INDOOR SMART GARDEN: A NEW ERA IN PLANT PRODUCTION

Branko MIHAILOVIĆ[1]*, Vesna POPOVIĆ[1], Katica RADOSAVLJEVIĆ[2]

[1]Institute of Agricultural Economics, Belgrade, Serbia
[2]Faculty of Economics, University of Belgrade, Belgrade, Serbia
*Corresponding author: brankomih@neobee.net

Abstract

Indoor smart gardens are becoming increasingly popular as a way to grow plants indoors without the need for natural sunlight and soil. Consequently, this paper is aimed at providing a comprehensive overview of indoor smart gardening, its benefits, and a comparison with traditional agriculture. The paper's methodology involves desk research, where existing literature and research on indoor smart gardening and traditional agriculture will be analyzed and synthesized to provide a holistic understanding of the topic. The paper will also conduct a comparative study of indoor smart gardening and traditional agriculture, examining their respective advantages and disadvantages in terms of resource utilization, yield, and environmental impact. The research findings will provide insights into the potential of indoor smart gardening as a sustainable and efficient alternative to traditional agriculture. Our study found that the use of an indoor smart garden can result in increased plant growth and yield, as well as improved plant health and resistance to pests and diseases. The smart garden system allows for precise control of environmental factors such as light, temperature, humidity, and nutrients. The potential benefits of indoor smart gardens for sustainable agriculture and food security include reduced dependence on traditional farming methods, increased production of fresh produce, and the ability to grow crops in areas where traditional agriculture is not possible. Overall, this paper aims to educate and inform readers about the benefits of indoor smart gardening and its potential to transform the way we grow food in the future.

Keywords: *plant productions, indoor smart garden, smart agriculture, hydroponic systems.*

Introduction

Indoor smart gardens are a recent technological innovation that could revolutionize the way we grow plants. By providing an optimal growing environment within the comfort of our own homes, indoor smart gardens offer a sustainable and convenient alternative to traditional outdoor gardening. The technology development is paving the way for the automation to be made to the existing machines leading to the new technology called Internet of Things (Kuppusamy, 2016). With advancements in technology and increasing concerns about the environmental impact of food production, indoor smart gardens have become a popular solution for individuals who want to grow their own fresh produce without relying on traditional farming methods. Smart garden is an electronic control and garden monitoring system for the process of watering plants so that it can help people care for plants (Astutiningtyas et al., 2021). Namely, indoor smart gardens typically consist of a small self-contained system that provides the necessary conditions for plants to thrive. These systems often include LED growth lights, automated watering systems, and sensors that monitor temperature, humidity, and nutrient levels. Some indoor smart gardens even come equipped with features such as voice control, mobile app integration, and automatic nutrient dosing.

The benefits of indoor smart gardens extend beyond just convenience and sustainability. They also offer a way for individuals to connect with nature and experience the therapeutic benefits of gardening, even if they live in an urban environment with limited outdoor space.

Additionally, indoor smart gardens can be used to grow a wide variety of plants, from herbs and leafy greens to fruits and vegetables.

Overall, the emergence of indoor smart gardens represents a significant shift in the way we think about plant production and food sustainability. As more individuals seek out innovative solutions to reduce their carbon footprint and live a more eco-friendly lifestyle, indoor smart gardens have the potential to play a crucial role in shaping the future of food production.

Materials and methods

To conduct this study on the indoor smart garden and its potential to revolutionize plant production, a detailed methodology has been developed. The methodology includes extensive desk research, where existing literature and research on indoor smart gardening and traditional agriculture will be thoroughly analyzed and synthesized to provide a comprehensive understanding of the topic. This desk research will include academic journals, books, conference proceedings, and online resources that cover the topic of indoor smart gardening and traditional agriculture. Additionally, to fully understand the potential of indoor smart gardening, this paper will conduct a comparative study of indoor smart gardening and traditional agriculture. The comparative study will involve an analysis of their respective advantages and disadvantages in terms of resource utilization, yield, and environmental impact. This analysis will be carried out by reviewing various case studies, empirical research, and industry reports.

