

Co-designing a conceptual controlled environment agriculture (CEA) model inside an Australian maximum-security prison: A research framework

Author:

Vaughan, S; Tietz, Christian; Ramirez, Mariano

Publication details:

Cogent Social Sciences

v. 9

Chapter No. 1

pp. 1 - 17

2331-1886 (ISSN)

Publication Date:

2023-12-31

Publisher DOI:

<https://doi.org/10.1080/23311886.2023.2188678>

License:

<https://creativecommons.org/licenses/by/4.0/>

Link to license to see what you are allowed to do with this resource.

Downloaded from http://hdl.handle.net/1959.4/unsworks_82964 in <https://unsworks.unsw.edu.au> on 2024-05-18



Co-designing a conceptual controlled environment agriculture (CEA) model inside an Australian maximum-security prison: A research framework

S Vaughan, Christian Tietz & Mariano Ramirez

To cite this article: S Vaughan, Christian Tietz & Mariano Ramirez (2023) Co-designing a conceptual controlled environment agriculture (CEA) model inside an Australian maximum-security prison: A research framework, Cogent Social Sciences, 9:1, 2188678, DOI: [10.1080/23311886.2023.2188678](https://doi.org/10.1080/23311886.2023.2188678)

To link to this article: <https://doi.org/10.1080/23311886.2023.2188678>



© 2023 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.



Published online: 09 Mar 2023.



Submit your article to this journal [↗](#)



Article views: 48



View related articles [↗](#)



View Crossmark data [↗](#)



Received: 19 December 2022
Accepted: 05 March 2023

*Corresponding author: Christian Tietz, School of Built Environment, Faculty of Arts, Design & Architecture, University of New South Wales, Sydney, High Street, Kensington, NSW 2052, Kensington Campus, Building Red Centre West, Office 2013, Australia
E-mail: Christian.tietz@unsw.edu.au

Reviewing editor:
Heng Choon (Oliver) Chan,
Department of Social Policy,
Sociology, and Criminology,
University of Birmingham,
Birmingham United Kingdom

Additional information is available at
the end of the article

LAW, CRIMINOLOGY & CRIMINAL JUSTICE | RESEARCH ARTICLE

Co-designing a conceptual controlled environment agriculture (CEA) model inside an Australian maximum-security prison: A research framework

S Vaughan¹, Christian Tietz^{1*} and Mariano Ramirez¹

Abstract: This research paper presents the framework for a research study that aims to define and evaluate the design requirements and the related feasibility of a controlled environment agriculture (CEA) system concept within a maximum-security prison in Australia. A co-design methodology will guide the study so that the views of a broad range of stakeholders can contribute to the conceptualization of a CEA farm system that is appropriately suited to correctional settings. The unique aspect of this research lies in the application of a bottom-up consultative process involving both prison administrators and inmates. Stakeholders will initially be asked to consider what CEA typology would be most suitable for a prison environment and then use this as a basis for developing a more extensive system design. As open-field agriculture represents a lower-cost alternative to CEA, this will also be considered to complement CEA. The co-design sessions will run in tandem with current growth trials of lettuce within the prison environment using different growing environments. The research is aimed at assisting to reduce the impacts of climate change, by growing produce locally. Growing produce within the prison walls reduces food miles and improves the nutritional quality of produce, which benefits longer-term inmate health. Growth trials that complement the co-design study are aimed at evaluating the ease of use for each of type growing environment. This research contributes significant new knowledge for the application of co-design in prisons, aimed at developing implementation guidelines for a CEA eco-system that would supply fresh vegetables to pre-cooked inmate meals. The researcher has a unique perspective as an inmate. Outside community groups wishing to try CEA may also benefit from this study.

Subjects: Design; Criminology and Criminal Justice; Energy; Landscape and Sustainability; Inclusion and Special Educational Needs

Keywords: co-design; participatory design; controlled environment agriculture; sustainability; prisons

1. Introduction

This research represents an approach that could inform improvements to the diet, health, and well-being of inmates in maximum-security prisons by asking stakeholders to co-design as a community. CEA is a controlled approach to growing produce which typically involves various types of growing environments such as Plant Factories Using Artificial Lights (PFALs), using

a vertical farming format and Greenhouses. External environmental conditions are almost negated in CEA and many crops can be grown year-round with a high consistency between yields. Participatory design techniques will be used in specially developed co-design sessions to help generate concepts for a CEA system design for use in prisons. It is intended that the prisons will produce fresh vegetables using CEA. The locus of this case study is a maximum-security prison for sentenced male inmates in regional New South Wales (NSW), Australia. The primary author of this paper is a product designer-researcher who will help guide and develop technical design solutions that may benefit both inmates and prison officers through specially developed focus groups that employ a co-design methodology. The co-design methodology is intended to elicit design concepts that have greater desirability, feasibility and viability for stakeholders, based on design elements in the Human Centred Design Toolkit (IDEO, 2011). Intended for community-based projects, this toolkit can assist in guiding co-design teams towards meeting the needs of participants in new ways and by ensuring that innovative design solutions are based upon genuine needs. This enables projects to be conceived while being grounded in the needs of the community, but with a focus on ensuring the long-term success of the project. Undertaking this task will involve applying IDEO's "three lenses of human-centred design"—namely, desirability, feasibility and viability—to categorise the strengths and weaknesses of the proposed design concept (IDEO, 2011).

