Green Rooftops using Hydroponics and Fresh Water

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Rapid urbanization and population growth have intensified challenges related to food security, water conservation, and urban climate management. Conventional agriculture's reliance on extensive water and land resources exacerbates these issues. This research addresses these challenges through rooftop hydroponic systems, which offer sustainable solutions by reducing water usage, optimizing space, and lowering carbon footprints. Conducted on the rooftop of the Urban Engineering Department at NED University of Engineering and Technology, Karachi, Pakistan, this study investigates the performance of hydroponic systems—Nutrient Film Technique (NFT) and Dutch Bucket System (DBS)—and compares their efficiency with conventional agricultural methods. The methodology involved setting up NFT and DBS hydroponic systems under controlled greenhouse conditions. Water recirculation techniques were employed to conserve resources, while parameters such as temperature, humidity, pH, and Total Dissolved Solids (TDS) were monitored daily. Crops like strawberries, lettuce, and soybean were grown using nutrient-rich solutions, and their growth performance was compared to plants cultivated through conventional soil-based methods.

Results demonstrated that hydroponic systems significantly reduced water consumption, with up to 33% less water usage compared to conventional methods, while maintaining optimal TDS and pH levels. Space utilization in hydroponic systems was notably efficient, accommodating 60 strawberry plants in just 30 square feet compared to 48 square feet required for conventional setups. Although conventional systems yielded higher plant output in some cases, hydroponics provided better control over environmental factors, enabling year-round production and improved crop quality. The study concludes that rooftop hydroponics is a viable solution for urban agriculture, addressing food security and sustainability concerns. By reducing water usage, optimizing spatial efficiency, and mitigating urban heat island effects, hydroponics presents an innovative approach to sustainable food production. Further research is recommended to enhance crop yield, improve cost efficiency, and adapt these systems to diverse climatic conditions for broader urban applications.

Keywords: Climate adaptation; Urban farming; Hydroponics; Water conservation; Urban sustainability.