Moreover, the paper will also examine the current state of the indoor smart gardening industry, including the latest technologies and innovations in this field. By conducting this analysis, the paper aims to identify the key factors driving the growth of indoor smart gardening and explore the potential implications for the future of plant production.

Overall, this study seeks to provide valuable insights into the potential benefits of indoor smart gardening and how it can transform traditional agriculture practices. By comparing and contrasting these two methods, this paper aims to provide a comprehensive understanding of indoor smart gardening and its potential to revolutionize plant production.

Results and discussion

The Earth's water resources have been strained due to population growth, accelerated urbanization, and climate change. However, the implementation of wireless networks of sensors that measure soil moisture can significantly enhance the efficient utilization of water resources (Abbas et al., 2014). Indoor smart gardening and traditional agriculture are two different approaches to plant production. Traditional agriculture involves cultivating crops in outdoor fields or greenhouses, using soil and natural sunlight. In contrast, indoor smart gardening uses technology such as LED lights, hydroponic systems, and climate control to create an optimal growing environment for plants indoors. In accordance with the changing times, a garden system has emerged that makes it easy to supply the ideal temperature, humidity, sunlight, and moisture conditions to grow plants (Woo and Suh, 2021). The amount of moisture present in the soil is a critical factor that impacts the growth of plants. The level of soil moisture is determined by the quantity of water it holds, and if the soil is dry, it can impede the process of photosynthesis, ultimately leading to subpar crop yields. The Internet of things (IoT) helped creating smart garden systems to solve this problem (Ayu et al., 2022). Namely, the advent of the Internet of Things (IoT) has shown a new direction of innovative research in the agricultural domain (Ray, 2017). The smart garden system mainly composes of several elements, such as sensors, microcontrollers, LCD display, plant water sprinklers, and small water pumps (Kwok, 2015). The Internet of Things (IoT) is a network of devices

that connect to the internet and communicate with each other, allowing them to gather and share data with consumers. For those who are interested in cultivating plants but tend to forget to water them, IoT technology can be particularly useful (Sadli, 2019).

Here are some potential advantages and disadvantages of indoor smart gardening and traditional agriculture:

- Resource utilization: *1) Indoor smart gardening.* Controlled environments allow for precise resource management, reducing waste and optimizing resource use. For example, hydroponic systems use up to 90% less water than traditional soil-based agriculture. Additionally, indoor smart gardens can be located in urban areas, reducing transportation costs and emissions associated with long-distance food transportation. *2) Traditional agriculture.* Relies on natural resources such as soil, water, and sunlight, which can be unpredictable and subject to variability. However, traditional agriculture may have lower upfront costs for resources such as land and equipment. Also, one of the main difficulties faced by people is that they do not know when to water the plants and also the amount of water to be poured, resulting in the death of the plant (Srithar et al., 2021).

- Yield: *1) Indoor smart gardening.* Automatic garden monitoring and controlling is a way where all the parameters are automatically monitored without any human support (Ramya et al., 2021). Precise control over environmental conditions and plant nutrients can lead to higher yields and faster growth rates. Indoor smart gardens can also grow crops year-round, allowing for consistent production. *2) Traditional agriculture.* Yields may vary depending on weather patterns, soil quality, and other factors outside of farmers' control. However, traditional agriculture can benefit from long-established knowledge and techniques that have been developed over centuries of farming.

- Environmental impact: *1) Indoor smart gardening.* Can be more sustainable than traditional agriculture in terms of reducing water usage, fertilizer runoff, and pesticide use. Indoor smart gardens can also use renewable energy sources to power their systems. *2) Traditional agriculture.* Can have negative impacts on the environment such as soil erosion, water pollution from fertilizer and pesticide runoff, and greenhouse gas emissions from transportation and equipment use. It's worth noting that the specific advantages and disadvantages may vary depending on the specific implementation and location of both indoor smart gardening and traditional agriculture.

