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Short Notes on Financial Risk Assessment for Vertical Farms Using Imprecise Probability

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Introduction

Agriculture faces a slew of challenges, including unusual weather patterns, water scarcity, and an ageing rural population. To meet the demands of a growing population, these combined challenges necessitate innovation in resilient farming methods. Vertical farming (VF) is one such method that has the potential to contribute to food and nutritional security. VF is a novel type of agriculture defined as multi-layer indoor crop production systems with artificial lighting that control growth conditions. Vertically (in towers) or horizontally (in trays or gullies), plants can be stacked. The goal is straightforward: produce more food with less land. It employs controlled-environment agriculture (CEA) techniques such as hydroponics [1,2] and light-emitting diodes for growing (LEDs).

Indoor vertical farms, also known as plant factories with artificial lighting (PFALs), are the most technologically advanced and expensive. As a result, they can control the majority of growing parameters independently of external environmental factors. With this unprecedented level of control, researchers have been able to optimise production by fine-tuning variables such as light spectrum, temperature, and irrigation. When managed properly, VF offers a slew of benefits, including higher yields all year, faster feedback cycles, longer shelf-life, and zero pesticide use. This type of agriculture can take advantage of the internet of things and big data to improve factory performance. Because of their high energy conversion to edible matter, leafy greens, herbs, and microgreens are the most popular crops to farm vertically. The industry has seen an increase in interest and significant investment in recent years, owing to advances in light-emitting diode (LED) technologies over the last decade. As a result, vertical farms are springing up all over the world, particularly in strategic locations (environments hostile to crops, regions with cheap electricity and markets for premium-quality food).

About the Study

The practice is uncommon and is met with scepticism. High capital and operational costs due to expensive equipment and the high-level expertise required to operate it, as well as high energy demands, which can result in low profit margins, have been criticised. As the market, expertise, and technology mature, the learning curve becomes steep. Market forces favour VF; however, there have been numerous failures over the last decade. Vertical farms [3-5] typically require ongoing investment to survive; otherwise, they may go bankrupt due to negative cash flow. As a result, there is still reluctance to invest in VF. The scarcity of peer-reviewed research investigating the economics underlying the construction and operation of VF is a recurring complaint from investors, researchers, and practitioners. Despite the fact that vertical farms operate in controlled environments and use data to optimise growing conditions, there is a scarcity of production, yield, and economic data in the literature. This is exacerbated by the lack of any standardised data framework or benchmarking.

Future Prespective

The lack of validated and peer-reviewed economic and risk data in the literature highlights an urgent need to address the economics of VF in order to improve it. One way around this is to use risk and uncertainty quantification techniques. Risk management, in theory, would reduce profit fluctuations and increase investments while increasing farmers' income. As a result, increased access to finance may aid in the achievement of sustainable development goals VF is a high-risk business, but no efforts have been made in the literature to quantify and evaluate financial risk. Risk and uncertainty must be factored into business models for a more accurate assessment and increased access to funding.

Customizable analyses are required to accommodate various scenarios and user inputs, especially since datasets are scarce. There are tools available to help entrepreneurs compare different locations, systems, and business models, but only one is commercially available. It lacks the rigour of peer-reviewed yield values as a commercial tool and currently does not allow the user to consider any uncertainty or risks. Furthermore, it is a black box, making it difficult to criticise; it is not fully functional, but it informs the framework used in this study. Mistakes can easily occur as a result of hypothetical data. In certain conditions, two studies conclude that vertical farms are more profitable than greenhouses. VF is preferred for both studies.

Conflict of Interest

None.

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