



## Research article

# Knowledge, attitudes, and perceptions of farmers towards urban agroecology in Malaysia

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## ARTICLE INFO

## Keywords:

Agroecological approaches  
Climate change  
Food security  
Resilient cities  
And sustainable urban agriculture

## ABSTRACT

Adopting agroecological approaches to build resilient urban food systems has recently gained traction around the world, but there is little to no reliable literature on the knowledge, attitudes, and perspectives of urban farmers towards these nature-based solutions in many developing nations, including Malaysia. The present study conducted an online survey to determine the extent to which local urban farmers understand and employ agroecology, as well as to assess their awareness and views on using agroecological practices and sustainable farm management. We found that the majority of respondents are unfamiliar with agroecological principles, with 79 % agreeing or strongly agreeing that implementing sustainable agricultural practices is challenging. However, more than 90 % of respondents are aware of the environmental consequences of excessive input utilisation. Our findings highlight the need for improved initiatives to promote agroecological approaches among farmers by sharing knowledge and best practices. In light of the growing threat posed by urban heat islands and the rapid urbanisation, this study offers novel insights into the knowledge gaps and perceptions about agroecological approaches among urban farmers, challenges that must be addressed to promote sustainable agriculture, and the potential role of farmers in achieving the three fundamental pillars of sustainability—planet, people, and prosperity.

## 1. Introduction

Research spanning the past decade demonstrates that the global food system is at a crossroads, with many nations still experiencing moderate to severe levels of undernourishment, particularly those that made the fewest strides towards modern agriculture and non-farm economic development and where policy stances have been insufficient in promoting agricultural development, improving infrastructure, reducing gender inequalities, and providing fundamental social services [1]. Climate change, ecological degradation, increased resource demand, biodiversity loss, and urbanisation warrant radical transformation of the food system to strengthen the four pillars of food security: availability, access, utilisation, and stability. Transforming the global food system will require involvement from multiple stakeholders (such as policymakers, researchers, farmers, and consumers) and nature-based solutions at each step of the supply chain, from governance to food production, processing, distribution, and consumption [2,3]. Beyond agricultural practices, the structural social injustices and ecological exploitation at the heart of industrial food systems must be considered to

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<https://doi.org/10.1016/j.heliyon.2024.e33365>

Received 19 January 2024; Received in revised form 17 June 2024; Accepted 20 June 2024

Available online 20 June 2024

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develop truly sustainable food systems [4]. Sustainable food system solutions, which include outcomes, drivers, and change actions, should address the underlying institutional, political, and economic causes of unsustainable food systems, as well as the historical, social, political, and cultural contexts in which they operate [4–6].

Urbanisation is a prominent example of anthropogenic modification of climate and natural landscapes. An estimated two-thirds of the world's population will live in urban areas by mid-century, potentially both benefiting and disrupting social and economic development for individual countries [7–9]. Certain food crops may not grow well in cities due to the urban heat island (UHI) effect, which makes urbanised areas to be warmer than non-urbanised areas [10]. Growing urbanisation, coupled with extreme heat events due to climate change, will directly impact global agriculture and food systems. Additionally, the coronavirus (COVID-19) pandemic highlights the fragility of large cities to unexpected global risks and crises, emphasising the need for research into robust and resilient food systems that can withstand climate change [2]. Urban agriculture, including urban farms, community gardens, and home gardens, is widely recognised for helping local communities economically and socially, increasing the connection between urban residents and their food, and offering educational opportunities and cost savings [11–13]. Rapid population growth, urbanisation, food insecurity, and climate change can be combatted using urban agriculture to support the economic, social, and environmental sustainability of cities [12,14].

Researching and improving dominant food systems (such as rice- or cereal-based cropping systems) using agroecological approaches, in both urban and rural areas, are necessary to ensure the social, economic, and ecological future of humans and all species. Ideally, agriculture should involve agroecological practice that mimics natural environmental cycles [2,4,15]. However, more comprehensive research is needed to characterise the complex human-environmental interactions that broadly affect sustainability [16]. Agroecological practices can produce an abundance of high-quality foods while improving soil fertility, nutrient cycling, agrobiodiversity, and food system resilience to social and ecological shocks. For example, diversified small-scale farms can increase yields using fewer inputs (such as land, water, and synthetic fertilizer) compared to industrial agriculture [11,17,18]. However, the frequent exclusion of small-scale production from national accounts has created ongoing debate over the actual and potential contributions of small-scale agriculture to food security, with estimates ranging from 30 % to 70 % depending mainly on how farm size is defined and how production is calculated [4,19,20]. Despite the controversy, the persistence of small-scale agroecological production systems worldwide demonstrates their continued importance for community livelihoods, cultural identity, and the environment. The presence of small farms also indicates the resilience of solidarity-based food production movements, which are frequently undermined by government subsidies for monocrop production and corporate consolidation [4,19–22].

Southeast Asian agricultural systems are particularly susceptible to trade-offs between food security and ecosystem services. Southeast Asia, made up of 11 geographically, culturally, and politically varied countries, is undergoing tremendous agricultural growth, driven by population increase, international trade, and technological progress [23]. Rapid development and intensification of agricultural processes challenge ecological resilience in the region. For example, resource demands and environmental change impact food production and livelihoods in agroecological zones that are characterised by labour-intensive and rain-fed agriculture, such as in Malaysia [24,25]. Addressing knowledge gaps for marginalized groups and creating a food system based on localism, participation, and equity will improve food security and food justice in the region [2]. Agroecology holds the potential to improve social networks in agricultural settings by encouraging urban farmers to adopt a holistic approach to reorienting their agricultural systems [17,26,27]. It can promote ecologically sustainable farming practices and build social systems in which small-scale farmers and food producers can thrive [20–22,27,28]. By strengthening and expanding existing networks and interactions among farmers in a particular region or country, agroecology can foster social cohesion and socioeconomic synergies via the exchange of agricultural information and inputs [27–29].