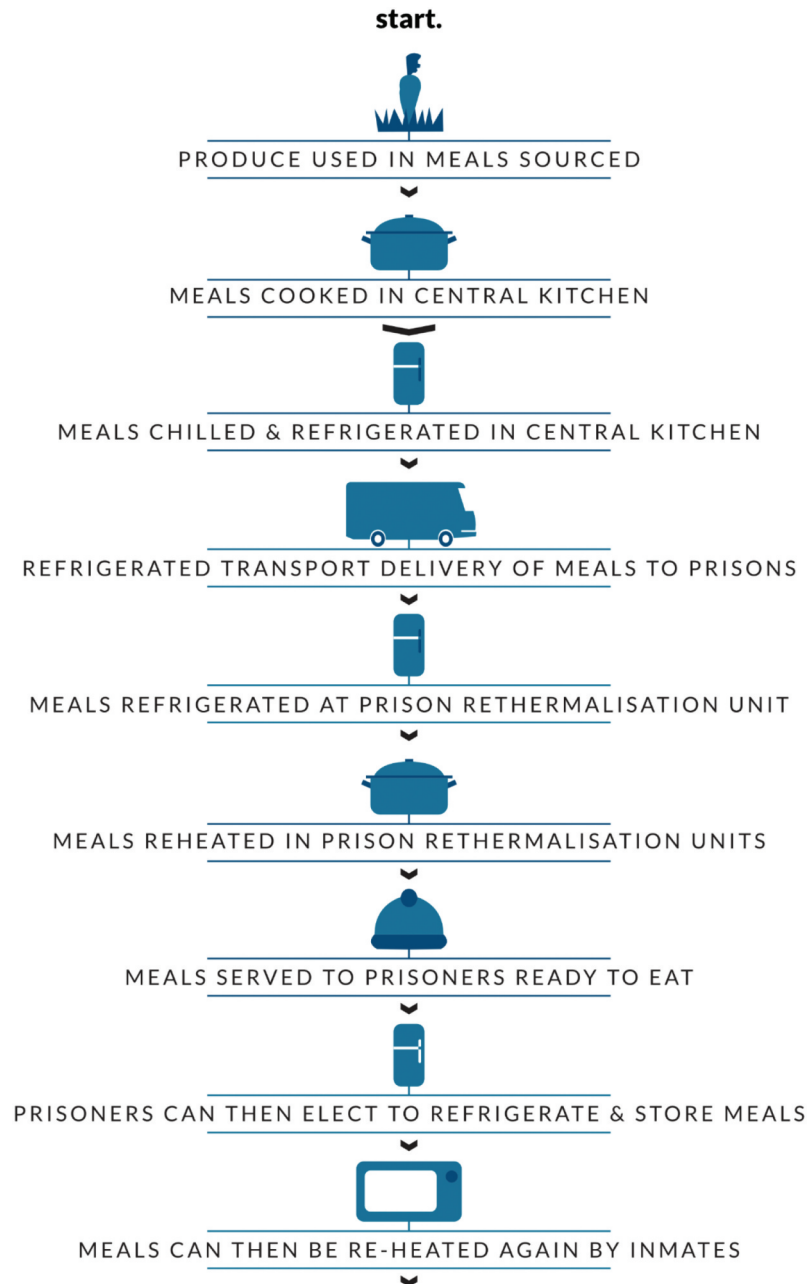
A range of stakeholders from prison inmates to prison officers will develop solutions based on "real-world" parameters. The designer-researcher, who is also an expert designer, will guide the co-design sessions. It will be beneficial to allow the co-designers within the focus group sessions to generate and develop their ideas with autonomy. This may mean that participants will have a greater level of investment in their conceptual ideas, allowing richer design solutions to evolve. Human research ethics approvals were obtained from both the NSW Corrective Services Ethics Committee (CSEC) and the University of New South Wales Human Research Ethics Committee (UNSW HREC). Both ethics committees were committed to the principles of diversity, equity, and inclusion in research participation, and required that potential participants be recruited from a range of cultural and ethnic backgrounds. One of the conditions of approval was to ensure that all participants felt comfortable openly contributing their thoughts and ideas during the mixed co-design sessions with both prison officers and inmates. The considered and empathic facilitation of the co-design sessions will help minimise any pre-existing power imbalances.

The ethics application for this study involved describing how a participatory design approach, where multiple participants provide inputs during the conceptual design phase, could succeed. The research team needed to demonstrate that the co-design sessions could be conducted in an ethical, safe, and collaborative manner and without coercion. Questions asked within the co-design sessions needed to be inclusive, and the facilitator must skilfully manage the sessions to ensure that all participants freely took part and that no coercion occurred. This approach is beneficial to proposing and creating new possibilities for new-generation manufacturing business units within the case-study prison.

Currently, fresh produce and cooked meals are often transported over large geographical areas. It is not unusual for NSW prisons to be located 500 km from a metropolitan food distribution hub. Once the inmates' meals have been cooked in centrally located cook-chill facilities, they can be refrigerated for days and in many cases could be stored for weeks before being delivered to inmates (Mathews, 1990). Inmate meals are not delivered fresh and meals for dinner service are often reheated many times before they are finally consumed (Williams et al., 2009). Dinner meals are typically cooked in a metropolitan kitchen in an aluminium foil tray by thermal pasteurisation (Peng et al., 2017) and delivered to prisons weekly. As inmate accommodation pods in NSW prisons often have kitchenettes equipped with microwave ovens, meals can be re-heated by inmates for a third or fourth time after at least two periods of refrigeration. The meal preparation, cooking and delivery process is shown in Figure 1.

A previous study across 8 countries revealed that 42% to 75% of male inmates gained weight and increased their body mass index (BMI) during their incarceration (Choudhry et al., 2018). AS

Figure 1. The typical meal preparation, heating, storage, re-thermalisation and delivery process in NSW prisons. Author's illustration.



previous studies have noted, there is a need to identify the health needs of inmates and to develop appropriate health improvement programmes for inmates (Smith, 2000). In the same context, it is important to ensure that health concerns comply with all the administrative, safety and security concerns of prisons.

Aside from analysing the nutritional aspects of prison food, this research will look into how prison administrators consider and assess new technologies when prisons have traditionally been viewed as conservative and bureaucratic systems (Jewkes, 2007). The co-design aspect of the study is key to understanding the stakeholders' needs and how novel technologies such as CEA can seek to address those demands systematically.

The research problem has been studied using existing literature derived from prison food production, therapeutical horticultural programs in prisons, and agricultural food production using CEA. The concept of health improvement programs in prisons is part of the literature review for this research. To avoid possible failure and expense, poorly conceived health programmes in prisons need to be considered comprehensively, rather than developed solely based on normative needs (Smith, 2000). The research problem is concerned with improving the supply and nutritional quality of fresh produce in inmate meals. There exists an opportunity to improve the nutritional quality of produce grown within the prison walls by creating CEA farms. Inmates in NSW prisons seldom have the opportunity to eat freshly picked produce or benefit from the higher levels of nutrition that are derived from fresh produce. Inmates and officers can potentially benefit from an improved diet that is richer because fresh produce can become available at their prison of classification. CEA is a stable and efficient way of producing fresh produce because there is less reliance on growing seasons when the environment is controlled. The adversity found in seasonal variations, rain or drought, and frost is far less important in CEA. Technological advancements have meant that CEA is an efficient method of fresh production, although there is a wide range of technologies available. Prison administrators struggle to identify what is the most suitable CEA typology to deploy into prisons, and manage demanding security protocols with each business enterprise that is adopted. For this reason, designed systems need to incorporate a wide range of stakeholder demands.

