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DESIGN OF AN AUTOMATED AND WIRELESSLY CONTROLLED AGRICULTURAL SYSTEM FOR SIBERIAN REGIONS

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Introduction. The primary issue with agriculture in Siberia and the Far East of the Russian Federation is that each settlement presents unique conditions, encompassing diverse climates and socio-economic landscapes. Within every locality, residents adhere to distinct rhythms and establish their own set of rules across various facets of life. Hence, managing the economy in this region is most effective when done in a way that preserves the existing microclimate and considers the specific characteristics of each municipality. Food crops that include vegetables such as leafy greens are an important component of the human diet, but in Yakutia, the actual annual vegetable intake is 70-77 kilos per capita, including about seven kilos of cucumbers and five of tomatoes. This is significantly below WHO's recommendation of around 146 kilos of fruit and vegetables per year. The primary reason could be the fact that vegetables are hard to grow all year round in these regions and meat is relatively easier to come across as most of these regions thrive on meat-based diets since the communities primarily involve themselves in livestock farming as it is far more productive in these regions than farming food crops such as leafy greens and high-fiber vegetables. In this paper, we present a design of a scalable automated, and wirelessly controlled controlled agricultural system that will enable year-round farming of essential food crops, primarily leafy greens such as spinach (Spinacia oleracea). We firmly believe that our design would contribute to the Yakutian community and also other communities that reside in these regions that experience harsh arctic circle climates.

The Main Part. This paper introduces a scalable and modular autonomous agricultural system for controlled environment agriculture (CEA), focusing on spinach cultivation. The system includes a mini-greenhouse with thermal insulation, sensors, and an Arduino Pro control system for autonomous climate and nutrient control. Utilizing LoRaWAN, the system allows remote monitoring and adjustments [1]. Key components include a Sensor Tower, Wireless Communications System, Control System, Power Management, and Controllable Units. Simulations indicate a power consumption of 25-30W for 15-20 spinach crops, supporting year-round cultivation without natural light. The system addresses pH control, temperature regulation (15-20℃), and lighting requirements (200-400 μmol/m²/s PAR) for optimal spinach growth, utilizing an SHT15 sensor module, LED lighting, and nutrient reservoir with a sensor [2-4]. The paper underscores the significance of maintaining pH levels, temperature control, sufficient lighting, and effective nutrient management for successful spinach growth in controlled environments, anticipating ongoing research advancements in controlled environment agriculture [5,6].

Conclusion. Our research introduces a scalable, autonomous, and wirelessly monitored agricultural system tailored for year-round cultivation of spinach in the challenging climates of Siberia and the Russian Far East, particularly Yakutia. Addressing the region's low vegetable intake, the system employs thermal insulation, a microcontroller-based control system, and long-range wireless communication for remote adjustments. Designed to adapt to diverse settlements, our modular system demonstrates versatility from small households to larger commercial setups. Despite challenges posed by harsh weather, our thermal design and heated airflow system aim to create an optimal internal environment for sustainable and energy-efficient spinach cultivation. By addressing key factors like pH control, temperature regulation, lighting optimization, and nutrient management, our research contributes to the advancement of controlled environment agriculture, offering a viable solution for year-round production in regions with arduous climatic conditions.

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