In Malaysia, urban agriculture is typically implemented on a small to medium scale, with an average land size of 0.25 acres. The most cultivated crops are temperate (such as spinach and lettuce) and tropical (such as vegetables, such as okra and brinjal) [30,31]. Because urban agriculture is still relatively new in Malaysia [30], little is known about how well local urban farmers are implementing sustainable approaches such as agroecology. Nonetheless, the 12th Malaysia Development Plan includes programmes aimed at developing the agricultural industry through urban agriculture, such as the Urban Community Agriculture Programme (ACF), which will benefit thousands of local farmers. This marks a noteworthy effort to promote sustainable agriculture in the country [30], especially given the dramatic increase in the number of urban farms locations in Malaysia following the COVID-19 pandemic (from 735 locations in 2019 to more than 17,000 locations in 2020) [31]. With the average local temperature projected to increase by up to 1.6 °C by 2050, there is a critical need to inform local urban farmers on crop selection and agroecological practices in the face of climate volatility [32,33]. Generally, farmers' lack of interest in agroecological practices as viable sustainable farming alternatives can be attributed to a variety of factors, including a lack of knowledge, training opportunities, and/or development initiatives [2]. Urban farmers need the necessary knowledge to improve agricultural production while contributing to food security. Essentially, the transition from conventional to agroecological systems requires farmers to redesign both their production and their commercialization systems [26,28,29]. Urban agroecology is known to offer multiple economic and social benefits for farmers or producers, particularly small-scale ones in terms of management and economic self-sustainability when appropriate education and awareness are put in place [2].

In this study, we sought to understand the factors surrounding agroecological farming among urban farmers in Malaysia. We evaluated their knowledge and attitudes towards sustainable agriculture through agroecology, as well as their existing farming approaches via an online survey. We also highlighted the potential contributions of farmers in sustaining urban food systems in a rapidly changing climate. This study was conducted in response to the growing importance of urban agroecology in the face of climate change, particularly due to UHI effect [2,10,18,28], as well as the realisation that there is a lack of literature on the knowledge, attitudes, and perspectives of urban farmers towards sustainable agriculture in Malaysia. The findings from this study are crucial for addressing

pertinent issues and assisting policy makers in developing policies that would strengthen the ecological and socioeconomic resilience of local urban food production. It is worth noting that our interest in urban agroecology was fueled by the rapid urbanisation and rising popularity of urban farms in Asia, as outlined in our previous work [2]. Overall, this study provides an in-depth understanding of urban farmers’ knowledge gaps and perceptions of agroecological approaches, underlying the challenges that must be addressed in order to promote sustainable urban agriculture.

## 2. Materials and methods

A carefully designed questionnaire was distributed to urban farmers from commercial farms in thirteen Malaysian states identified through the Department of Statistics Malaysia (DOSM) website (<https://v1.dosm.gov.my/v1/index.php>), which maintains the sample frame for agricultural data. The questions were designed in accordance with several previously published agroecology surveys [34–37], and refined in line with the Sustainable Development Goal (SDG) Indicator 2.4.1 [38] and the Tool for Agroecology Performance Evaluation developed by the Food and Agriculture Organization (FAO) of the United Nations [39]. The developed questions were related to agroecological approaches, resource-use efficiency, sustainable agriculture, and social behaviour supporting the achievement of the SDGs, especially SDG2 (Zero Hunger) and SDG11 (Sustainable Cities and Communities), and SDG13 (Climate Action). The questionnaire is available in Supplementary Material.

Our survey collected information on farmers’ socioeconomic demographic profiles as well as their knowledge, attitudes, and

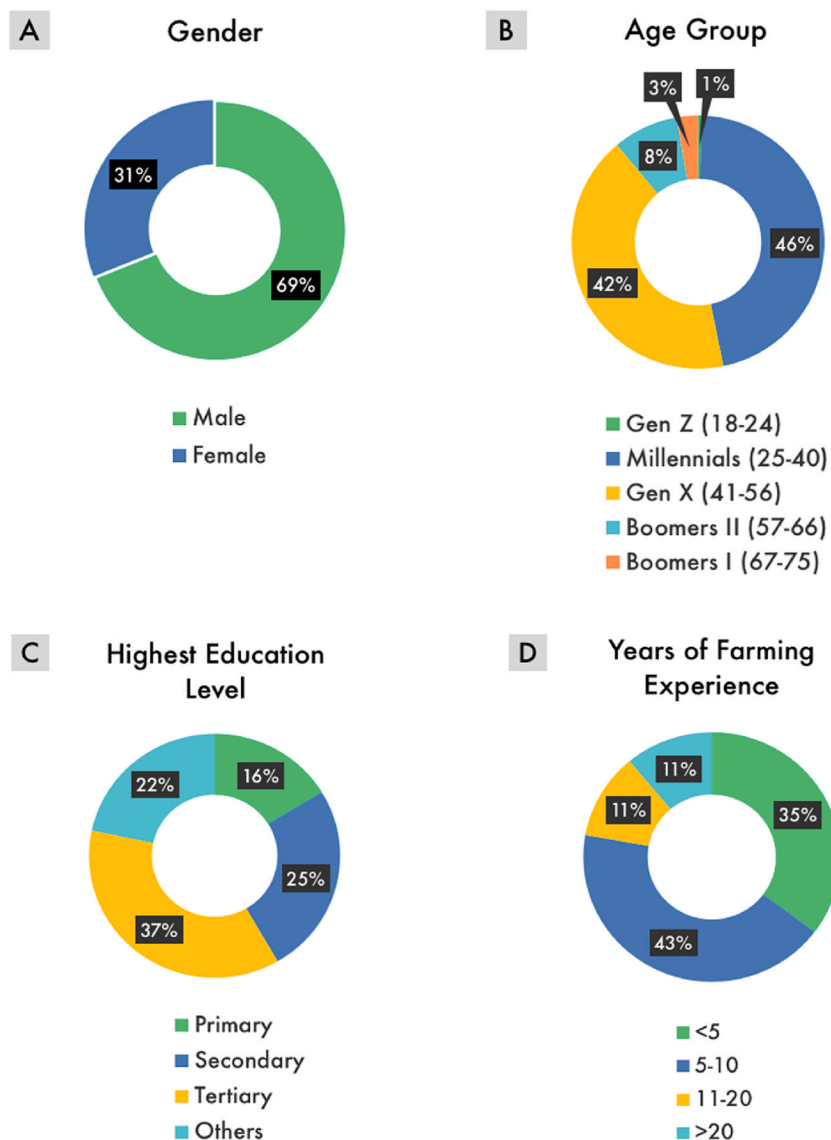


Fig. 1. Demographic information. (A) Gender. (B) Age group. (C) Highest education level. (D) Years of farming experience.