CEA can become the vehicle for reliable vegetable production, thus reducing food miles through the elimination of refrigerated transport. Sustainability is an important aspect of the research. Fresh produce that has not been held in refrigerated storage and that is picked fresh are perceived to be of higher nutritional quality. The novelty in this research study is concerned with adopting a co-design approach to the research problems by harnessing what amounts to decades of first-hand experience that the participants possess in this case. The intimate knowledge that participants have concerning the food system in NSW prisons can be viewed collectively. Having both inmates and officers participate in the same focus group sessions can assist to clarify competing concerns and develop a hierarchy of design considerations that are situated in the real world. As funding has been gained for this study, the participants will be able to see their solutions realised in the form of a working business unit that will supply fresh produce on-site for the case-study prison.

2. Literature review

The co-design sessions have been developed and structured based on other successful prison-based co-design studies. One such inspiration is the Makeright program that was run in the United Kingdom, which involved inmates designing a range of anti-theft bags. The project was so successful that it evolved into a retail store in London that sells the products that have been designed and developed by inmates and former inmates (Gamman & Thorpe, 2018). In the context of this research, CEA and urban horticulture initiatives are being considered to not only reflect on how a community of inmates can benefit from fresh produce but also to learn how co-design using participatory design techniques can be deployed to give inmates and officers a sense of purpose and ownership through their contribution to the process.

Another co-design study that was run in a women's prison in Iowa, USA, sought the collaboration of inmates to remodel a sterile visitor garden space, inviting them to input their ideas to make the space more child-friendly and more home-like, to improve its affective experience and to promote better parent-child interactions (Toews et al., 2020). Research also demonstrates that natural environments such as garden spaces restore attention and mitigate stress, which has particular implications for prison environments which are often regarded as highly-stressful environments (Kaplan, 1995; Toews et al., 2020; Ulrich, 2002; Vanaken & Danckaerts, 2018). There are tangible design outcomes for incorporating urban horticulture into prisons, which can be viewed positively through the lens of wanting to improve sustainability through environmental and social actions. Designers understand that the design of a space has a strong human health aspect that

can be an important contributor to curing illnesses, both mental and physical (Jewkes, 2018). For example, prison gardening initiatives that were developed through the GreenHouse Program at the Rikers Island Jail Complex in New York have revealed a reduction in the recidivism rate of offending by 54% (Sander, 2015).

Using design as a tool for collective benefits as previously mentioned, analysing community gardening programs, and using co-design principles in this research study provides a coherent justification for this research. Relevant principles from community gardening that apply to co-design were also studied by McGlone et al. (1999), who found that not all benefits apply to community food studies generally and stated that there is a clear difference between those managed top-down and those more successfully managed bottom-up (Firth et al., 2011; McGlone et al., 1999). Key to this study is arriving at design solutions that leverage the expertise and the inherent design knowledge that may already exist within the prison community. Such expertise can be found by including prison officers in the co-design process who often have long-term experience working in prisons and who are deeply embedded in the system. Similarly, the same contemporary knowledge can be found among inmates, who have years of collective lived experience in the same prison environment.

Even though the research participants in this study may be considered novice designers, they understand which of the proposed design solutions may work and which ones may not be applicable in correctional settings, and it is important for a working design solution to elicit and utilise this type of feedback and experience in the design process. Finding creative, artful, and productive forms of participatory design in the prison context is particularly important to help build empathic and resilient communities. Corrective Services New South Wales staff and inmates at the case-study prison seem to be very open to a co-design approach to new research studies. When the idea of a prison-specific CEA farm was proposed by the designer-researcher, many officers and inmates openly expressed their interest in becoming involved in a study that they viewed as being both mutually and socially beneficial. Dozens of inmates responded positively to the invitation to participate, exceeding the number of available places.

Participatory design techniques such as prototyping, storytelling, photo elicitation, and prompt cards will be used to aid in running the group co-design sessions. The resulting co-design processes of “thinking together” and using participatory design techniques can become a key part of meaningful “communities of practice” (Pyrko et al., 2016). When people unite they can mutually guide each other through their different understandings of the same problems in their area of mutual interest, and by doing this they indirectly share tacit knowledge (Pyrko et al., 2016). When community studies involve all stakeholders, they can significantly become more successful than less participatory ones (Bonow & Normark, 2018; Firth et al., 2011; Samaddar et al., 2019).

Most prisons in New South Wales have industries-based business units with manufacturing capabilities. Therefore, the co-designed solutions can potentially be realized from functional prototypes right through to large-scale commercial production units. In this sense, a creative path in this study has the potential to adopt learnings from the co-design sessions that will flow into the prototyping process and that have the potential to inform the commercial manufacturing of future CEA units. Such endeavours could eventually transform into viable business units, where inmates could gain experiential industry-based learning experience whilst beneficially gaining an insight into the cyclical natural processes of growth, blossoming, die-back and germination (Viljoen & Bohn, 2014).

The implications of carbon dioxide emissions are an important consideration when developing new business models for use in prisons. CO₂ emissions can be reduced by growing vegetables on-site and by minimising the refrigerated transportation of fresh produce across all NSW prisons. A single trip from a metropolitan area to just one prison in NSW can result in a return trip range of

over 1000 kilometres, so making adjustments to the whole system design of the supply of fresh produce can have enormously positive sustainability impacts.

Considering the impact of healthy energy systems on CEA business models is another important impact of this research. Previous research has demonstrated that transitioning to clean energy by just 1% can decrease the environmental footprint by 0.027385% (Khan et al., 2022). Decentralised methods of fresh produce production can help to realise organisational sustainability goals for prisons, as they also transition towards a neutral or zero-carbon model. Prisons can by considering CEA technologies, seek to address the core aspects of the energy trilemma, which are affordability and access to energy, energy security, and environmental sustainability (Khan et al., 2022). Addressing the energy trilemma can assist prisons to build a foundation for future prosperity and business competitiveness within the fresh produce production marketplace (Khan et al., 2022).

CEA and greenhouse production methods have the potential to assist prisons to gain energy security in the current worldwide climate of economic volatility and inflation, by reducing fresh produce procurement costs where they control production costs rather than being at the mercy of market price fluctuations. CEA offers a relatively short return on investment times for prisons wishing to transform their fresh produce supply chain by decentralising production. Access to reliable and affordable energy is an important consideration for prison operators who may wish to consider CEA. In this respect access to clean and affordable energy will become a much higher priority for prison operators wanting to transition to using new technologies such as CEA, which will likely be driven by environmental sustainability policies (Khan et al., 2022).

