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An Overview on Vertical Farming

Dr. Rahat Ashraf[1], and Dr. Sachin Kishor[2]

[1,2]Assistant Professor, School of Agriculture Science and Technology, RIMT University, Mandi Gobindgarh, Punjab, India

Correspondence should be addressed to Dr. Rahat Ashraf; rahatashraf@rimt.ac.in

ABSTRACT- Vertical farming methods allow for the effective use of space by growing fresh food vertical in dissimilar layer piled atop each other's. Vertical farming techniques do not require sunshine or soil since the atmosphere is entirely regulated. Only one hand, vertical farming, with its higher crop yield per square metre utilised than conventional farming, might assist to provides nutritious diets for world's expanding population; on the other hand, it may provide the possibility to grow foods in the climatically challenged locations. However, atypical growth circumstances, as well as the entire vertical farming systems, might well be considered unsustainable. As a result, it's vital to understand if vertical farming techniques are acceptable to customers. This is the first research to look at how three distinct vertical farming methods are accepted by customers. The information was gathered in February 2018 through an online poll of 482 German customers. Structural equation modelling is used to identify the factors that influence customer acceptability of vertical farming systems. The findings show that consumer adoption of vertical farming systems is mostly driven by perceptions of sustainability. The greater the system's size, the more likely it is to be regarded sustainable. Consumers clearly detect things like scale ecologies.

KEYWORDS- Agriculture, Farming, Production, Population, Vertical.

I. INTRODUCTION

Vertical farming technologies make efficient use of space by producing fresh food vertical in several layers stacked on top of one another. Vertical farming techniques do not require sunshine or soil since the environment is entirely regulated. Only one hand, vertical farming, with its higher crop yield per square metre utilised than conventional farming, might assist to provides nutritious diet for the world's expanding population; on the other hand, it may provide the possibility to grow foods in climatically challenged locations [1-5]. However, atypical growth circumstances, as well as the entire vertical farming system, might well be considered unsustainable. As a result, understanding client acceptance of vertical farming systems is crucial [6]. This is the first research to look at how three distinct vertical farming methods are accepted by customers. Structural equation modelling is used to identify the factors that influence customer acceptability of vertical farming system. The findings show that consumer adoption of vertical farming systems is mostly driven by perceptions of sustainability [7-9].

The greater the system's size, the more likely it is to be regarded sustainable. Consumers clearly detect things like scale ecosystems. Urban Cultivator (British, Columbia, Surrey) and Fibonacci (Moscow, Russia). In-store vertical farms, the second type of vertically farming system, is offered by firms like In farm (Berlin, Germany) as well as Urban Cultivator. Aero Farms (Newark, New Jersey), Grow Up Urban Farm (Great Britain, London), or Plenty (California, San Francisco,) are among the companies that sell indoor vertical farm. Vertical farming offers both benefits and drawbacks. Vertical farming has the benefit of not requiring soil or sunlight, therefore soil-borne insects and also most abiotics stressors, like as ecological impacts caused by weather or day length, do not affect the systems. LED lights are preferred in vertical farms because their spectral spectrum corresponds to the demands of plants; LED lights are also long-lasting, low-cost, but also energy-efficient [10]. It is possible to change the temperature within the [11] vertical farm. Crops may be gathered and cultivated at any time of the year. Because the layers inside the farm are placed on top of each other, the productivity per unit (m2) is substantially higher than in traditional agriculture. Another advantage is the capacity to feed the city's fast growing population [12].

In 2050, the world populations is anticipated to exceed 10 billion people, with 80 percent of them living in cities. In addition, unlike traditional farming, organic agriculture does not use a big amount of fuel for agricultural chores such as ploughing or planting. Thermal management is indeed a disadvantage in LEDs since semi-conductor heat dissipation is critical for LED lifetime. Another disadvantage is CO2 control, which is required in dense vertical gardens with stacked layers. Natural resources like as light, carbon dioxide, as well as water are all free, yet they all contribute to the expense of vertical farming. Another drawback is the restricted number of acceptable plants that must match specific criteria. When comparing the pros or negatives of vertical farming, it's vital to remember that hydroponic systems don't require sunlight or soil, which might affect their nutritional composition. The global population is expected to reach 9 billion people by 2050, with 80 percent of those living in cities. In addition, like traditional farming, organic agriculture does not use a big amount of fuel for farming chores such as ploughing or planting [13].

