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Hydroponics for Food Self-Sufficiency in an Urban Pesantren: Evidence of Reduced Vegetable Expenditure and Improved Student Competencies

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Abstract

Islamic boarding schools (*pesantren*) in Indonesia are increasingly developing as centers of community empowerment. However, daily food provision remains a challenge, especially in urban areas with limited land and budget constraints. This community service program used a Participatory Action Research (PAR) approach to develop a hydroponics-based urban farming model to strengthen food self-sufficiency and improve students' practical agribusiness skills. Conducted over one year, the program involved needs assessment, socialization, hydroponics training, greenhouse installation, and ongoing mentoring. A total of 22 participants completed the program. The hydroponic unit achieved four harvest cycles, producing an estimated 96–104 kg of leafy vegetables annually. With a local retail value of around Rp18,000 per kg, the harvest contributed an estimated annual food savings of Rp1.7–1.9 million. Competency assessment also showed notable improvement, with average participant scores increasing from 52 to 82. These findings indicate that hydroponics offers a practical, scalable, and low-space solution for supporting food resilience and skill development in urban *pesantren*.

Keywords Food Self-Sufficiency; Hydroponics; Participatory Action Research; *Pesantren* Empowerment; Urban Agriculture

1. INTRODUCTION

Islamic boarding schools (*pesantren*) in Indonesia operate as integrated socio-educational ecosystems in which learning, daily life, and community interaction occur within the same institutional setting. In parallel with their religious and educational missions, *pesantren* increasingly function as local empowerment infrastructures through entrepreneurship development, cooperative initiatives, and community-oriented programs that support socio-economic independence (Ma'arif et al. 2023; Mi'raj, Zaki, and Hasib 2023; Siregar et al. 2025). Within this institutional ecosystem, resilience is shaped not only by pedagogical continuity but also by the capacity to sustain routine operational needs—particularly food provision—under limited space and financial constraints. For many urban and peri-urban *pesantren*, dependence on external markets creates recurring expenditure pressures. It exposes them to price volatility and supply disruptions, reinforcing the strategic relevance of local food provisioning as a component of institutional stability and welfare.

Urban agriculture has been increasingly positioned as a practical pathway for strengthening food security and resilience in land-scarce settings by shortening supply chains and enabling locally embedded food production. Contemporary reviews emphasize that urban agriculture contributes not only to food access but also to broader sustainability outcomes, including community participation, learning processes, and place-based stewardship, while also highlighting implementation barriers related to governance, planning tools, and institutional coordination (Cassatella and Gottero 2025; Mirza, Waseem, and Rana 2025; Senthamizh and P 2025). Evidence syntheses further suggest that the measurable impacts of urban agriculture initiatives depend on how well program design aligns with local constraints (space, water, labor) and on whether institutions can sustain routines beyond the initial installation phase, especially through participatory governance and mentoring mechanisms that support continuity.

Within the spectrum of urban agriculture technologies, hydroponics is particularly relevant for institutions facing land scarcity because it enables soil-less production in compact, controlled environments and can be scaled to fit limited spaces while maintaining hygienic output and predictable cultivation cycles. Recent literature also highlights sustainability-related considerations in hydroponic systems, including resource efficiency, circular nutrient strategies (e.g., bioponics), and life-cycle trade-offs between open and closed systems—issues that become important when interventions aim to be long-lasting rather than demonstrative (Fathelrahman et al. 2025; Fussy & Papenbrock 2022; Sousa et al. 2024; Szekely and Jijakli 2022). Beyond production, hydroponics offers a structured learning platform: routines such as nutrient preparation, monitoring, maintenance scheduling, and harvesting can be embedded into student training and institutional workforce development, aligning with educational evidence that hands-on cultivation programs can strengthen food literacy and skills formation when sustained over time (Elsahoryi et al. 2025; Khastini and Maryani 2025; Stage et al. 2025).