The whole system design of CEA in prisons needs to be carefully considered in the early phases of design to ensure that prison infrastructure of this type does not contribute to higher waste generation, increased total utilization of energy or higher levels of pollution (Dagar et al., 2022). Co-design must become a vehicle to carefully analyse every aspect of the CEA production process in prisons, from sustainable operations in growing environments to packaging goods and final delivery to inmates ready for their consumption. Avoiding greenhouse gas emissions derived from fossil fuel consumption and economic growth is another important consideration for prison operators who may wish to develop CEA farms with case study prisons (Dagar et al., 2022). Most greenhouse operators constantly struggle with the battle to cool and heat greenhouses throughout the annual seasons, which has brought about significant research in this area. Research studies into climate control systems for greenhouses have found that basic climate control systems such as shade cloth systems used externally above the transparent glass or polycarbonate panels can dramatically reduce temperatures in greenhouses in hotter seasons. Geothermal systems can be used as simple and low-cost alternatives to using fossil fuels to heat greenhouses in winter months. Such systems can be installed in the ground below the footprint of a greenhouse structure and represent an efficient use of land that greenhouses are built upon.

Early greenhouse trials at the case-study prison have used a 100% renewable energy source, using solar panels and battery storage to drive the pumps that are required in the hydroponic flood and drain system used and to power the small fan that is required for providing a constant air exchange, thus avoiding fossil fuels altogether. Lettuce is the main crop that the growth trials are being conducted on because trials involving lettuce have been highly successful even when temperatures have reached close to 30 degrees Celsius. Some varieties of lettuce are more tolerant to higher summer temperatures, with fewer issues found with cooler months which lettuce is ideally suited to. The same early trials have found that new-generation fans that are used for air exchange, can also be successfully used with simple cooling methods using retractable shade cloth coverings or evaporative cooling panels. New generation extraction fans used for cooling and air exchange in CEA systems have RPM controls which can automatically increase in speed as greenhouse temperatures increase through daylight hours, but that decrease when temperatures become lower, providing a new method to reduce energy consumption. As Dagar et al. (2022) suggest, the degradation of the environment will be decreased in the long run if the direction of real GDP growth for nations is

towards greener technology. CEA can provide the ideal settings for prisons to implement so-called greener technologies, by carefully selecting cleaner production techniques for CEA and by reducing emissions from the refrigerated transport of fresh produce to prisons from metropolitan areas.

3. Methodology

This study involves co-design, which is a methodology that will be used to best determine the requirements of a CEA system for use in NSW prisons. A co-design methodology has been selected for this study as it is a method that can be used to develop transformational learning for prison inmates, and build resilience and entrepreneurship skills (Gamman & Thorpe, 2018). By developing design thinking skills with end users in mind, inmates can build positive social understandings useful for life outside prison and help them develop entrepreneurial skills (Gamman & Thorpe, 2018). It is also important to apply design thinking strategies related to democratising innovation and learning through doing which are central themes in co-design methodologies (Gamman & Thorpe, 2018). Human-centred design considerations and design for sustainability principles are primary considerations. The case-study prison is a maximum-security prison in New South Wales where the designer-researcher is an inmate who is currently working on his PhD project. The researcher's lived experience in the prison helps to facilitate access to the co-design participants. This case-study prison has a high-level security overlay which is typical of most maximum-security prisons in the world. The prison currently has a small horticulture plot where selected inmates grow seasonal vegetables for their consumption. TAFE NSW, a state-owned vocational training provider, operates a campus within the prison, awarding various trade-specific competency qualifications, including a TAFE Certificate Level II in Horticultural Studies and a Traineeship in Horticulture. These factors have helped to establish and situate this study at the case-study prison.

The research journey in this study will begin with a literature review, as shown in Figure 2, followed by a series of co-design focus group sessions. The CEA design concepts for maximum-security prisons will then be ideated in these focus groups by the participating co-designers. The culmination of the co-design focus groups will result in the design of a conceptual vertical farm system design and the development of a range of small-scale working prototypes. It is intended that the final design solution will become a larger-scale working farm that will benefit horticultural students as a teaching laboratory. Initially, the focus will be on producing a smaller range of vegetables, such as lettuce, capsicum, cucumbers and tomatoes. Expansions to incorporate a broader range of produce will be considered after the bedding process is complete. Smaller prototypes will be developed to test growing environments based on the outcomes and recommendations of the focus group sessions.

The study framework comprises four stages. Each stage sequentially flows to the next. All stages are interrelated except for the final Stage 4.

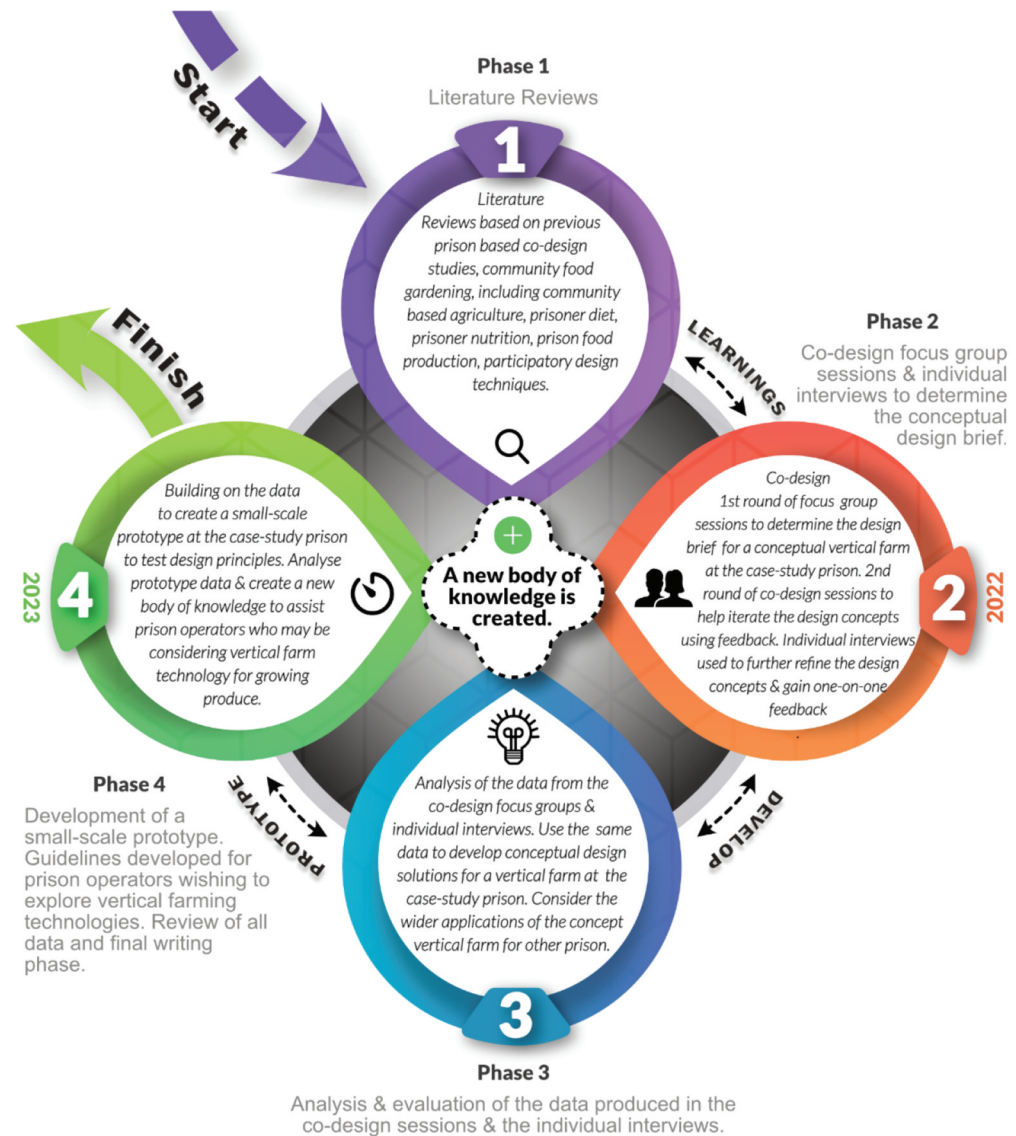
Stage 1 comprises the review of related literature.