perceptions of agroecology and sustainable agriculture practices in cities. It used a combination of binary, multiple-choice selection, and Likert scale questions, in a manner comparable to other large-scale studies for the same purpose [35–40]. The complete questionnaire draft was improved by five subject-matter experts before being piloted with a random sample of urban farmers. The final version was submitted for ethical approval to the University Malaya Research Ethics Committee (UMREC), and the application was approved in 2021 (Reference number: UM.TNC2/UMREC.1445).

Formal data collection was conducted between September 2022 and January 2023. Out of 1050 survey invitations, 411 responses were received, representing approximately 40 % response rate, which is typical for online surveys. Wu et al. [41] reported that the average response rate to an online survey is 44.1 %, and that increasing the number of respondents did not necessarily result in greater response rate. To minimize sampling bias, a highly varied and deliberate survey outreach strategy was adopted, which included posting invitations on farming-related site pages, disseminating them via social media (such as Facebook), and contacting farmers directly using email addresses and contact numbers obtained from public databases and web search engines. Following data cleaning, 406 data points were determined to be valid for the final analysis.

The data was primarily analysed using descriptive statistics to understand the levels of knowledge, attitudes and perceptions about urban agroecology and sustainable practices among farmers. Non-parametric analyses were used because the majority of the variables selected for the study were nominal or ordinal data. The Mann-Whitney test [42,43] was used to compare gender groups, whereas the Kruskal-Wallis test [44] was used to compare other demographic details of respondents, including generational cohort, highest education level, and years of agricultural experience. The IBM SPSS Statistics for Windows Version 29.0 statistical software was used to carry out the statistical analyses.

### 3. Results

#### 3.1. Socio-economic demographics

The selected demographic details of the 406 respondents are presented in Fig. 1, which include gender, generational cohort represented by age group, highest level of education, and years of farming experience. The majority of respondents in this survey were males (69 %;  $n = 280$ ) in the millennial group (46 %;  $n = 187$ ), followed by those in the Gen X group (42 %;  $n = 171$ ). In terms of educational attainment, 41 % of the respondents completed primary (16 %;  $n = 66$ ) or secondary (25 %;  $n = 103$ ) education, while 37 % ( $n = 149$ ) had completed tertiary education. The majority of respondents have 5–10 years (43 %,  $n = 173$ ) of experience in urban farming, while the rest have less than 5 (35 %;  $n = 143$ ), 11–20 (11 %;  $n = 45$ ), or more than 20 years (11 %;  $n = 45$ ) of experience (Fig. 1).

#### 3.2. Farmer's knowledge towards urban agroecology

Although the term "agroecology" was coined in the 1920s, many different branches of the discipline, such as social and economic components, have since emerged, leading to confusion and misconception among scholars and the general public about the field [2, 15]. This is evident in the analysis of one of our survey questions, which asked farmers if they were familiar with agroecological principles (Fig. 2). Only 8 % of the respondents ( $n = 33$ ) have a thorough understanding of the principles of agroecology, and about 40 % have little (7 %;  $n = 27$ ) to no (33 %;  $n = 132$ ) knowledge of them. A lack of knowledge of agroecological principles among local farmers can pose a number of challenges to improving the sustainability of urban agriculture.

The Mann-Whitney and Kruskal-Wallis tests were carried out to determine the relationship between farmers' knowledge (Fig. 2) and the selected demographic variables (Fig. 1). Generally, the knowledge of local urban farmers on agroecology is similar regardless of their highest education level, but the knowledge differed by gender, generational cohort, and years of farming experience at a significance level of 0.01 (Table 1).

On a positive note, despite a general lack of understanding of agroecology among local urban farmers, more than 90 % of the

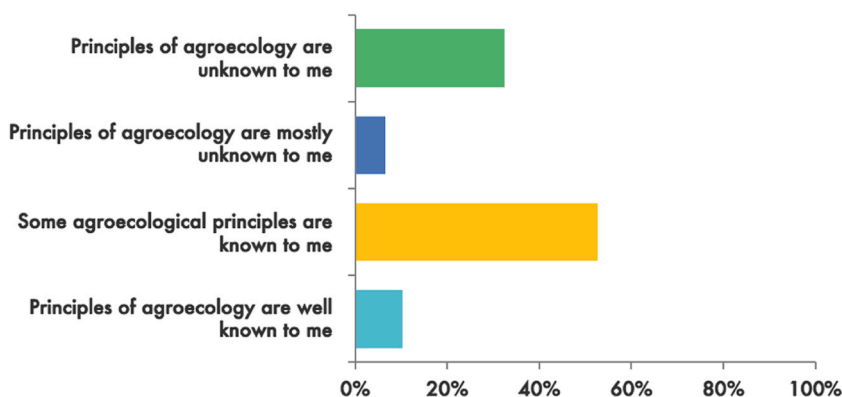


Fig. 2. Familiarity with agroecological principles.

respondents (Fig. 3) are aware of the environmental consequences associated with excessive use of inputs such as fertilizer (93 %, n = 378) and pesticides (95 %; n = 384). This may suggest that some local urban farmers practise integrated farm management, a concept that promotes sustainable agriculture [37]. Furthermore, approximately 80 % of respondents (n = 318) are aware of the nutritional values of crop products from their farm that could meet the demands of health-conscious consumers (Fig. 3), assisting in achieving urban nutritional security, which has a significant impact on urban health [44].