In the modern mechanized era, we can hardly think of any activity that doesn't require technology (Muhtasim et al., 2018). Consequently, researchers are working to integrate modern technologies in agriculture to develop new practices for the enhancement of healthy agriculture and production (Rasel et al., 2022). Namely, indoor smart gardens offer the convenience of year-round cultivation of fresh flowers, herbs, and produce. With the aid of smart technology, it is possible to create an optimal environment for any plant variety irrespective of the season. Setting up and maintaining these gardens is as simple as clicking a button from the comfort of your home or office. It is recommended to begin with a single small plant on your desk and gradually expand as you become familiar with the benefits of indoor gardening. Eventually, you may find yourself transforming your entire living space into a sprawling indoor hydroponic garden. The benefits of gardening have been emphasized to improve the quality of life (Min, Park, 2018). Consequently, what are the benefits of Indoor Smart Gardens (https://www.healthline.com)?

- It's easy: You don't need a degree in horticulture to grow an indoor garden. Smart gardens leverage advanced technology to automatically water your plants, herbs, flowers, and food on your behalf. These machines are also programmed to provide the

perfect amount of artificial sunlight. Once your indoor smart garden is setup and plugged in, you can simply relax and watch it grow.

- It's space-saving: You don't need a massive yard to grow your own food and flowers from home. Indoor smart gardens take up minimal space, and can be conveniently stationed on your desk, in your bedroom, or anywhere you'll see them and remember to monitor them. Indoor hydroponic gardens let you grow your own organic food from home, with minimal space or effort required.
- It's convenient: There's little as frustrating as toiling in the garden for weeks to nurture a plant, only to see it die out of the blue one morning. With an indoor smart garden, this is never a concern. The best indoor smart gardens leverage something called "smart soil", bringing NASA-inspired technology down to Earth. Smart soil looks like an ordinary pot of dirt, but it's been engineered to release nutrients in line with the plant's natural life cycle. Smart soil is also infused with small oxygen pockets to ensure breathing room, even if the soil it wet. This keeps the soil's pH balanced at all times, while regulating the plant's root system.
- It's natural: An indoor smart garden might look like something out of the space-age, but the fundamentals of the technology are completely natural. The food and herbs you grow with a smart garden are free from harmful substances, plus, you can relax knowing your plants are receiving nutrients automatically.
- It's spiritual: Some plants – like sage, basil, thyme, and peppermint – are considered to be more spiritual than others. But you don't need to sow the seeds of spiritual plants in particular to enjoy the infinite benefits of an indoor hydroponic garden. There's something inexplicably fulfilling about creating something out of nothing. Gardening gives you the chance to sow seeds and watch them throw into thriving plants. Not only is this a fun and relaxing activity after a long, hard day of work, but the journey also satisfies our emotional need to have an impact on our surroundings.
- It's great for your body: There are countless surprising health benefits of indoor gardening. When we feel good, we release little "happy" hormones known as endorphins. A better mood is directly linked to a faster metabolism, a healthier heart, and better brain health. There's no need to jog around the block ten times to get your heart racing and your endorphins flowing.
- It fuels mental health: Countless studies show that being in the presence of greenery is directly linked to lower instances of anxiety and depression. Gardening can also make you feel more at peace and content with life, while boosting your self-esteem and lowering your stress levels. That's what's so great about having an indoor garden. You don't need to leave your home or office to improve your memory and attention span by at least 20%! The benefits of indoor plants are backed by science, and science never lies.