Thermal management is a disadvantage in LEDs since semi-conductor heat dissipation is critical for LED lifetime. Another disadvantage is CO2 control, which is required in dense vertical gardens with stacked layers. Natural resources like as light, carbon dioxide, and water are all free, yet they all contribute to the expense of vertical farming. Consumer surveys show that local food manufacture, naturalness, ethics, and environmental concerns are all important variables to consider when purchasing food. According to the poll, 95% of respondents go out of their way to buy locally produced food. Furthermore, buyers' local food selections are driven more by naturalness, safety, and the absence of pesticides than by conventional production practises. Consumers are often worried about ethical or environmental issues, thus these concerns must be considered while food sector innovations are developed. Subjective knowledge is more important than objective information when it comes to selecting environmentally responsible food choices. The social consequences, environmental and strategic issues, and procedures of vertical farming methods have previously been investigated. Furthermore, research on the adoption of various kinds of urban agriculture, such as public greenspaces, rooftop gardens, and vertical farming, has included the interests of shareholders or stakeholders, including such customers, lawmakers, and municipal planning authorities. People embrace urban food production for a variety of reasons, including organic production, great quality, or regionality [14].

The current study's goal is to determine the major factors that influence the acceptability of three distinct vertical farming systems, as well as behavioral intent to purchase the product or even systems itself. Vertical farming is viewed as a solution to feed a growing population as well as produce food in climatically tough locations, thus it's an essential issue. It is determined whether the three systems are seen differently when they are compared. The three systems were chosen because they represent the smallest (vertical household farms) or largest (indoor vertical farms) systems in (Figure 2), both of which are used for vertical farming in a totally regulated environment. Apart from that, unlike the other two systems, the in-store vertically farm was chosen since it can be implemented in grocery stores or restaurants. This variety of system allows the researcher to examine if customer decision as well as attitudes varies based on the kind of vertical farming systems that is being used. Figure 1 shows an example of in-store vertical farming [15-16].

Figure. 1: illustrate the in store vertical farming [17]

Figure. 2: illustrate the indoor vertical forming [18]

A. Contextual Framework

To examine the acceptance of vertical farming methods, this study used an enlarged technology acceptance model acceptance or use of technology model or the theory of planned behaviour. TAM and the theory of planned behaviour are both based on the concept of reasoned action. Perceived utility and user satisfaction of use, which examine attitudes towards usage; attitudes towards utilisation, in turn, assesses behavioural intent to use in combination with user satisfaction. Actual system usage is used to measure the behavioural intention to use the technology. The phrase "attitude toward ecological sustainability" refers to a person's perception of sustainability, as per the final model. The concept involves an attitude toward sustainability as both a result of these systems being presented as sustainable methods of agriculture. Furthermore, the perceived utility of a product may be altered by the consumers' subjective perceptions [19-20].

Additional criteria that relate to perceived utility include recognised sustainability, environmentalist attitude toward farming, subjective norm, as well as technology affinity. As

judged by these criteria, perceived usefulness is connected to a positive attitude toward purchase, which leads to a behavioural intention to buy. As per the theory of reasoned action, perceived behavioural control reflects the attitudes toward buying or the behavioural intention to buy. Figure 3 depicts every one of the finished model's described relationships [21-24].