### 3.3. Farmer's attitudes and perceptions of urban sustainable agriculture

A 5-point Likert scale was used to assess respondents' attitudes towards sustainable agricultural practices, specifically whether they perceived adopting these practices may be difficult. The majority of respondents agreed (46 %; n = 188) or strongly agreed (33 %; n = 134) that the adoption of sustainable agricultural practices in their urban farm can be challenging, and only 10 % either disagreed (6 %; n = 23) or strongly disagreed (4 %; n = 16) (Fig. 4). Based on our analysis, the primary reason for this is that some of them are unfamiliar with agroecological practices. Nonetheless, approximately 60 % (n = 247) of the local urban farms produced more than three types of crops, implying that these farms can contribute to crop diversity, which is an important aspect of sustainable agriculture [45].

To better understand whether the local urban farmers implement sustainable agricultural practices, the respondents were asked if they use crop rotations, intercropping techniques, and water saving irrigation on their farm, as well as what they thought about those approaches. Interestingly, the majority of respondents practiced crop rotations and/or intercropping techniques (80 %; n = 323) on their farm, as well as water-saving irrigation (63 %; n = 256), though approximately 25 % were unsure if these approaches helped produce more agricultural output. Despite practicing those techniques, about half of the respondents had at least agreed that adopting the techniques was challenging (Fig. 5).

In terms of farm management, we found that 40 % (n = 161) of respondents produced crops that have been certified organic or were in the process of being certified organic (Fig. 6), indicating that some local urban farms are geared towards sustainable agriculture. Additionally, 67 % (n = 274) of respondents worked on farms that engaged in activities other than crop production, such as eco-tourism and aquaculture (Fig. 6). It is also worth noting that 38 % of the responded farmers (n = 154) have regular relations and participate in some events with the local community (Fig. 7). However, about 9 % of respondents (n = 35) did not engage with the local community, and approximately 26 % (n = 106) were unsure (Fig. 7). Raising the awareness of urban farmers about the importance of community engagement is critical, as social cohesion is a key factor in achieving sustainable agriculture through agroecology [2].

In order to understand farmers' perceptions of available knowledge sharing platforms in Malaysia, respondents were asked if they had ever attended any platforms for knowledge transfer and good practices, and if so, how satisfied they were with the experience. Of the 392 survey respondents, 63 % (n = 248) made an effort to join at least one platform relevant to knowledge transfer and best practices, but 72.6 % (n = 180) attended less than five times (Fig. 8). Of those who attended any platforms, approximately 60 % of these respondents were satisfied (41 %; n = 101) or very satisfied (26 %; n = 63), but 24 % (n = 61) were neutral and only 9 % (n = 23) were dissatisfied (Fig. 8) with it. This could be because agroecology is still a relatively new field in the country [2], with few awareness-raising initiatives currently underway. Appropriate measures must be taken to achieve sustainable urban agriculture.

## 4. Discussion

To sustain urban food systems in the face of deteriorating UHI effects and other climatic variables, as well as rapid urban population growth that leads to uncontrolled urbanisation, it is imperative to support and encourage farmers to adopt sustainable and nature-based agriculture. Transformative agroecology, which involves holistic ecological and socio-economic change through oriented research and action, is the best fit for the context [15,46]. Although anecdotal evidence of the importance of agroecology has been observed in recent years, there has been a lack of available information on the knowledge, attitudes, and perspectives of different

**Table 1**  
Association between demographic variables with knowledge of farmers.

H <sub>0</sub>	Category	Mean rank	p
Male and female farmers have the same level of knowledge on agroecology	Male	236.44	<0.001
	Female	130.31	
The knowledge of agroecology among farmers is similar across all age groups	18–24	266.50	<0.001
	25–40	195.93	
	41–56	227.22	
	57–66	123.88	
	67–75	198.68	
The knowledge of agroecology among farmers is similar regardless of education level	Primary	205.21	0.798
	Secondary	195.22	
	Tertiary	204.68	
	Others	209.91	
The knowledge of agroecology among farmers is similar regardless of the length of farming experience	<5	166.06	<0.001
	5–10	212.45	
	11–20	245.78	
	>20	245.78	

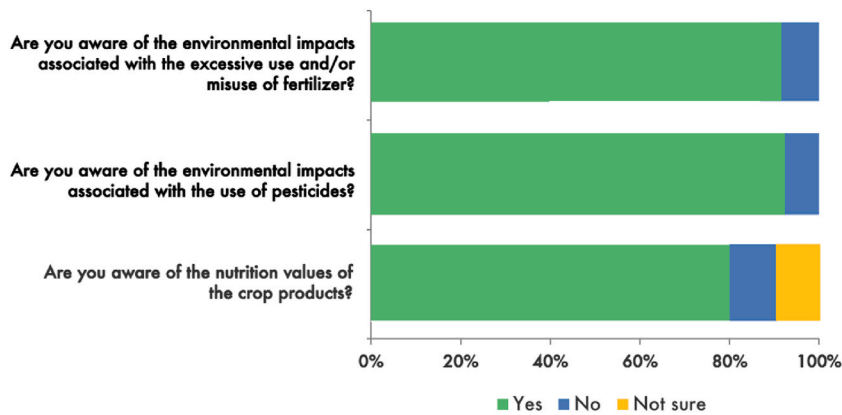


Fig. 3. Awareness of sustainability.