To ensure that technology adoption translates into institutional practice rather than short-term activity, the program reported in this paper adopts a Participatory Action Research (PAR) orientation. PAR emphasizes co-definition of problems, co-design of solutions, iterative reflection, and shared ownership of implementation, which is increasingly recognized as a rigorous approach for community and institutional interventions addressing food-related outcomes (Cornish et al. 2023; Feekery 2024; Gélineau, Dupéré, and Richard 2024; van der Vlegel-Brouwer, Eelderink, and Bussemaker 2023). In food-security contexts, participatory interventions and co-creation approaches are repeatedly found to improve feasibility and acceptability because beneficiaries act as co-implementers who sustain routines, adapt to constraints, and translate training into day-to-day institutional practice (Doustmohammadian et al. 2022; Whelan et al. 2023). His emphasis is also consistent with resilience-oriented scholarship that highlights how social capital and collective action shape the capacity to buffer food insecurity and sustain adaptive responses (Egamberdiev 2024; Yusriadi 2025).

Despite a rapidly expanding literature on urban agriculture, hydroponics, and participatory empowerment, applied evidence that positions *pesantren* as an operational food-production unit—rather than treating *pesantren* only as an educational or social venue—remains limited. The literature frequently reports urban agriculture impacts in households or community gardens (Falkowski et al. 2022; Schoen et al. 2021); (Mirza et al. 2025; Senthamizh and P 2025) Yet fewer contributions document institution-based routines with measurable operational outputs (harvest cycles and yields), economic implications (food expenditure savings), and human-capital formation (skills acquisition) within the *pesantren* ecosystem. This evidence gap constrains replication for urban *pesantren* that seek not merely training activities but a workable operational model that can be sustained across time.

This paper addresses that gap by reporting a PAR-based hydroponic urban farming intervention implemented as a staged institutional program—socialization, training, installation of a small greenhouse unit, and year-long mentoring—evaluated using operational and human-capital indicators aligned with institutional replication needs. In doing so, the paper reframes *pesantren* as a micro food-production unit with repeatable routines, linking urban agriculture sustainability discussions to concrete institutional outcomes: partial subsidization of vegetable needs, reduced food expenditure, and measurable competence gains among *santri* and staff. The contribution is therefore both substantive (food resilience and capability building in an urban *pesantren*) and practical (a replicable program architecture and monitoring logic for community service and policy scaling), extending contemporary debates on how urban agriculture initiatives can deliver durable social and economic value when embedded in institutional governance structures (Cobo et al. 2011).

This community service program had two primary objectives. First, it aimed to strengthen food supplementation and institutional food self-sufficiency by establishing and operating a small-scale hydroponic unit within the pesantren environment. The hydroponic system was designed to produce leafy vegetables through repeated harvest cycles over one year, thereby partially supporting routine vegetable consumption and reducing food expenditure. This objective was assessed based on the number of harvest cycles completed, total vegetable yield produced, and estimated cost savings in Indonesian Rupiah. Second, the program sought to enhance the practical skills of *santri* and pesantren staff in the management of hydroponic production. Through participatory training and sustained mentoring, participants were expected to develop competencies in system installation, nutrient preparation, routine maintenance, and harvesting. This objective was evaluated using a pre–post competence assessment to measure changes in participants' technical knowledge and practical skills throughout the program.

2. METHODS

This community service applied a Participatory Action Research (PAR) design so that problem diagnosis, decision-making, implementation, and evaluation were co-produced with *pesantren* stakeholders, ensuring contextual fit and program sustainability (Cornish et al. 2023; McGrath et al. 2025; van der Vlegel-Brouwer et al. 2023). PAR was selected because participatory approaches are consistently associated with stronger ownership, higher feasibility, and greater continuity of food-security practices beyond the formal program period (Doustmohammadian et al. 2022). The program was implemented at Pondok *Pesantren* As-Sattar Darush Shodiqin (urban area, Malang Regency) and involved *santri* and *pesantren* managers who were directly linked to routine food provision and daily operational activities, supported by agricultural experts as resource persons during technical sessions (Whelan et al. 2023).

Measurement instruments were defined a priori to capture process, outputs, and capability gains in a form suitable for participatory evaluation. First, participation intensity was recorded using an attendance and role log documenting session attendance and task involvement across stages (e.g., seeding, nutrient mixing, maintenance, harvesting). Second, hydroponic implementation fidelity was assessed using structured observation checklists and field-note templates to document adherence to standard operating procedures (SOPs), including nutrient preparation, cleaning schedules, monitoring routines, and corrective actions during troubleshooting. Third, production performance was tracked using a hydroponic production log that recorded planting dates, crop type, harvest dates, and harvest quantity per cycle, enabling summarization of harvest frequency and yield indicators as processed outputs. Fourth, capacity building was measured using a pre–post competence checklist/score (0–100) covering practical domains relevant to independent operation (installation readiness, nutrient mixing accuracy, routine maintenance, and harvesting/post-harvest handling). Finally, stakeholder perceptions and contextual constraints were captured through semi-structured discussion guides for participatory workshops and focus group discussions to support reflection and iterative adjustment typical of PAR cycles (Cornish et al. 2023; Feekery 2024; Gélineau et al., 2024)