Stage 2 represents the co-design focus group sessions and individual interviews, where the design brief for a conceptual CEA system model at the case-study prison will be developed and iterated a further three times. A combination of 2 groups (A & B) comprising 3 officers and 6 inmates will participate in the co-design sessions.

Stage 3 includes the physical prototyping phase, which will test the design principles and theoretical concepts developed in the co-design sessions.

Stage 4 embodies the conclusion of the study where guidelines for prison operators wishing to consider the implementation of a CEA farm are developed and proposed. The outcomes are then fed into a full-scale working farm using CEA principles on the same site as the case-study prison. This will enable participants to see their design concepts realised and participate in the build process.

Figure 2. Framework representing the four phases of the study. Author's illustration.



The research will take place in the second year of the designer-researchers PhD journey, with the studies due to conclude in early 2024. Participants will be recruited via a flyer distributed to staff and inmates within the case study prison.

The flyer is written using plain language descriptors and details the research objectives as follows.

- (1) Participants will help determine what Controlled Environment Agriculture or vertical farm typology is the most suitable for NSW prisons.
- (2) Guided by co-design (using empathy), the designer-research will construct a series of small-scale working prototype CEA farms based on the outcomes of the co-design sessions.
- (3) Participants will be invited to determine what system design, construction, cultivation & management guidelines need to be developed for NSW prisons and the large-scale farm that will be constructed at the case-study prison.

The flyer will detail why a co-design method has been chosen as follows; You will be able to have your say, through the process of co-design, in how the design and operations of a proposed future vertical farm at Macquarie could be. Having a team co-design solutions with people from that community can be a great way to leverage

local knowledge, this can lead to better-adapted innovations because participants have invested resources in their creation. This method is useful when the politics of the community require it & when solutions from outside can't be easily adopted.

The research methodology and literature review are summarised in Figure 3. The experiences of the designer-researcher and the lead facilitator bring extra skill sets to the co-design sessions to better connect with participants. The lead facilitator is also an inmate, with a background in design and metal fabrication. Skilled designers can bring a wide range of design research tools to the co-design process including “making tools” such as collages, maps, models, and mock-ups (Ferguson & Candy, 2014) and it is intended that maps and collages will be used in the focus group sessions. The designer-researcher and the lead facilitator, understand the culture and group dynamics that exist at the case-study prison. Not all inmates may feel comfortable speaking in a group within a prison environment, however, knowing that the designer-researcher and the lead facilitator are fellow inmates might help relieve any discomfort they experience and enable them to openly articulate their honest opinions and contribute their design ideas. Understanding the social undercurrents at the case-study prison means that their genuine needs can be considered and understood from the outset by the designer-researcher.

This research is innovative because it is set within a maximum-security prison and uses a co-design methodology to evaluate CEA methods for fresh produce production in prisons. The lead facilitator for the co-design sessions, who has volunteered his time, is an inmate with a background in running public speaking workshops at the case-study prison. The experience and background of this inmate along with the designer-researcher will be used to elicit truthful opinions and insights from participants. The case-study prison has an Inmate Delegate Committee (IDC) which meets monthly and is a forum where inmates can contribute their concerns and propose solutions to overcome issues that arise within the prison. In this sense, there is a history of inmates here being openly able to propose and contribute ideas towards the improved operation of the prison. This is essentially a perpetual process of improvement and is considered fairly unique at the case-study prison.

Figure 3. Framework representing the four phases of the study. Author's illustration.



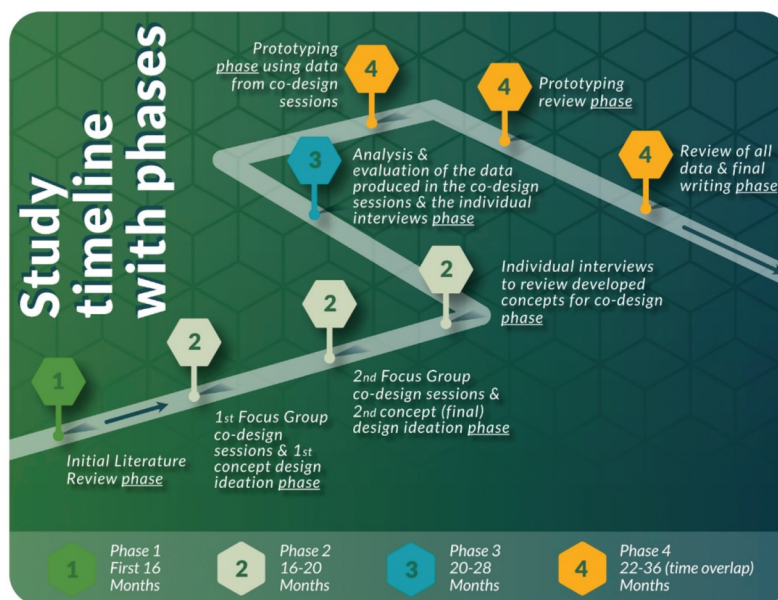
In this study, a completely new and adapted method of CEA to produce leafy greens, tomatoes, cucumbers, capsicums and in the future—berries will be considered for supplying the produce for use in the inmate meals. The benefits of this system include the reduction of health costs through making nutritional improvements, and the enhancement of operational safety in the prison by positively influencing the behaviour of inmates through improving their diet (Cerbini 2021; Bourn, 2006; Smoyer & Minke, 2016; Stanikowski et al., 2020). Additionally, by growing fresh produce within the prison walls, contraband items entering the prison via fresh produce deliveries can potentially be minimized or eliminated.