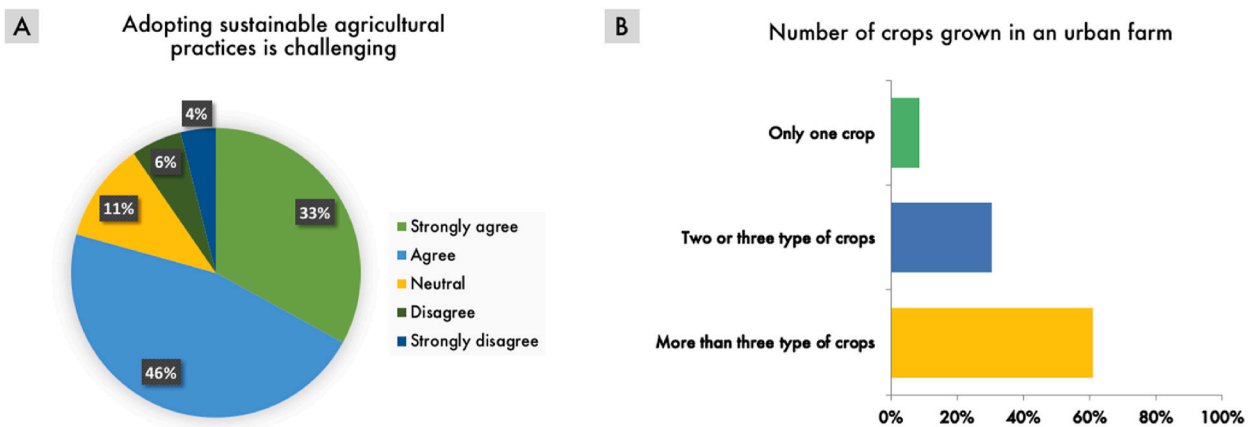


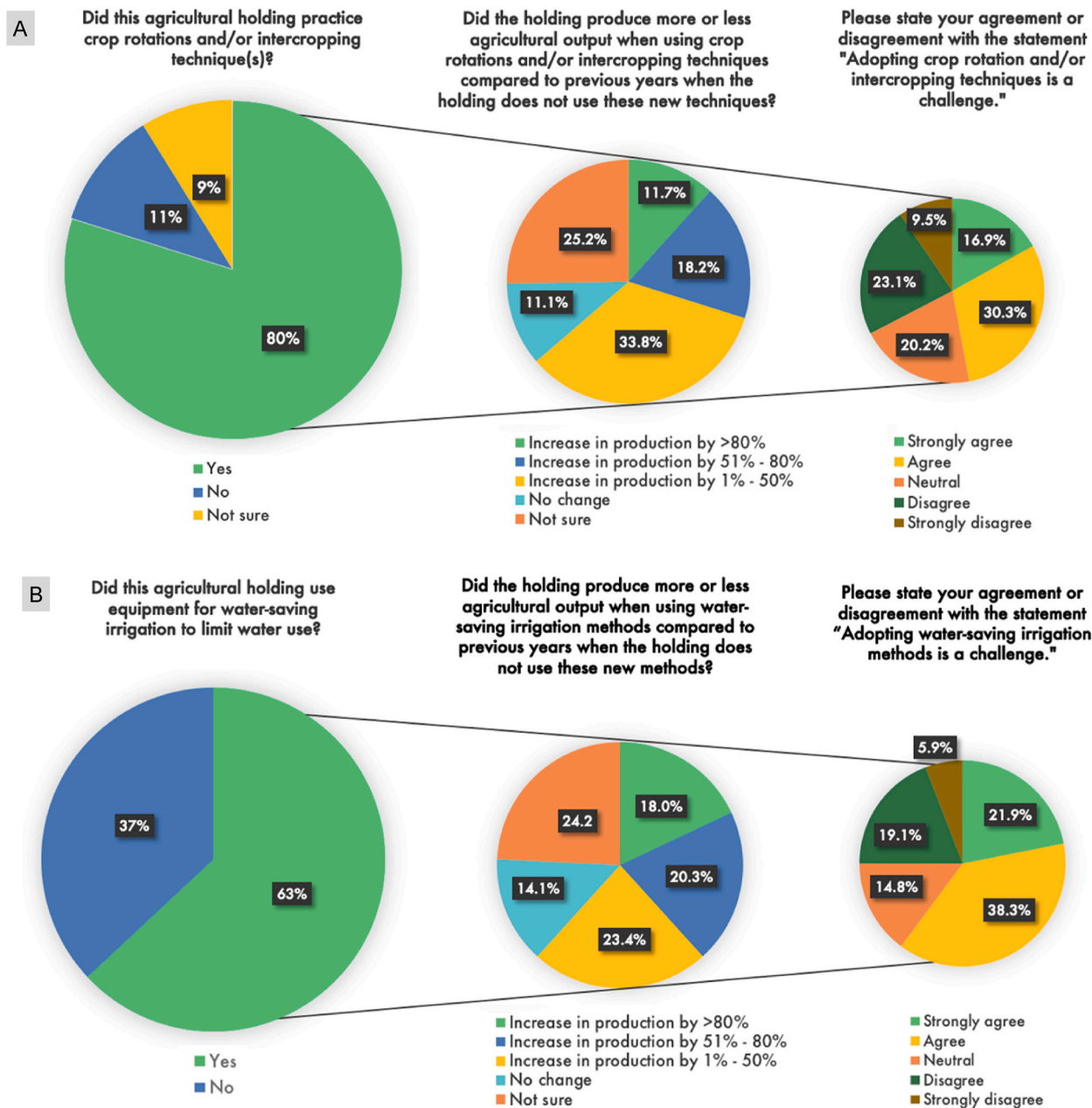
Fig. 4. Attitudes towards sustainable agricultural practices. (A) Adopting sustainable agricultural practices is challenging. (B) Number of crops grown in an urban farm.

actors (such as farmers and policymakers) about the field in both local and regional contexts [2,47]. Therefore, the current study sought to determine the extent to which local urban farmers understand and employ agroecological approaches, particularly low-input agriculture practices, as well as to assess their awareness and perceptions of the utilisation of agroecological practices and sustainable farm management.

The demographic information collected in this study (Fig. 1) is generally consistent with previous reports, in which the majority of urban farmers are between the ages of 25 and 56 and have completed tertiary education [48,49]. Rezai et al. [49] reported that young urban dwellers with higher levels of education tend to be more involved in urban agriculture activities. Based on our survey, the majority of respondents were males with less than ten years of farming experience (Fig. 1). The lower percentage of female farmers, which is consistent with previous reports [50–53], could be due to a lack of opportunities to participate in cooperative organisations, and policies that tend to overlook them [54]. The lack of opportunities among females may also contribute to the differences in knowledge on agroecology between males and females (Table 1). According to Inhetveen et al. [55] and Yan et al. [53], women play a critical role in agricultural production and management in developing countries, producing up to 80 % of food and accounting for half of global food production, it is therefore critical to promote their economic rights, adjust policy propaganda, and balance their economic and social development on a local or regional scale. It is expected that the majority of our respondents have only a few years of urban farming experience, given that urban farming in Southeast Asia is still relatively new, limited, and scattered [56], and that it has historically been difficult to support the expansion of urban agriculture in cities due to its low economic viability [57].