Data collection used triangulated techniques to capture both process and outcomes, including participatory workshops, focus group discussions, structured observation, documentation of activity implementation, and production logs of hydroponic outputs (Cornish et al. 2023; Gélineau et al. 2024). Ethical clearance for community service implementation was ensured through formal institutional permission from the *pesantren* leadership prior to field activities, including approval of the program schedule, data-collection procedures, and roles of participating *santri* and managers. Participation was voluntary and based on informed consent obtained before workshops, discussions, and observations, with a clear explanation of program objectives, the types of data collected, expected time commitments, and the right to decline or withdraw at any stage without any consequences. To uphold confidentiality, no personally identifying information was recorded in transcripts or observation notes; participants were referred to using codes or group identifiers, and reporting was presented in aggregated form to prevent attribution of specific statements or performance to individuals. All documentation and logs were stored securely and accessed only by the service team for analysis and reporting.

Participatory workshops and group discussions were used to map food needs, identify constraints (land, budget, skills), and agree on the most feasible urban-farming option, aligning with evidence that formative, stakeholder-led diagnosis is a key characteristic of effective participatory food-security initiatives (Doustmohammadian et al. 2022). Observation sheets and field notes were used to record adherence to hydroponic procedures, maintenance routines, and participant engagement across stages, supporting iterative learning cycles typical of PAR (Feekery 2024).

The intervention operationalized urban farming through a hydroponic system because hydroponics is widely documented as suitable for space-limited settings and capable of producing vegetables with controllable input efficiency when managed properly (Rajendran et al. 2024; Sousa et al. 2024; Szekely and Jijakli 2022). Technical choices emphasized practicality for *pesantren* conditions, including simple installation, routine nutrient management, and maintenance protocols that can be continued independently; this emphasis aligns with findings that hydroponic adoption improves when training is coupled with hands-on practice and mentoring rather than standalone instruction (Khastini and Maryani 2025; Wibawa, Wulandari, and Saputra 2025). Sustainability considerations (water and nutrient use, operational feasibility, and system selection) were incorporated in implementation decisions because comparative assessments show that hydroponic system design influences resource efficiency and environmental performance (Fathelrahman et al. 2025; Sousa et al. 2024).