3.1. Phase one

The study timeline, as illustrated in Figure 4, sets out the trajectory for the 3-year study period. The first activity in Phase One of the co-design journey involves a review of responses to a series of questions contained in a question-and-answer booklet that participants will receive before starting the first co-design session. The first task involves ideating a proposed CEA system design via a whole system mapping exercise. In this 90-minute session, the designer-researcher and the lead facilitator must both approach the co-design session carefully to elicit responses with the foresight to anticipate any organisational cultural barriers that might emerge. People might differ in their views regarding vegetable choices for example, and in their belief systems on health and wellness. Ethnocultural groups may be oppositional to one another due to different values and expectations. From the outset, the co-design sessions need to be handled skilfully and the facilitator must seek to acknowledge the uniqueness of the group dynamics and organisational culture within the case-study prison. Adopting this approach to the co-design sessions can help to ensure that the overall co-design objectives are met.

The first of the co-design sessions will begin with a 15-minute introductory presentation where all participants will be provided with an overview of current CEA technologies and typologies. The short presentation is intended to assist participants in understanding how CEA functions and to demonstrate its respective capabilities and limitations. At the end of the presentation, participants can ask questions. As a group, the participants will then respond to a series of open-ended questions that were raised in the question-and-answer booklets that participants completed before coming to the first co-design session. The questions to be proposed were framed into three distinct categories involving desirability, feasibility and viability (IDEO, 2011).

Figure 4. Study timeline with phases. Author's illustration.



System mapping is important to this study, because whilst various CEA typologies are available commercially, the uniqueness of a maximum-security prison environment means that difficulties lie in having to resolve all the design problems and complexities that may arise. Challenges arise because of budgetary pressures that prison administrators face in delivering new technologies, which could benefit them in the longer term. The design complexities that may arise could range from sufficiency in security camera coverage to contraband-free delivery of produce to the inmates in their accommodation pods. The benefits to designers in mapping the whole system also lie in the need to better understand how a system would function in a holistic and financially viable manner.

The first focus group session during Phase One will be followed by a further 60-minute focus group session, then a design review will occur in Phase Two. During Phase One participants will hypothesize a real-world commercial-scale vertical farm operation that could be built inside the case-study prison. The subsequent co-design session in Phase Two will occur approximately 14 to 21 days after the first session, to give sufficient time for the designer-researcher to prepare 3D CAD-rendered design concepts. As such, these developed concepts will be based on the common design elements identified in the first focus group sessions.

The focus group sessions for both Phases One and Two will run with a total of 18 participants divided evenly into two focus groups, A and B. Each focus group will contain three prison officers and six inmates. As previously mentioned, the first session will include a CEA system mapping and a design ideation exercise where participants will work in groups of three, divided up into groups comprising one prison officer and two inmates. The divided ratio between officers and inmates had to be determined based on practical grounds to minimise staff attendance hours so the costs for their attendance were reduced.

The practical design exercises in the first session will begin with Step 1, as shown in Figure 5, where participants will be asked to choose “prompt cards.” The prompt cards will assist participants in choosing the CEA typology that they believe will be the best fit for the case-study prison. These cards enable groups to choose a CEA typology with efficiency. The cards show four different types of farms: an indoor vertical farm situated in a warehouse; a small-scale farm type that can be located in void spaces within the prison walls; a refrigerator-style accommodation-based CEA unit; and a mobile unit that could enable access to live products at its final stage of production. The choices in this respect were deliberately limited to ensure that the system mapping would be more straightforward. To enable efficiency, key decisions can be made in the system mapping task by group consensus if it is agreed by most participants that they feel comfortable managing the decision-making process this way. A proven track record exists within the case study prison through the Inmate Delegates Committee, where inmates must reach a consensus on given issues. However, if the focus group participants fail to reach a consensus concerning the key design issues, they can still express their opinions regarding the final proposed system design during the final one-on-one interviews. It is anticipated that the designer-research and lead facilitator will assist groups to make key decisions based on the whole system design so they complete the system mapping task within the session. There is flexibility for participants to choose more than one farm typology if this is seen as being advantageous. It will be explained to participants that they are also able to consider both open-field horticulture plots, greenhouses or indoor farms because combining these options can mean greater financial viability in the long term. Participants are not limited to vertical farm types alone; a mix of options may prove to be more sustainable in contrast with an indoor farm that typically has high energy demands due to energy demands involved in fully controlling the environment.

In Step 2, as shown in Figure 6, participants will be asked to identify two factors relating to what people desire. This process is based upon the IDEO Human Centred Design Toolkit (IDEO, 2011). Once group consensus establishes desirability, two further categories including the feasibility of the technical and organisational aspects of the proposal and the financial viability will be

Figure 5. Four farm typologies depicted on prompt cards for the first co-design session. Author's illustration.



canvassed. Descriptors under each heading are broken down into plain language explanations to assist participants in better understanding what is required of them in the system mapping task. The designer-researcher will have already explained these descriptors in the aforementioned presentation of the CEA in the overview.

Once the participants have completed Step 2 they will then be asked to develop a system map in Step 3 by working collaboratively on a “design board” and a 2D plan of the case-study prison, as shown in Figure 5 will be developed. Undertaking the system mapping exercise in this manner will help ensure that the farming enterprise concept is grounded in reality.

During Step 3 “icon prompt cards” as shown in Figure 7, will be used to aid in the generation and flow of ideas. Participants will be constrained by time limits, so having these icon prompt cards helps to accelerate the system mapping task and will ensure that a range of options and considerations are addressed. The icon prompt cards can help spur the participants in the design process by offering them hints on the system mapping process requirements. An example of this is an icon prompt card for a photovoltaic system that might be used to supply renewable energy to the farm. The icon prompt cards are not intended to be an exhaustive list of considerations and options, but rather a method to kickstart and drive the co-design exercise forward.

After each group has mapped their system, they will make short presentations. These presentations will help consolidate each group’s ideas so that the designer-researcher can better understand the proposal and move to the next phase of modelling the CEA farms using 3D CAD (three-

Figure 6. Design board. Author's illustration.



Step 1

CLIP
CHOSEN
FARM
TYPE/S
HERE

Step 2

Desirability

What do people want?

1.
2.

Feasibility

What is doable (technically) or what can this organisation achieve?

3.
4.

Viability

What can we afford?

5.
6.