Despite growing global awareness of sustainable agriculture through agroecology, there is uncertainty and confusion among different actors (such as farmers) about its nature-based approaches, which may stymie the progress of this promising field towards sustainable urban agriculture. Our survey found that many local urban farmers were unfamiliar with agroecology (Fig. 2). When asked if they are familiar with the principles of agroecology, approximately 40 % (n = 159) of respondents have little or no knowledge of the principles, regardless of their education level (n = 406; p = 0.798) (Fig. 2; Table 1). This is consistent with the findings by Prost et al. [58], which highlighted the need for the development of knowledge and tools to support farm transitions to agroecology, with content and layout that farmers can understand. By and large, the knowledge of agroecology among local urban farmers are very likely (p <





**Fig. 5.** Current agricultural practices and perceptions associated with sustainable farming. (A) Agricultural holdings practiced crop rotation and/or intercropping technique(s). (B) Agricultural holdings used equipment for water-saving irrigation to limit water use.

0.001) to be influenced by their gender, age group, and years of farming experience (Fig. 2; Table 1). A similar finding was reported in a survey [59], which investigated the theoretical and empirical influences of farming experience on urban dwellers' entrepreneurial decisions. While experience can increase farmers' knowledge and attitudes towards sustainable farming, age can have a negative impact on their attitudes [60]. This could be attributed to an unwillingness or resistance to change among the older generation of farmers who are accustomed to conventional farming [61]. On the other hand, experience has an impact on farmer's growing knowledge and skill in how to profit from farming while protecting the environment [60]. There was no relationship between agroecology knowledge and education level (Table 1), which is understandable considering that agroecology is an emerging field [2], with education in agroecology only being widely considered in recent years [62,63]. FAO [63] recognised a gap in agricultural education programmes, both in higher and vocational education systems, to get a better grasp of agroecological approaches. To transform agricultural systems towards resilience, it is essential to ensure that proper agroecological education is available in all regions or countries.

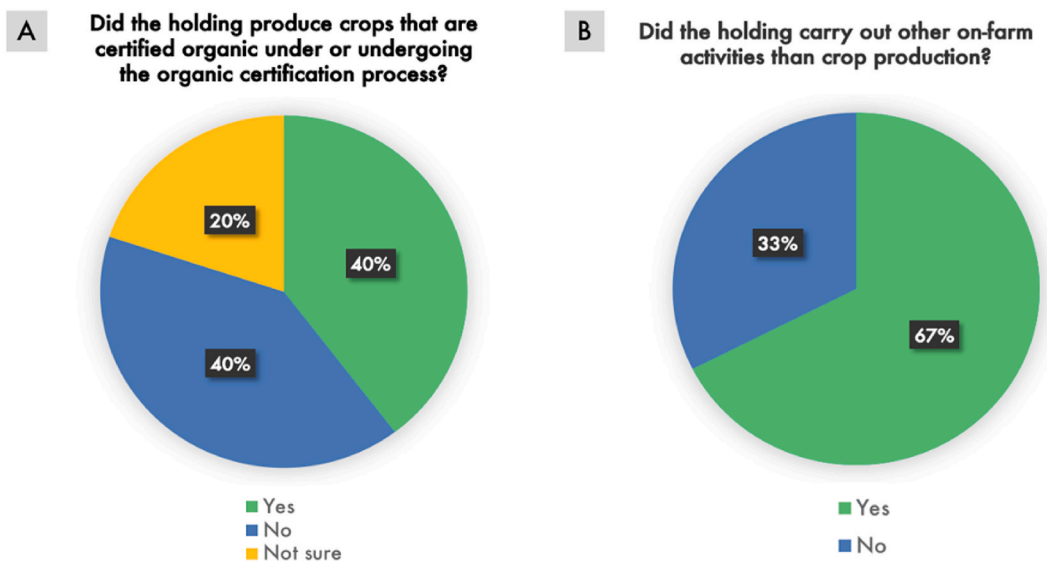


Fig. 6. Approaches to sustainable and/or integrated farm management. (A) Agricultural holdings produced crops that are certified organic under or undergoing the organic certification process. (B) Agricultural holdings carried out other on-farm activities than crop production.

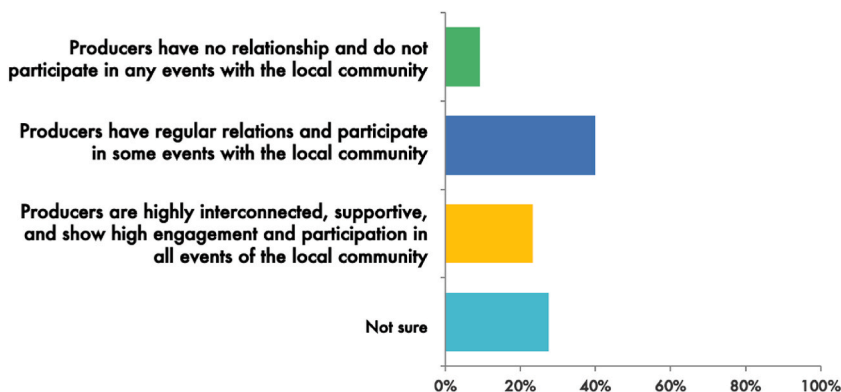


Fig. 7. Attitudes towards the necessity of community engagement to enhance farming systems.