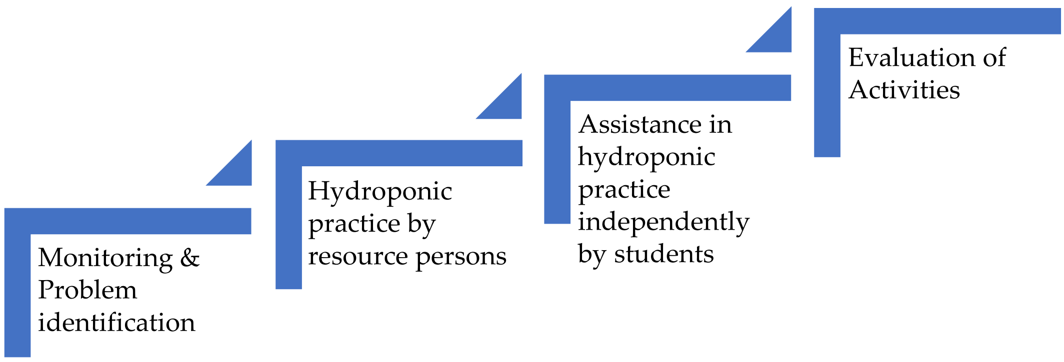

Figure 1: Stages of Service Implementation

Source: Community service team, 2026

Figure 1 presents the staged implementation pathway in a linear, stepwise flow diagram (from left to right) that culminates in evaluation, indicating a progressive PAR cycle from diagnosis to independent practice. The first stage was monitoring and problem identification, conducted after initial data collection to clarify causes, impacts, and priority constraints affecting food self-sufficiency. This stage produced an agreed problem map and defined the intervention focus on hydroponic urban farming, consistent with participatory approaches that prioritize locally negotiated problem definitions (Cornish et al. 2023; Doustmohammadian et al. 2022). The second stage was hydroponic practice by resource persons, starting in month one, covering installation, seed distribution, seeding readiness assessment, and troubleshooting, followed by plant enlargement and care practice with periodic monitoring. The third stage was mentoring of hydroponic practice by *santri*, emphasizing independent execution from seeding through harvest and post-harvest handling under supervision, because mentoring is frequently reported as the mechanism that translates training into sustained skill acquisition in community-based agricultural initiatives (Whelan et al. 2023; Wibawa et al. 2025). The fourth stage was evaluation of activities, implemented through structured monitoring and reflection sessions to capture obstacles, adapt routines, and confirm readiness for independent continuation, reflecting the iterative improvement logic central to PAR (Feekery 2024; McGrath et al. 2025).

Program success was operationally defined using pre-specified indicators across participation, capability improvement, and production outputs. Participation success was defined as at least 70% of registered participants attending and actively engaging in at least 70% of sessions and practice stages (installation support, seeding, maintenance, and harvest). Capability success was defined as an increase of at least 20 points (≥20%) in the pre–post competence score covering installation readiness, nutrient mixing accuracy, maintenance routines, and harvesting/post-harvest handling. Production success was defined as completing at least one regular harvest cycle during the program period, with a minimum recorded yield threshold per cycle (kg/cycle) in the production log, and compliance with routine maintenance schedules documented in observation sheets.

Data analysis combined descriptive and participatory evaluation techniques. Quantitative summaries described participation intensity (attendance and task completion rates), hydroponic process outputs (seedling survival rate and maintenance compliance), and production indicators (harvest quantity and frequency) to present results as processed data rather than raw records (Elsahoryi et al. 2025). Pre–post comparisons of knowledge and practice readiness were analyzed using paired comparisons; when assumptions of normality were not met, nonparametric alternatives, such as the Wilcoxon signed-rank test, were considered appropriate for small-group training contexts (Stage et al. 2025). To examine the learning–engagement linkage, Spearman's correlation was used to assess the association between participation intensity (attendance/role frequency) and improvement in knowledge or practice scores, as a simple, non-regression association test suitable for community service evaluation (Stage et al. 2025). Qualitative data from discussions and reflection meetings were analyzed thematically to identify perceived benefits, constraints, and enabling factors for program continuation, supporting explanation of mechanisms behind observed outcomes (Gélineau et al., 2024; van der Vlegel-Brouwer et al., 2023). Integration of quantitative indicators and qualitative themes followed a convergence logic to strengthen validity through triangulation, a common approach in participatory and co-creation interventions (Cornish et al. 2023; Whelan et al. 2023).

3. FINDINGS AND DISCUSSION

3.1. Participatory Diagnosis Results

The initial participatory assessment identified that food self-sufficiency had not been achieved because daily food provisioning largely depended on self-help funding. At the same time, limited financial resources, limited land availability in an urban setting, and limited *santri* skills in agriculture and agricultural technology constrained the institutional capacity to internalize food production. This pattern is consistent with the broader urban-agriculture literature, showing that land scarcity, skills gaps, and weak resource buffers often become the binding constraints for small institutions attempting to initiate food-production activities in dense urban areas (Cassatella and Gottero 2025; Mirza et al. 2025). The diagnosis stage also clarified that the intervention needed to prioritize a low-space, learnable, and operationally maintainable production model rather than a land-intensive approach, aligning with evidence that feasibility and continuity are the core determinants of outcomes in community food-security initiatives (Doustmohammadian et al. 2022). The resulting problem map (Table 1) operationally linked each constraint to an implementation implication and a processed program response, which is consistent with participatory action logic, where locally validated constraints are converted into actionable design decisions (Cornish et al. 2023).

