**Design of an Automated and Wirelessly Controlled  
Agricultural System for Adverse Environments**

***Barua S.1, Chatterjee S.2, Iakovchenko N.V.1***

*PhD student, 2nd year of study*

*1ITMO University, Faculty of Biotechnologies, St. Petersburg, Russia*

*2 ITMO University, Faculty of Physics, St. Petersburg, Russia*

*E-mail: sbarua@itmo.ru*

This paper introduces a scalable and modular autonomous agricultural system for controlled environment agriculture (CEA), focusing on spinach cultivation, particularly in challenging regions like Siberia and the Russian Far East, notably Yakutia. The system integrates a mini-greenhouse with thermal insulation, an Arduino Pro control system, and LoRaWAN for remote monitoring and adjustments [1]. Key components include a Sensor Tower, Wireless Communications System, Control System, Power Management, and Controllable Units. Simulations suggest 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]. It 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 CEA [5,6].

**Литература**

1. Grunwald, A., Schaarschmidt, M., & Westerkamp, C. (2019, May). LoRaWAN in a rural context: Use cases and opportunities for agricultural businesses. In Mobile Communication-Technologies and Applications; 24. ITG-Symposium (pp. 1-6). VDE.

2. Thi Phuong Dung, N., Ngoc Thang, V., Nguyen, Q.-T., Tran, T.-T.-H., Phi Bang, C., Kim, I.-S., & Jang, D.-C. (2022). Growth and Quality of Hydroponic Cultivated Spinach (Spinacia oleracea L.) Affected by the Light Intensity of Red and Blue LEDs. Sains Malaysiana, 51, 473-483. <https://doi.org/10.17576/jsm-2022-5102-12>

3. Tang, Y., Guo, S., Ai, W. D., & Qin, L. (2009). Effects of Red and Blue Light Emitting Diodes (LEDs) on the Growth and Development of Lettuce (var. Youmaicai). SAE Technical Papers, 23, <https://doi.org/10.4271/2009-01-2565>.

4. Stagnari, F., Polilli, W., Campanelli, G., Platani, C., Trasmundi, F., Scortichini, G., & Galieni, A. (2023). Nitrate Content Assessment in Spinach: Exploring the Potential of Spectral Reflectance in Open Field Experiments. Agronomy, 13, 193. <https://doi.org/10.3390/agronomy13010193>.

5. Bula, R. J., Morrow, R. C., Tibbitts, T. W., Barta, D. J., Ignatius, R. W., & Martin, T. S. (1991). Light-emitting diodes as a radiation source for plants. HortScience : a publication of the American Society for Horticultural Science, 26(2), 203–205.

6. LAZAR T. (2003). Taiz, L. and Zeiger, E. Plant physiology. 3rd edn. Annals of Botany, 91(6), 750–751. <https://doi.org/10.1093/aob/mcg079>