Although there is ambiguity surrounding agroecological approaches among our local farmers, more than 90 % of respondents are aware of the adverse effects on the environment caused by the excessive utilisation of agrochemicals such as pesticides and fertilizer (Fig. 3). This is a positive outlook in the local context, though several recent studies suggest that farmers' knowledge and awareness of the dangers of agrochemicals remains relatively low, particularly in developing nations [64,65]. It is also worth noting that the vast majority of respondents (78 %; n = 318) are aware of the nutritional benefits of their crop products that could satisfy the needs of health-conscious urban dwellers (Fig. 3), thereby having a significant impact on local urban nutrition and health [45,66]. Nonetheless, local urban farmers generally perceived the adoption of agroecology as difficult, with 79 % (n = 322) of them either agreeing or strongly agreeing that sustainable agriculture practices can be challenging (Fig. 4). This corroborates with the study conducted by Gütschow et al. [67], and is most certainly attributed to a general lack of knowledge about agroecology practices. Additionally, among the respondents that adopted crop rotations and/or intercropping techniques (n = 328) and water-saving irrigation (n = 256), about half of the respondents agreed or strongly agreed that adopting crop rotations and/or intercropping techniques (47 %; n = 153) and water-saving irrigation (66 %; n = 169) were challenging (Fig. 5), which could explain why these techniques have yet to be widely adopted not only in Malaysia but globally [68].

Due to the effects of globalization and rapid structural change, farmers today require a wide range of competencies to manage and sustain their farms, ranging from effective labor management to agronomic skills and advanced technology [69]. Data from our survey revealed that local urban farmers have begun to implement some farm management sustainability initiatives, with 40 % (n = 161) of respondents producing crops that were certified organic or were in the process of being certified organic, and 67 % (n = 274) working on farms that engaged in activities other than crop production, including eco-tourism and aquaculture (Fig. 6). However, some urban farmers had little to no engagement with the local community (Fig. 7), which is a concern that needs to be addressed because



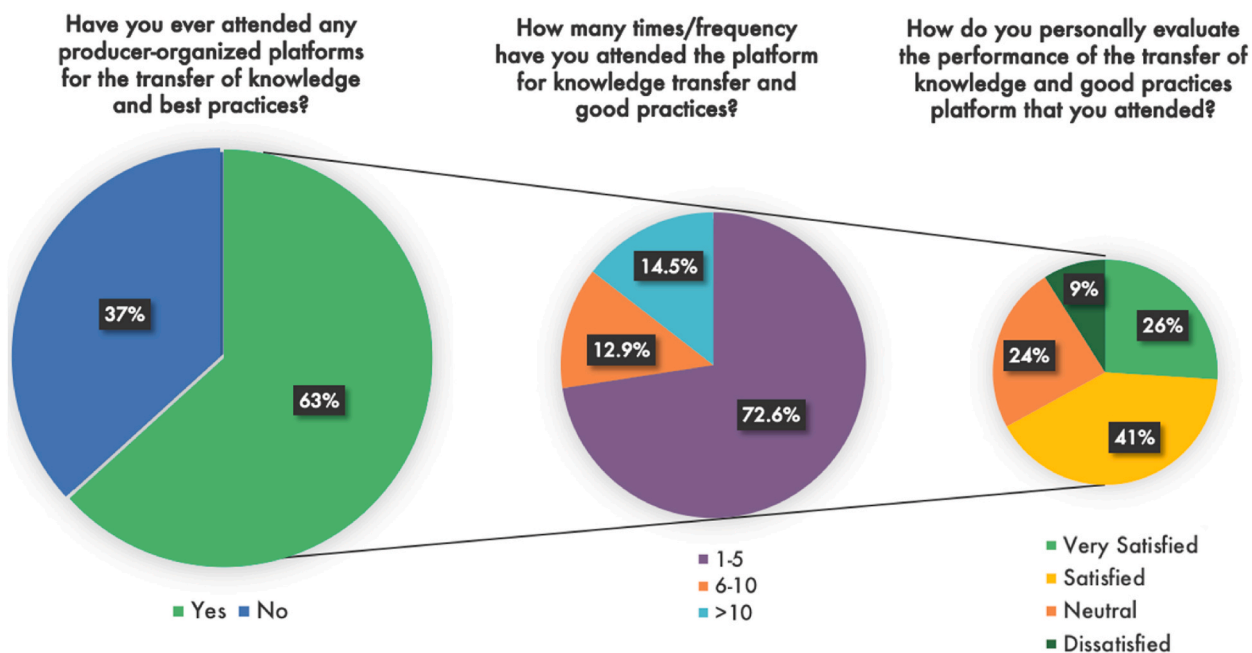


Fig. 8. Efforts and perceptions of transfer of knowledge and good agricultural practices.

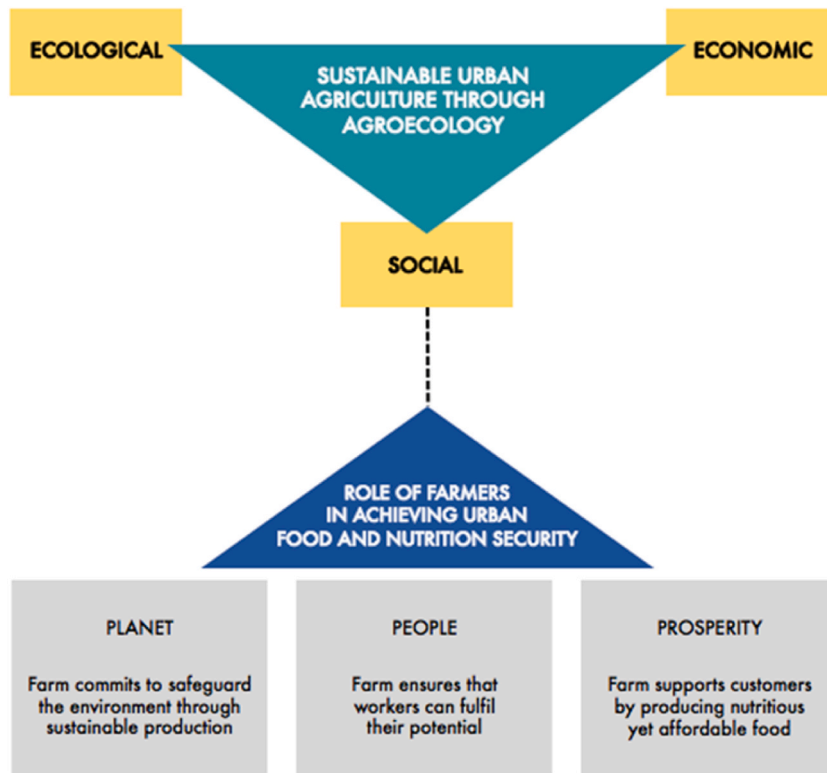
community engagement is becoming increasingly important in promoting sustainable food production and consumption, as well as bolstering efforts to strengthen urban food systems [70]. This will be critical in achieving multiple SDGs, especially SDG11 (Sustainable Cities and Communities) and SDG12 (Responsible Consumption and Production).