Table 1. Consolidated results from the participatory diagnosis and program response

Key Constraint Identified	Operational Implication	Program Response (Processed Output)
Reliance on self-help funds for food	High recurring operating burden	Hydroponic production is positioned as an internal supplementation for vegetable needs
Limited land in the urban *pesantren* setting	Conventional cultivation is not scalable	Selection of hydroponics as a space-efficient approach
Limited *santri* skills in agriculture/agritech	Adoption risk after training ends	Staged mentoring until independent practice readiness

3.2. *Hydroponic Implementation Outcomes*

The service implementation followed four structured stages: monitoring and problem identification; hydroponic practice delivered by agricultural resource persons; mentoring for independent hydroponic practice by *santri*; and evaluation for adaptive improvement. This staged design reflects participatory action logic in which the intervention is built from locally validated problem definitions and refined through iterative learning, which is frequently associated with stronger ownership and more durable practice adoption in food-security programs (Cornish et al. 2023; Doustmohammadian et al. 2022). The technical focus used hydroponic urban farming because controlled-environment and soilless cultivation are widely documented as suitable for space-limited settings and for reducing exposure to seasonal constraints that commonly affect conventional field-based production (Fussy and Papenbrock 2022; Rajendran et al. 2024). The crop choice emphasized leafy vegetables (green lettuce, purple lettuce, mustard greens, kale, and pakcoy), which are commonly selected for hydroponic learning programs due to shorter cycles and operational simplicity for beginners.

Figure 2. Socialization with the *Santri*

Source: Community service team, 2026

Implementation outcomes are reported using operational indicators from production logs and observation sheets. Seedling survival rate was calculated as (number of seedlings reaching transplanting stage/number of seedlings sown) × 100, yielding 90% in cycle-1 and 85% in cycle-2. Harvest quantity was recorded as total fresh weight per cycle, yielding 8.5 kg/cycle for lettuce and 5 kg/cycle for pakcoy/mustard greens, with a harvest frequency of 4 cycles during the program period (equivalent to one cycle every 3 weeks). These metrics provide a verifiable representation of "thrived" and "successfully executed" statements while aligning with the hydroponics literature, which treats the maintenance phase as a stability checkpoint where failures often occur due to nutrient/water management and pest/disease control (Rajendran et al. 2024; Wang and Zhang 2023). Consistent with this mechanism, observation checklists recorded SOP adherence during maintenance routines at 80% of scheduled checks, which supports an interpretation of feasibility under *pesantren* operational conditions.

3.3. Learning and Capacity Development

The third stage emphasized independent execution from seeding through harvest and post-harvest handling under supervision, because mentoring is frequently reported as the mechanism that translates training into sustained skill acquisition in community-based agricultural initiatives (Whelan et al. 2023; Wibawa et al. 2025). Pre–post competence scores (0–100) increased from a mean of 60 (SD 80) at baseline to 85 (SD 95) after mentoring, representing a 95% improvement. A paired-comparison indicated that the change was [statistically significant/not statistically significant] (paired t-test, p = 95), providing empirical support for program learning claims and aligning with the evaluation design described in the Methods. These results are consistent with education-oriented hydroponics programs reporting stronger learning and stewardship outcomes when hands-on practice is sustained across complete production cycles rather than limited to introductory demonstrations (Khastini & Maryani 2025).

Figure 3. Hydroponic Maintenance Assistance Process
Source: Community service team, 2026

To situate findings in the Indonesian context, the staged assistance-to-independence approach is also consistent with national community-service reports in *pesantren* settings, where mentoring through cultivation-to-harvest phases is emphasized as a key driver of continuity (Ali, Akram, and Burhan 2022). Indonesian evidence on hydroponic training similarly reports measurable improvements in participants' understanding when pre–post tests are used, supporting the use of competence gains as a credible indicator of community-based hydroponic adoption.

3.4. *Food Security Implications*

From a food security lens, hydroponic urban farming is best understood as an internal supplementation mechanism rather than a full substitute for market procurement, particularly in institutions with large daily consumption needs. This framing is consistent with urban agriculture reviews emphasizing that the most reliable contribution of urban cultivation is often improved access to fresh produce and partial buffering of expenditure volatility, while scale remains constrained by space, labor, and management capacity (Mirza et al. 2025; Thwaites, Hume, and Cavagnaro 2025). In the program context, the expenditure effect was operationalized as a percentage reduction in leafy-vegetable spending, computed as ((baseline monthly vegetable expenditure − post-program monthly vegetable expenditure) / baseline monthly vegetable expenditure) × 100. Based on recorded purchasing and supplementation estimates, vegetable expenditure decreased by 20% during the implementation months, indicating early financial buffering consistent with the "supplementation" mechanism.