Smart indoor gardens are the low maintenance gardens of the future. They offer even city apartment owners the opportunity to grow their own fresh produce, flowers, and plants in the comfort of your own home. So, whether you're looking to add a little nature to your living room or start a home-grown healthy diet, here are 5 of the best plants for smart indoor gardens (https://www.realsimple.com):

1) Grow fruits at home. Imagine a world where you wake up in the morning and pack lunch for work that contains fruit of your own labor. Well, if you have a smart indoor garden, you can grow almost any fruit your heart and taste buds desire. Become a citrus super-grower and install potted oranges, grapefruits, lemons, and limes. Or start a small strawberry or banana farm in the four corners of your very own home. When you grow fruits at home, you'll finally unlock the freshness and goodness grocery stores can't compete with.

2) Grow vegetables at home. Greens, beans, and aubergines – these are just some of the many vegetables your smart indoor garden can produce. When you decide to grow vegetables at home, you can be absolutely certain that only the best of the best will be entering your body. Growing vegetables in your smart indoor garden gives you the guarantee that no pesticides, insecticides, additives, or preservatives have contaminated your otherwise healthy produce. And best of all, having your own vegetables to cook with will fill every meal with taste-bud-bending flavor you've never experienced before.

3) Grow herbs at home. If there's one thing you should know about cooking, it's that salt and pepper are not suitable seasoning. They're standard ingredients in almost every dish. So if you're ready to ramp up the flavor on your home-cooked meals, you need a handful of herbs to help you turn up the heat. A smart indoor garden empowers you to grow herbs at home. You can find fresh lime basil to bring out other flavors, Italian herbs to spice up your pasta dishes, and even steak seasoning herbs to beef up your Sunday barbecue.

4) Grow tea leaves at home. Some of us can't live without coffee. And for some of us, a day without tea is too terrible to even think about. If you're a part of the latter, then a smart indoor garden is exactly what you need to grow tea leaves at home. As a tea lover, you know the difference between tea bags and loose-leaf tea. Equipped with an indoor garden, you'll never have to settle for a bad cup of tea again. You can grow peppermint, lemon balm, holy basil, and more. Simply wait until your leaves are fully grown and prune as much of them as needed for your next pot of tea. Best of all, your tea leaves will grow back just as beautiful, so making use of them is something you should do as often as you can.

5) Grow flowers at home. The final fresh item on the list is none other than beautiful and fragrant flowers. You see, smart indoor gardens offer more than a place to grow herbs and produce. They are the perfect indoor gardening system that enables you to add a bit of color to your living space. If you want to grow flowers at home, a smart indoor garden can help you grow pansies, petunias, gazanias, lavender, painted needles, snapdragons, and alyssum – to name a few. So, not only will your home be vibrant in color and natural texture, but you can enjoy the sweet-smelling benefit of your flowers' aromas filling the space too.

What are the limitations of an indoor smart garden?

If you want to grow enough strawberries to feed a village, then an indoor smart garden might not be for you. Hydroponic gardens offer a relatively small output of plants, making them ideal for small homes and apartments – but the benefits of indoor gardening far outweigh any limitations you might experience. Another reason why people avoid buying indoor smart gardens is that they believe refill seed pods are unaffordable. While many are, there are plenty of budget-friendly seed pods available if you know where to look. The benefits of indoor gardening are truly infinite, giving you the chance to nurture your green thumb and take control of your anxiety for good! Ask any owner of an indoor smart garden, and they'll agree: It's not an expense. It's an investment into your physical, mental, spiritual, and emotional wellbeing. The creation of a smart and robust garden through the use of simple IoT devices can encourage the development of a sustainable system that can be constructed and utilized with ease. Making this system open-source would enable everyday users to incorporate a smart garden into their households, thereby promoting sustainability and collaboration in community gardens (Penzenstadler et al., 2018). Additionally, it would encourage open-source development to improve and enhance this technology in the future.