While approximately 63% of the 406 respondents in our survey joined at least one platform related to knowledge transfer and best practices, only about 60% were satisfied or very satisfied with the available platform(s) (Fig. 8). As such, efforts should be made to improve or develop effective platforms for transferring knowledge and best practices to local farmers. It is also critical for relevant actors, particularly researchers, to highlight novel strategies and raise pertinent issues to policymakers in order to adopt legislation or develop appropriate policies that can improve farmers' knowledge and awareness of agroecology and sustainable food production at large [71,72]. However, one of the ultimate challenges to promote urban agroecology is to create a dynamic integrated network capable of bridging the knowledge gap between various actors, particularly between researchers who design climate-resilient urban systems and farmers who will use and manage the systems [2,71], because transformative agroecology is complex and involves ecological, economic, and social dimensions (Fig. 9).

Urban agroecology is gaining momentum throughout the world, but farmers who adopt it could face some challenges that must be overcome before it can reach its full potential. While urban agroecology faces multiple challenges, Cheng et al. [2] identified several feasible ways to promote this sustainable farming alternative, including fostering knowledge sharing between actors (such as researchers and urban farmers). As urbanisation and UHI continue to threaten food systems in many cities worldwide, the role of urban farmers in reducing hunger and malnutrition in the face of climate change is more important than ever [73–75]. Based on our recent review on urban agroecology [2] and the findings of this study, we identified the potential contributions of farmers in assisting to attain urban food and nutrition security through agroecological approaches, as presented in Fig. 9. We strongly urge urban farms in Malaysia and elsewhere to protect the environment by implementing suitable agroecological practices that result in sustainable production, to ensure that all farm workers can realise their full potential by participating in relevant knowledge transfer or social engagement activities that can improve their knowledge and awareness of sustainable agriculture, and to support the urban dwellers by producing nutritious yet affordable food for local consumption (Fig. 9). Correspondingly, the three fundamental pillars of sustainability—planet, people, and prosperity—could be achieved.

### 5. Conclusions

Based on our survey, the majority of local urban farmers are unfamiliar with the principles of agroecology but are aware of the environmental issues brought on by the excessive use of inputs or agrochemicals such as fertilisers and pesticides. We found that farmers generally perceived the adoption of agroecological approaches as challenging, owing primarily to a lack of knowledge about agroecology, a relatively new yet promising field that can help them increase profits while protecting the environment. Our overall findings highlight the need for better initiatives to share knowledge and best practices that support and promote agroecological approaches and raise farmers' understanding and awareness of urban sustainable agriculture. Yet, this can only be achieved if different actors—including researchers, decision-makers or policymakers, and the general public—play their respective roles. Local



**Fig. 9.** Dimensions of agroecology and farmers' potential contributions to sustaining urban food and nutrition security through agroecological approaches.

policy-makers can collaborate with researchers to make agroecology education more inclusive, while also improving support mechanisms for sustainable agriculture, such as subsidies and tax incentives for farmers who adopt agroecological approaches. Our survey has two major limitations: (1) the sample cannot be considered representative of the population outside of Malaysia because urban agriculture status may vary by country, and (2) there is a possibility of low respondent coverage due to the difficulty in estimating coverage in the burgeoning local urban farming industry following the COVID-19 pandemic. Our findings, however, are significant in the local context, and they offer unprecedented insights into farmers' knowledge, attitudes, and perceptions about urban agroecology, enabling us to suggest how urban farmers might help realise the SDGs that focus on the planet, people, and prosperity, which are the three cornerstones of sustainability. Future research should go beyond the local scale to assess the viability and applicability of various agroecology approaches on a regional or global scale, especially for urban agriculture, which is much needed at a time when rapid urbanisation and UHI pose a threat to global food and nutrition security. In conclusion, the present paints a compelling picture of Malaysian farmers' understanding and views towards the principles and implementation of urban agroecology. Increased education and awareness, coupled with sound legislation or regulations, could help address the underlying challenges, particularly farmers' misperceptions and concerns about the difficulty and practicability of agroecology practices.

#### Statements and declaration

Informed consent was obtained from all the respondents. The study was reviewed and approved by the Research Ethics Committee of Universiti Malaya, with the approval number: UM.TNC2/UMREC\_1445. All participants provided informed consent to participate in the study.

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

#### Data availability statement

The data supporting the findings of this research are available upon request from the corresponding author. The data is not publicly available because it contains information that could compromise the privacy of survey respondents.

## CRedit authorship contribution statement

**Nurul Syafiqah Noor Azmi:** Writing – original draft, Methodology, Investigation, Formal analysis. **Yin Mei Ng:** Writing – review & editing, Validation, Supervision, Data curation, Conceptualization. **Muhammad Mehedi Masud:** Writing – review & editing, Validation. **Acga Cheng:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Acga Cheng reports financial support and article publishing charges were provided by University of Malaya. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

This research was supported by the projects IIRG002D-2020FNW, PV059-2023, and RMF1229-2021, with Universiti Malaya, Malaysia funding a portion of the Article Processing Charge (APC). The publication is also partially funded by the Faculty of Business and Economics, Universiti Malaya, Malaysia Special Publication Fund.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e33365>.

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