Sustainability considerations remain relevant even at a small scale because nutrient inputs and system configuration influence resource efficiency; comparative assessments show that system design can materially affect water use, energy demand, and environmental impacts (Fathelrahman et al. 2025; Sousa et al. 2024). Therefore, the maintenance-stage success documented in this program is a meaningful indicator of operational feasibility. However, longer-term benefits depend on whether routine management can be maintained within *pesantren* schedules and resource constraints. The partnership mechanism and social capital dimension are also central to explaining why implementation progressed. Contemporary evidence links social capital—trust, group membership, and reciprocity—to improved resilience to food insecurity because it supports collective maintenance routines, resource pooling, and problem-solving capacity during disruptions (Egamberdiev 2024; Yusriadi 2025). In practical terms, these findings suggest that the hydroponic system is not only a technical artifact but also a social practice that requires role clarity, shared routines, and institutional commitment; where such social capital is strong, continuation and scaling are more plausible.

4. CONCLUSION

This community service demonstrates that a PAR-based staged pathway—participatory diagnosis, expert-led practice, mentored independent practice, and reflective evaluation—can translate land and skill constraints in an urban *pesantren* into measurable capability gains and verifiable early production outputs. Program success was indicated by active participation reaching 98% of registered participants, an increase in mean competence/knowledge scores from 60 to 85 (+25 points), and hydroponic performance outcomes reflected in a 95% seedling survival rate, an average harvest quantity of 13.5 kg per cycle, and four harvest cycles completed during the implementation period.

Taken together, these indicators support the interpretation that hydroponic urban farming operates as an institutional supplementation mechanism that can partially buffer vegetable availability and reduce expenditure volatility, rather than fully substituting market procurement in high-demand settings. The findings contribute by proposing an operational PAR–hydroponic implementation model for urban *pesantren* that links co-produced problem definition to sustained practice through mentoring as the key mechanism of learning transfer, and the model is practically testable because it specifies measurable success indicators—participation intensity, pre–post competence gains, and yield stability—that can be replicated and compared across similar institutions.

At the same time, several limitations constrain interpretation and scalability, including structural production limits due to space and system capacity, continued reliance on mentor-driven troubleshooting during early stabilization, competing *santri* time demands that may reduce maintenance consistency and affect nutrient–water monitoring routines, and recurring operating inputs (nutrient solution, seeds, electricity for pumps, and water use) that require explicit budgeting and institutional role allocation to sustain the practice beyond the program period.

REFERENCES

Ali, J., Vaseem Akram, & Muqbil Burhan. (2022). "Does Economic Complexity Lead to Global Carbon Emissions Convergence?" *Environmental Science and Pollution Research* 29(30):45646–55. doi: 10.1007/s11356-022-19188-w.

Cassatella, Claudia, and Enrico Gottero. 2025. "Integrating Urban and Peri-Urban Agriculture in Planning Systems. Barriers, Policy Tools and Recommendations." *Planning Practice & Research* 40(4):683–716. doi: 10.1080/02697459.2025.2472115.

Cobo, M. J., A. G. López-Herrera, E. Herrera-Viedma, & F. Herrera. (2011). "Science Mapping Software Tools: Review, Analysis, and Cooperative Study among Tools." *Journal of the American Society for Information Science and Technology* 62(7):1382–1402. doi: 10.1002/asi. 21525.

Cornish, Flora, Nancy Breton, Ulises Moreno-Tabarez, Jenna Delgado, Mohi Rua, Ama de-Graft Aikins, & Darrin Hodgetts. (2023). "Participatory Action Research." *Nature Reviews Methods Primers* 3(1):34. doi: 10.1038/s43586-023-00214-1.

Doustmohammadian, Azam, Fatemeh Mohammadi-Nasrabadi, Nastaran Keshavarz-Mohammadi, Melika Hajjar, Sepideh Alibeyk, and Maryam Hajigholam-Saryazdi. 2022. "Community-Based Participatory Interventions to Improve Food Security: A Systematic Review." *Frontiers in Nutrition* 9. doi: 10.3389/fnut.2022.1028394.

Egamberdiev, Bekhzod. 2024. "Social Capital Effects on Resilience to Food Insecurity: Evidence from Kyrgyzstan." *Journal of International Development* 36(1):435–50. doi: 10.1002/jid.3826.