Step 3 + Idea development through System Mapping ...
(area below can be sketched over)

Only mandatory Non Prompt Card

Sketch your ideas here;

dimensional computer-aided design) and photo-realistic visualisation software. The conceptual renderings will be made to appear almost like a lifelike “walk-through” of the conceptual system designs that are offered.

3.2. Phase two

The second phase of the co-design focus group sessions is a 60-minute-long design review session as previously stated. Participants will be called upon to critically analyse the initial design concepts in a structured manner, noting considerations that were developed during the first co-design focus group session. The conceptual designs themselves will be used as tools to elicit feedback which will be framed as opportunities. By seeking to explore opportunities that participants provide in this session, the designer-researcher will be then able to develop a further, second round of 3D CAD conceptual iterations.

3.3. Phase three

Once the feedback has been incorporated into the second round of 3D CAD conceptual iterations, Phase Three will commence and this will involve presenting these concepts to participants in a final one-on-one personal interview. Each interview will last between 15 and 20 minutes and will be loosely structured to allow feedback to evolve during the interview process. The framework

Figure 7. Icon prompt cards.
Author's illustration.



for the proposed interviews is to look at the final design concepts of the system map to determine where improvements may be made.

The interviews are intended to gain accurate feedback from participants who may not have felt comfortable expressing their honest views in front of the other co-design participants. This enables a further opportunity to review the validity of the CEA farm concept designs and to make changes before the concepts are finalised and ready for production in a large-scale working facility. The justification for running both group sessions and individual interviews is that it may be possible to discover a greater diversity in opinions given, whilst balancing views and opinions in different forms of participation. The focus group sessions may also provide conflicting opinions, whereas the one-on-one interviews allow participants to express their opinions in a private setting and it is hoped that this will assist in refining the conceptual designs. The feedback from the co-design sessions will also become data points for the development of a small-scale prototype at the case-study farm, that will be developed and tested in the second year of this research. The societal benefits include the fact that inmates will be trained in emerging CEA technologies to enable them to become job ready once released, which can assist in reducing recidivism because parolees can engage in meaningful employment post-release which becomes a protective factor. Societal benefits can be derived from improving the diet of inmates, which in turn can enhance custodial behavioural outcomes and the mental health of inmates throughout custody, and ultimately assist in re-entry to the community. The society also benefits when taxpayer funding for prisons is measured through meaningful employment and rehabilitative pathways to release.

4. Discussion

Forging new future-focussed relationships with external business enterprises that have successfully established CEA operations themselves will also be important to ensuring the long-term success of this type of business unit model in prisons. There is currently much technological development in the field of CEA, and this can lead to future opportunities where parolees could continue building their skills on the outside. As previous research demonstrates, if the correctional practice is to support desistance from crime, it must extend far beyond its traditional concerns. Professionally led interventions using

participatory design techniques in co-design sessions that are focused on gaining a deeper engagement can help inmates with social integration (Gamman & Thorpe, 2018; Weaver & Nicholson, 2012). Key to this concept is re-establishing “the circuit of social reciprocity” where inmates can learn from the experiential expertise of those engaged in that same struggle and also from the designers running co-design research studies (Gamman & Thorpe, 2018).

5. Conclusion

In contemporary prisons, it has become increasingly important for inmates to be able to voice their concerns when things are not working or at worst when they are failing (Jewkes, 2007). Co-design methods can help reduce the inmates’ perceptions of marginalization, by providing them with opportunities to express their genuine feelings, thinking, and ideas, which they may not have previously had the opportunity to do. Co-design can help to ensure that participants are included in the process of changing their environment for the better, and can become a practice that positively values their contribution (Toews et al., 2020). The Inmate Delegate Committee in the case-study prison can function as a platform for open-mindedness and inclusivity. However, these types of structures are only one side of the equation and the key to their success is the commitment of prison administrators to listen when problems occur and act decisively to remedy any given situation that arises in the day-to-day running of prisons.

This co-design study has the potential to expand on the success achieved in the various good examples of prison gardening and community gardening programs that can be found around the world. Co-design has the potential to be an equalising act that gives agency to both inmates and officers within a prison environment. Inmates seldom have the opportunity to contribute, to be heard, or to be acknowledged for their ideas being worthwhile or useful. The act of using co-design focus groups alone implies an appreciation of their views, which can contribute to improved rehabilitative outcomes and healing from the grief of incarceration. This activity can manifest to enable inmates and officers to become an expert in one aspect of their lives, giving them inner confidence.

Ultimately, co-design can become embedded in studies in developing new prison infrastructure, so that the future needs of those incarcerated can be fully considered, from the viewpoint of inmates. Co-design can unite communities that are wanting to innovate and create future-focussed new industries. The direct benefits of co-designing a CEA system concept include being able to adapt emerging new technologies to prisons by carefully targeting what the community desires and what prison administrators require. Co-design focus group sessions offer the potential for stakeholders to hear a more diverse range of opinions. Inmates desiring to co-design better corrective environments can benefit prison operators and the broader outside community. Placing both prison officers and inmates in a shared thinking space can help drive and unify the design process and further develop a range of requirements being considered through co-design.

Co-design can become a conduit for creating better relationships between inmates and prison officers through the running of carefully managed workshops which may lead to positive rehabilitative outcomes. Using empathy in these workshops can help to bring opposed groups closer together with the common goal of co-creating enhanced prison infrastructure. Design for sustainability initiatives can also be discussed through the process of co-design focus groups, so that sustainability outcomes are realised. Co-design can create new data sets that then become actionable in terms of being able to innovate novel design solutions. Having many stakeholders come together in co-design focus groups can help to speed up the design process and make it more effective (IDEO, 2011). When teams co-design solutions it can mean that experts and those with lived experience would be able to collaboratively develop more suitable design solutions because they are situated close to the design challenge. Applying the three lenses of desirability, feasibility and viability in the Human-Centred Design process (IDEO, 2011), in tandem with using co-design and participatory design techniques, can mean that it is possible to better understand the needs and behaviours of the communities we are designing for.

Funding

This work was supported by the University of New South Wales.

Author details

S Vaughan¹
Christian Tietz¹
E-mail: Christian.tietz@unsw.edu.au
Mariano Ramirez¹

¹ School of Built Environment, Faculty of Arts, Design & Architecture, University of New South Wales, Sydney, Australia.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Citation information

Cite this article as: Co-designing a conceptual controlled environment agriculture (CEA) model inside an Australian maximum-security prison: A research framework, S Vaughan, Christian Tietz & Mariano Ramirez, *Cogent Social Sciences* (2023), 9: 2188678.