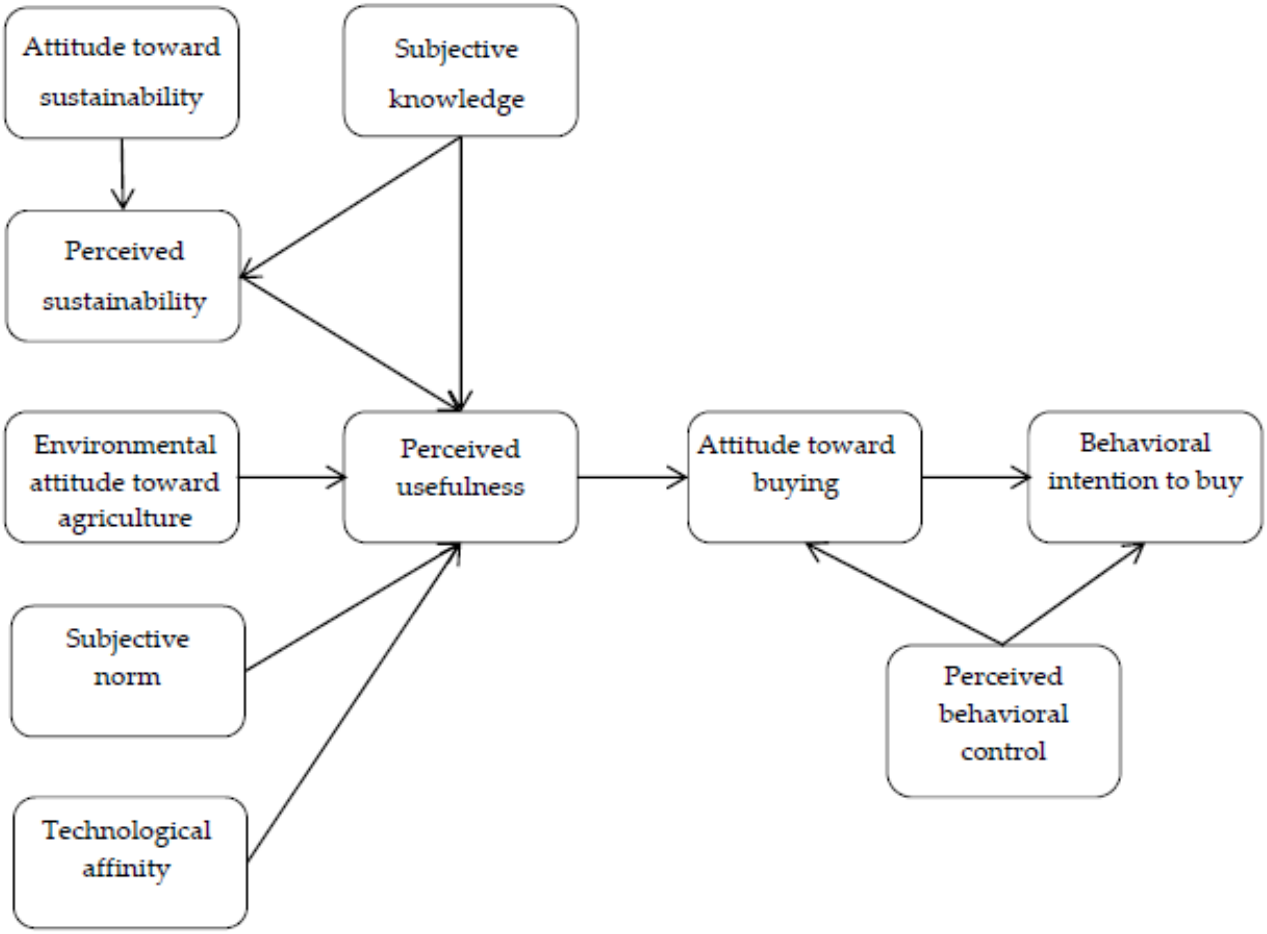

Figure. 3: illustrate diagram showing conceptual frameworks of extended method acceptances model

B. Advantage and disadvantage of vertical Farming

Vertical farming has a lot of potential, or it appears to be the farm of the future. However, before plunging headlong into modern agriculture, there are a few stumbling hurdles to consider.

Advantage

- As a result, it provides a strategy for meeting future food demands, allows crops to be grown year-round, and consumes a lot less
- Crops are not affected by the weather.
- As a result, it is possible to grow more.
- Chemicals and diseases are less likely to be a problem.

Disadvantage

- Construction may be too expensive, and economic feasibility assessments have yet to be completed.
- Pollinations would be difficult or expensive.
- It would require more manpower.
- It is highly technologically dependant, and a power loss would be terrible.

C. Vertical Farming's Limitations

There are benefits and drawbacks to vertical farming. The benefits of modern agriculture are frequently overstated, while the drawbacks are frequently neglected. The most significant disadvantages of vertical farming are given below.

II. LITERATURE REVIEW

Fatemeh Kalantari and colleagues investigated in next 60 years, 81 percent of world's populations will be living in cities as global populations continue to expand at rapid rates, supported by significant increase in the foods consumption. There is a needs for sustainable urban food to feed this expanding populations. Producing sustainable urban food necessitates taking into account all aspects of sustainability, particularly environmental, social, or economic progress. Designing and implementing vertical farms is an innovative method to addressing the issue of sustainability and meeting growing food demands. When land but also space are limited, metropolitan skyscrapers can be utilized to produce plants or

livestock in vertically inclined areas in urban environments. The significance of 60 papers from relevant publications and scientific online sites was examined in this study. Growing food vertically has the potential to boost food production, maintain high food quality and safety standards, and contribute to a more sustainable future. Food production in cities has well-known environmental, social, and economic benefits. Vertical farms may also help to increase global food security [25].