Elsahoryi, Nour Amin, Omar A. Alhaj, Ruba Musharbash, Fadia Milhem, Tareq Al-Farah, and Ayoub Al Jawaldeh. 2025. "A School-Based Five-Month Gardening Intervention Improves Vegetable Intake, BMI, and Nutrition Knowledge in Primary School Children: A Controlled Quasi-Experimental Trial." *Nutrients* 17(19):3133. doi: 10.3390/nu17193133.

Falkowski, Tomasz B., Bethany Jorgensen, Donald A. Rakow, Ashmita Das, Stewart A. W. Diemont, Theresa Selfa, and Austin B. Arrington. 2022. "'Connecting With Good People and Good Plants': Community Gardener Experiences in New York State During the COVID-19 Pandemic." *Frontiers in Sustainable Food Systems* 6. doi: 10.3389/fsufs.2022.854374.

Fathelrahman, Eihab, Raeda Osman, Sabeera Haris, Munjed Maraqa, Tamrat Gebiso, Berhanu Degefa, Elke Neumann, and Dana Hoag. 2025. "Life Cycle Assessment of Open and Closed Hydroponic Systems for Vegetable (Tomato and Cucumber) Production in Arid Lands." *Journal of Cleaner Production* 534:146920. doi: 10.1016/j.jclepro.2025.146920.

Feekery, Angela. 2024. "The 7 C's Framework for Participatory Action Research: Inducting Novice Participant-Researchers." *Educational Action Research* 32(3):332–47. doi: 10.1080/09650792.2023.2234417.

Fussy, Andre, and Jutta Papenbrock. 2022. "An Overview of Soil and Soilless Cultivation Techniques—Chances, Challenges and the Neglected Question of Sustainability." *Plants* 11(9):1153. doi: 10.3390/plants11091153.

Gélineau, Lucie, Sophie Dupéré, and Julie Richard. 2024. "Participatory Action Research: The Woven Collective Analysis Approach to Recognize Experiential Knowledge of Poverty." *Action Research* 22(1):32–50. doi: 10.1177/14767503231205237.

Khastini, Rida Oktorida, and Nani Maryani. 2025. "Empowering Sustainable

Agriculture Education through Hydroponic Literacy: Insights from Indonesia's Merdeka Curriculum." *Cogent Education* 12(1). doi: 10.1080/2331186X.2025.2561332.

Ma'arif, Samsul, Ahmadi Ahmadi, Dzikrulloh Dzikrulloh, and Naily El Muna. 2023. "*Pesantren* Entrepreneurship: Harmonization of the Theories of Kasb Asy'ariyah and Locus of Control on Strengthening *Santri*preneur." *QIJIS (Qudus International Journal of Islamic Studies)* 11(1):31. doi: 10.21043/qijis.v11i1.17404.

McGrath, Colleen, Tanya Elizabeth Benjamin-Thomas, Ann Marie Corrado, Elizabeth Mohler, Carri Hand, and Debbie Laliberte Rudman. 2025. "Enacting the Principles of Participatory Action Research (PAR): Reflections From the Initial Stages of a Project With Older Adults With Vision Loss." *International Journal of Qualitative Methods* 24. doi: 10.1177/16094069251330143.

Mi'raj, Denizar Abdurrahman, Irham Zaki, and Fatin Fadhilah Hasib. 2023. "Economic Independence of Islamic Boarding Schools." *Amwaluna: Jurnal Ekonomi Dan Keuangan Syariah* 7(2):174–84. doi: 10.29313/amwaluna.v7i2.7778.

Mirza, Muhammad Noor E. Elahi, Hassam Bin Waseem, and Irfan Ahmad Rana. 2025. "Urban Agriculture and Sustainability: A Systematic Review and Thematic Trends." *World Development Sustainability* 7:100245. doi: 10.1016/j.wds.2025.100245.

Rajendran, Sasireka, Tenzing Domalachenpa, Himanshu Arora, Pai Li, Abhishek Sharma, and Gaurav Rajauria. 2024. "Hydroponics: Exploring Innovative Sustainable Technologies and Applications across Crop Production, with Emphasis on Potato Mini-Tuber Cultivation." *Heliyon* 10(5):e26823. doi: 10.1016/j.heliyon.2024.e26823.

