study outcomes. For instance, small-scale gardening-style UA without mechanisation should deliver outcomes mostly towards a particular objective, while a different style of UA (e.g., a large-scale mechanised commercial UA farming operation) should deliver outcomes towards a different objective.

5. Conclusions and Recommendations

UA has gained significant focus from researchers, with an emphasis on economic, social and environmental aspects. From the study of 15 similar past research projects related to the feature studies of UA, a clear gap exists in studying UA using an integrated approach and developing a better system for evaluating the combined multiple benefits. Past quantitative UA research has tended towards economic evaluation but has done so in a very inconsistent way, with different studies accounting for costs and benefits differently, for example, by not including land or labour costs. Social and environmental benefits tend to be discussed in connection to UA but without clear quantification or connection back to economic viability, especially where trade-offs are concerned.

Several key features of UA (scale, distance, purpose, market mechanism and mechanisation) have been shown to influence the economic, social and environmental benefits of the system. Characterising and refining the governing features of UA will help us understand its positive and negative impacts as it continues to be scaled up across cities, in two important ways. Firstly, if people continue to participate in whatever form of UA they prefer, then a more refined theoretical framework will help decision-makers and policymakers to understand whether this increasingly popular activity is likely to be delivering actual cost savings, social benefits, food-related emissions reductions, or some combination of the above (or none of the above). Secondly, it is essential to analyse the salient features of UA to ensure sustainability, viability and replicability. For better viability and replicability, understanding the importance of the farming area, distance, purpose, mechanisation level, and market mechanisms will help identify the necessary planning and regulatory features for broader economic, social and environmental benefits. This analysis can therefore help to guide the formulation of corrective policy measures or program tools.

The economic, social and environmental objectives are intertwined and ultimately influence UA's sustainability, viability and replicability. UA has been growing in popularity irrespective of reporting on these costs and benefits. Our approach allows us to guide policy in the hope that policymakers can support particular types of UA that are more beneficial, ideally with multiple benefits. Likewise, the approach allows us to characterise the benefits and trade-offs with UA, in whatever form it takes, to better understand its positive and negative impacts, which is an essential component of system study either for developing a better UA system or refining existing ones. Further field-based exploratory studies focusing on key features of UA identified through past research are recommended, especially if such studies can contribute to the adoption and refinement of a consistent, holistic evaluation framework.

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