Conclusion

Indoor smart gardens offer a promising new approach to plant production, providing a controlled environment for optimal growth and yield while reducing resource use and promoting sustainable agriculture. As technology continues to advance, it is likely that indoor smart gardens will become increasingly popular and widely used in both residential and commercial settings. Moreover, indoor smart gardens can be adapted to any location, making it possible to grow food and other crops in urban areas, further reducing the carbon footprint of transportation. However, indoor smart gardening also presents some challenges, such as high initial investment costs and the need for technical expertise to operate the system effectively. The use of artificial lighting and other energy-consuming equipment also raises concerns regarding the sustainability of the system. Overall, indoor smart gardening has the potential to revolutionize plant production and contribute to a more sustainable future. As technology continues to evolve, it is likely that we will see further advancements in indoor smart gardening, making it an even more attractive option for farmers and individuals looking to produce their own food.

Acknowledgement

References

Abbas, A. H., Mohammed, M. M., Ahmed, G. M., Ahmed, E. A., & Seoud, R. A. A. A. A. (2014). Smart watering system for gardens using wireless sensor networks. In 2014 International Conference on Engineering and Technology (ICET), April, pp. 1-5.

Astutiningtyas, M., Nugraheni, M., & Suyoto, S. (2021). Automatic plants watering system for small garden. https://www.learntechlib.org/p/218917/

Ayu, H. R., Syahputri, D. N., Surtono, A., & Apriyanto, D. K. (2022). Internet of thing for smart garden: Automatic plant sprinkler. In AIP Conference Proceedings, AIP Publishing LLC, Vol. 2563, No. 1, October, p. 030002.

Kuppusamy, P. (2016). Smart home automation using sensors and internet of things. Asian Journal of Research in Social Sciences and Humanities, 6(8), 2642-2649.

Kwok, T. (2015). Proposal for a Smart Garden System. http://www2.ensc.sfu.ca/~whitmore/courses/ensc305/projects/2015/eprop.pdf

Muhtasim, M. A., Fariha, S. R., & Ornab, A. M. (2018). Smart garden automated and real time plant watering and lighting system with security features. In 2018 International Conference on Computing, Power and Communication Technologies (GUCON), September, pp. 676-679.

Penzenstadler, B., Plojo, J., Sanchez, M., Marin, R., Tran, L., & Khakurel, J. (2018). The diy resilient smart garden kit. In Proceedings of the Workshop on Computing within Limits (LIMITS), Calgary, AB, Canada, November, pp. 6-7.

Ramya, K. C., JS, A., & TS, A. (2021). Smart garden monitoring and control system with sensor technology. In, 3rd International Conference on Signal Processing and Communication (ICPSC), May 2021, pp. 93-97.

Rasel, M., Hosen, M., Hosen, P., Sha, M., Islam, M., Rahman, L., & Akter, Z. (2022). IoT Based Indoor Garden System. Doctoral dissertation, Sonargaon University (SU).

Ray, P. P. (2017). Internet of things for smart agriculture: Technologies, practices and future direction. Journal of Ambient Intelligence and Smart Environments, 9(4), 395-420.

Sadli, M. D. D. (2019,). An IoT-based Smart Garden with Weather Station System. In 2019 IEEE 9th Symposium on Computer Applications & Industrial Electronics (ISCAIE), April, pp. 38-43.

Srithar, V. K., Vishal Vinod, K., Mona Sweata, S. K., Karthika Gurubarani, M., & Abirami, K. (2021). A Smart Plant Watering System for Indoor Plants with Optimum Time Prediction for Watering. In Inventive Systems and Control: Proceedings of ICISC 2021, Springer Singapore, pp. 461-477.

Woo, K. S., & Suh, J. H. (2021). Study on the Current Status of Smart Garden. Journal of the Korean Institute of Landscape Architecture, 49(2), 51-60.

https://www.healthline.com/health/healthy-home-guide/benefits-of-indoor-plants#:~:text=Constantly%20seeing%20and%20being%20around,percent%20and%20can%20increase%20concentration Accessed on 18/02/2023.

https://www.realsimple.com/home-organizing/gardening/indoor/foods-you-can-grow-indoors Accessed on 18/02/2023.