References

- Bonow, M., & Normark, M. (2018). Community gardening in Stockholm: Participation, driving forces and the role of the municipality. *Renewable Agriculture and Food Systems*, 33(6), 503–517. <https://doi.org/10.1017/S1742170517000734>
- Bourn, J. (2006). *HM Prison service: Serving time: Prisoner diet and exercise*. National Audit Office.
- Cerbini, F. (2021). Food and order. An ethnography of daily meals and contamination in a Bolivian self-governed prison. *Food, Culture & Society*, 1–19. <https://doi.org/10.1080/15528014.2021.1890890>
- Choudhry, K., Armstrong, D., & Dregan, A. (2018). Systematic review into obesity and weight gain within male prisons. *Obesity Research & Clinical Practice*, 12(4), 327–335. <https://doi.org/10.1016/j.orcp.2018.02.003>
- Dagar, V., Ahmed, F., Waheed, F., Bojnec, Š., Khan, M. K., & Shaikh, S. (2022). Testing the pollution haven hypothesis with the role of foreign direct investments and total energy consumption. *Energies*, 15(11), 11. <https://doi.org/10.3390/en15114046>
- Ferguson, K., & Candy, S. (2014). *Participatory design handbook: A collaborative approach to address community-based challenges*. CoDesign Studio.
- Firth, C., Maye, D., & Pearson, D. (2011). Developing “community” in community gardens. *Local Environment*, 16(6), 555–568. <https://doi.org/10.1080/13549839.2011.586025>
- Gamman, L., & Thorpe, A. (2018). Makeright, bags of connection: Teaching design thinking and making in prison to help build empathic and resilient communities. *She Ji: The Journal of Design, Economics, and Innovation*, 4(1), 91–110. <https://doi.org/10.1016/j.sheji.2018.02.010>
- IDEO. (2011). *HCD: Human-centered design toolkit, 2ed*.
- Jewkes, Y. (2007). *Handbook on prisons*. Willan.
- Jewkes, Y. (2018). Just design: Healthy prisons and the architecture of hope. *Australian & New Zealand Journal of Criminology*, 51(3), 319–338. <https://doi.org/10.1177/0004865818766768>
- Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169–182. [https://doi.org/10.1016/0272-4944\(95\)90001-2](https://doi.org/10.1016/0272-4944(95)90001-2)
- Khan, I., Zakari, A., Zhang, J., Dagar, V., & Singh, S. (2022). A study of trilemma energy balance, clean energy transitions, and economic expansion in the midst of environmental sustainability: New insights from three trilemma leadership. *Energy*, 248, 123619. <https://doi.org/10.1016/j.energy.2022.123619>
- Mathews, L. E. (1990). Cook/chill centralized food service in corrections. *Large Jail Network Bulletin*, 2(1), 8–10. <https://www.ojp.gov/ncjrs/virtual-library/abstracts/cookchill-centralized-food-service-corrections>
- McGlone, P., Dobson, B., Dowler, E., & Nelson, M. (1999). *Food projects and how they work*. Joseph Rowntree Foundation.
- Peng, J., Juming Tang, D. M., Barrett, S. S., Sablani, N. A., & Powers, J. R. (2017). Thermal pasteurization of ready-to-eat foods and vegetables: Critical factors for process design and effects on quality. *Critical Reviews in Food Science and Nutrition*, 57(14), 2970–2995. <https://doi.org/10.1080/10408398.2015.1082126>
- Pyrko, I., Dörfler, V., & Eden, C. (2016). “Thinking together: What makes communities of practice work?”. *Human Relations*, 70(4), 389–409. <https://doi.org/10.1177/0018726716661040>
- Samaddar, S., Ayaribilla, A. J., Oteng-Ababio, M., Dayour, F., & Yokomatsu, M. (2019). Stakeholders’ perceptions on effective community participation in climate change adaptation. In A. Sarkar, S. R. Sensarma, & G. W. van Loon (Eds.), *Sustainable solutions for food security: Combating climate change by adaptation* (pp. 355–379). Springer International Publishing.
- Sander, V. D. L. (2015). Green prison programmes, recidivism and mental health: A primer. *Criminal Behaviour and Mental Health*, 25(5), 338–342. <https://doi.org/10.1002/cbm.1978>
- Smith, C. (2000). “Healthy prisons: A contradiction in terms?”. *The Howard Journal of Criminal Justice*, 39(4), 339–353. <https://doi.org/10.1111/1468-2311.00174>
- Smoyer, A. B., & Minke, L. K. (2016). *Food systems in correctional settings: A literature review and case study*. World Health Organization.
- Stanikowski, P., Michalak-Majewska, M., Domagała, D., Jabłońska-Ryś, E., & Aneta, S. (2020). Implementation of dietary reference intake standards in prison menus in Poland. *Nutrients*, 12(3), 3. <https://doi.org/10.3390/nu12030728>
- Toews, B., Wagenfeld, A., Stevens, J., & Shoemaker, C. (2020). Feeling at home in nature: A mixed method study of the impact of visitor activities and preferences in a prison visiting room garden. *Journal of Offender Rehabilitation*, 59(4), 223–246. <https://doi.org/10.1080/10509674.2020.1733165>
- Ulrich, R. S. (2002). Health benefits of gardens in hospitals. In *Plants for People: Floriade 2002 Expo, 2010*. Haarlemmermeer NL. https://jardinessanadores.cl/wp-content/uploads/2019/09/Health_Benefits_of_Gardens_in_Hospitals.pdf
- Vanaken, G.-J., & Danckaerts, M. (2018). Impact of green space exposure on children’s and adolescents’ mental health: A systematic review. *International Journal of Environmental Research and Public Health*, 15(12), 2668. <https://doi.org/10.3390/ijerph15122668>
- Viljoen, A., & Bohn, K. (2014). *Second nature urban agriculture: Designing productive cities, 1ed*. Routledge.
- Weaver, B., & Nicholson, D. (2012). Co-producing change: Resettlement as a mutual enterprise. *Prison Service Journal*, 204, 9–16. <https://www.crimeandjustice.org.uk/sites/crimeandjustice.org.uk/files/PSJ%20November%202012%20No.%20204.pdf>
- Williams, P., Walton, K. L., & Hannan-Jones, M. (2009). Prison foodservice in Australia - systems, menus and inmate attitudes. *Journal of Foodservice*, 20(4), 167–180. <https://doi.org/10.1111/j.1748-0159.2009.00144.x>



© 2023 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

You are free to:

Share — copy and redistribute the material in any medium or format.

Adapt — remix, transform, and build upon the material for any purpose, even commercially.

The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.

You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

No additional restrictions

You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.



Cogent Social Sciences (ISSN: 2331-1886) is published by Cogent OA, part of Taylor & Francis Group.

Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com