Shomefun et al. studied about Food is an essential human requirement. It is the means through which man gets fed and fortified in order to carry out his everyday tasks. Agriculture has been placed at head of the man's activities on the Earth due to the requirement for food for survival. With the world's population continually rising, man has devised new and novel techniques to cultivate crop. This production is mostly concentrated in rural parts of countries across the world; but, with today's rapid urbanisation, having enough agricultural output to feed the world's growing population has become increasingly difficult. Growing urbanisation in Nigeria, for example, has resulted in a high demand for land, energy, or water resources in the country's cities. The great bulk of food consumed in urban regions comes from rural areas. On the other hand, this method needs longer transit times from rural to urban areas, which usually leads to pollution and degradation. This study suggests a way for conveniently producing food crops in urban settings by planting them in vertical stacked layers to conserve space but then irrigating them with the least amount of energy or water [15].

Malek Al-Chalabi studied about around 9 billion people are expected to reside on the planet by 2050, with 70 percent of them living in metropolitan areas. Changes in climate will put pressure on Earth's resources, notably in the food supply chain as a result of Vertical farming has been offered as solutions to this problem. Despite being an intriguing theoretical hypothesis, there are presently no research that measure or evaluate its validity. From a socio-technical, mixed-methods perspective, our research tries to evaluate if vertical farming is practical. A few of the phases in this process include creating an energy model including comparing the carbon footprint of vertically produced food to that of commercially grown produce. Interviewing important parties to discover how they view viticulture is also a component of the process. Farming may be used to give food to cities in such a sustainable manner, as per the research, albeit this is reliant on location and design. The importance of future research is stressed [12].

III. DISCUSSION

In vertical farming, plants are grown in stacked rows that are piled on top Hydroponic, aquaponic, or aeroponic farming techniques are commonly used in conjunction with controlled-environment agriculture in order to maximize plant development. Innovations in greenhouse technology like as aeroponics as well as pest-free growing have changed the greenhouse business as well as prepared the path for new farming approaches such as rooftop agriculture. When it comes to residential complexes and business buildings, energy-saving temperature control and natural light management systems have contributed to reduce greenhouse gas emissions. On the other side, abnormal growing conditions or the whole vertical farming systems may be viewed as unsustainable. As a result, it's critical to comprehend customer acceptability of vertical farming systems. This is the first research to look at how three distinct vertical farming methods are accepted by customers. The information was gathered in February 2018 through an online poll of 482 German customers. Structural equation modelling is used to identify the factors that influence customer acceptability of vertical farming systems. The findings show that consumer adoption of vertical farming systems is mostly driven by perceptions of sustainability. The greater the system's size, the more likely it is to be regarded sustainable. Consumers clearly detect things like scaled ecologies.

IV. CONCLUSION

Humans may come to the conclusion that even a simple grasp and awareness of VF might increase food security or viability greatly. Aeroponic systems, insulation technologies, and pest-free plant growth have not only transformed the greenhouse industry, but have also paved the way for new farming approaches like rooftop farming. In residential and corporate buildings, innovative temperature control and natural light management systems helped to save energy and minimise greenhouse gas emissions. Traditional food production in densely populated cities, where more people need more food but also their needs can't be met, has distinguishable benefits over previous farming, including greater efficiency, adaptability, as well as environmental benefits, all of which are enabled by carefully controlled VF processes. There is no waste as well as pollution in VF, and there is plenty of opportunity. Surprisingly, VF has made it possible to incorporate all of the aforementioned advantages into a single solution. The fear of starvation will vanish, and detrimental global warming will be mitigated, if its use becomes popular and pervasive over the world. Nearly every single major Vertical Farm might be found in a city with a population of over 150,000 people. Sustainable food production is centred in Europe and The United states, but high-density Asian cities like Hong Kong, Tokyo, or Kuala Lumpur look to be focusing on developing sustainable food production inside city cores. In addition, VF has opened up new opportunities in the fields of architecture and urban planning. Urban planners have highlighted the need of making cities green, economic, or safe. VF does this by combining agricultural output with architecture, producing in facilities that can serve a large number of people.

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