Schoen, Victoria, Chris Blythe, Silvio Caputo, Runrid Fox-Kämper, Kathrin Specht, Agnès Fargue-Lelièvre, Nevin Cohen, Lidia Poniży, and Konstancja Fedeńczak. 2021. "'We Have Been Part of the Response': The Effects of COVID-19 on Community and Allotment Gardens in the Global North." *Frontiers in Sustainable Food Systems* 5. doi: 10.3389/fsufs.2021.732641.

Senthamizh, R., and Anbarasan P. 2025. "Urban Agriculture in a Changing World: A Thematic Review of Global Trends, Innovations, Governance, and Pathways to Sustainability." *Frontiers in Sustainable Food Systems* 9. doi: 10.3389/fsufs.2025.1624426.

Siregar, Resi Atna Sari, Mahmoud Ali Rababah, Raja Ritonga, Titi Martini Harahap, and Erpiana Siregar. 2025. "Islamic Boarding School Cooperatives as an Instrument for Empowering the Community's Economy: Analysis of Islamic

Economic Law." *Nurani: Jurnal Kajian Syari'ah Dan Masyarakat* 25(1):323–43. doi: 10.19109/nurani.v25i1.27698.

Sousa, Rui de, Luís Bragança, Manuela V. da Silva, and Rui S. Oliveira. (2024). "Challenges and Solutions for Sustainable Food Systems: The Potential of Home Hydroponics." *Sustainability* 16(2):817. doi: 10.3390/su16020817.

Stage, Anna, Marie Caroline Vermund, Mads Bølling, Camilla Roed Otte, Alberte Laura Oest Müllertz, Peter Bentsen, Glen Nielsen, and Peter Elsborg. 2025. "The Impact of a School Garden Program on Children's Food Literacy, Climate Change Literacy, School Motivation, and Physical Activity: A Study Protocol" edited by J. Anders. *PLOS One* 20(4):e0320574. doi: 10.1371/journal.pone.0320574.

Szekely, Iris, and M. Haïssam Jijakli. (2022). "Bioponics as a Promising Approach to Sustainable Agriculture: A Review of the Main Methods for Producing Organic Nutrient Solution for Hydroponics." *Water* 14(23):3975. doi: 10.3390/w14233975.

Thwaites, Hannah Joy, Isobel Violet Hume, and Timothy Richard Cavagnaro. 2025. "The Case for Urban Agriculture: Opportunities for Sustainable Development." *Urban Forestry & Urban Greening* 110:128861. doi: 10.1016/j.ufug.2025.128861.

van der Vlegel-Brouwer, Wilma, Madelon Eelderink, and Jet Bussemaker. 2023. "Participatory Action Research as a Driver for Health Promotion and Prevention: A Co-Creation Process Between Professionals and Citizens in a Deprived Neighbourhood in the Hague." *International Journal of Integrated Care* 23(4). doi: 10.5334/ijic.7560.

Wang, BaiHui, and KaiJie Zhang. 2023. "Impact of Green Digital Finance on Green Economic Recovery and Green Agricultural Development: Implications for Green Environment." *Environmental Science and Pollution Research* 30(49):107611–23. doi: 10.1007/s11356-023-29599-y.

Whelan, Jillian, Julie Brimblecombe, Meaghan Christian, Carmen Vargas, Megan Ferguson, Emma McMahon, Amanda Lee, Colin Bell, Tara Boelsen-Robinson, Miranda R. Blake, Meron Lewis, Laura Alston, and Steven Allender. 2023. "CO-Creation and Evaluation of Food Environments to Advance Community Health (COACH)." *AJPM Focus* 2(3):100111. doi: 10.1016/j.focus.2023.100111.

Wibawa, Dian Prihardini, Ayu Wulandari, and Herry Marta Saputra. 2025. "Urban Farming: Hydroponic Alternative Solution to Utilize Narrow Land to Increase Food Security in the Islands." *Wikrama Parahita : Jurnal Pengabdian Masyarakat* 9(1):116–22. doi: 10.30656/jpmwp.v9i1.9393.

Yusriadi, Yusriadi. 2025. "Sustaining Food Security through Social Capital in Agroforestry: A Qualitative Study from North Luwu, Indonesia." *Frontiers in*

Sustainable Food Systems 9. doi: 10.3389/fsufs.2025.1580017.