Education on Hydroponic Technology to Increase the Productivity of Modern Farmers

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Abstract

The study aimed to investigate the impact of education on hydroponic technology among modern farmers, contributing to a deeper understanding of the educational implications involved. The study employed a qualitative methodology, utilising in-depth interviews and observations as data collection techniques. The participants consisted of ten farmers residing in Desa Sukamanah Pangalengan. The implementation of a complete hydroponic curriculum, together with the utilisation of varied training methodologies, has provided farmers with the necessary tools and knowledge to facilitate the shift from conventional agricultural practises to hydroponics. Education enhanced their comprehension, bolstering self-assurance and fostering sustainable, high-caliber farming methodologies. This study highlights the crucial role of education in the adoption of novel practises and contributes to the ongoing dialogue on developments in agriculture. The results indicate that there is a need to broaden educational programmes to reach a larger audience, which can be achieved through partnerships and the utilisation of online platforms.

Keywords: *community education, hydroponic technology, modern farmers productivity.*

INTRODUCTION

Agriculture has served as the fundamental foundation of human civilization, exerting significant influence on civilizations, economies, and cultures over successive generations (Arniati et al., 2022; KHAN, 2018; Safuri et al., 2022). Nevertheless, in light of the ongoing evolution of the modern world, driven by the rapid process of urbanisation, advancements in technology, and the changing dynamics of the environment, conventional agricultural methods encounter new obstacles.

A crucial issue in contemporary life is around the significant constraint posed by the limited availability of arable land (CifuentesTorres et al., 2020). The expansion of urban areas and the increase in population have resulted in the depletion of arable land for agricultural purposes. The issue of shortage presents a multifaceted predicament, given the ongoing escalation in demand for food production. Traditional agricultural methods, which typically rely on large tracts of land, face challenges in meeting the increasing need for food production due to limited available space (Sabandi et al., 2021). The presence of this limitation, in conjunction with apprehensions regarding deforestation and ecological disparities, mandates a reassessment of current agricultural practices

Hydroponic technology has emerged as a disruptive answer in the context of this shifting ecosystem. Hydroponics, an agricultural technique that involves the cultivation of plants in nutrient-rich solutions devoid of soil, possesses significant capacity to revolutionise the field of agriculture (Sabandi et al., 2021; Wibowo et al., 2018). This technique provides the opportunity to cultivate crops in regulated situations, such as vertically stacked systems and urban settings, hence offering increased flexibility. Hydroponics optimises resource efficiency, diminishes water use, and augments agricultural yields by means of meticulous regulation of nutrients, water, and ambient conditions(Khan et al., 2020; Sharma et al., 2018). In addition to optimising resource utilisation, hydroponics serves to reduce reliance on chemical inputs, so mitigating environmental consequences and fostering sustainability. Moreover, the implementation of a controlled environment effectively mitigates the potential hazards associated with pests and diseases, hence

resulting in the production of superior-quality agricultural products. The amalgamation of these advantages renders hydroponic technology an attractive route to tackle the varied issues encountered in contemporary agriculture.

Considering the potential benefits of hydroponic technology in improving agricultural output, there exists a noticeable study gap pertaining to the influence of education on the adoption of these new practises. The current body of research primarily centres around the technological aspects of hydroponics, with limited attention given to the impact of education on the adoption of this technique (Jan et al., 2020; KHAN, 2018). The objective of this study is to address the existing knowledge gap by examining the influence of education on the adoption of hydroponic technology within contemporary farming communities. Through an examination of the complex interplay between education, technological adoption, and subsequent shifts in agricultural output, this study enhances scholarly comprehension of the comprehensive ramifications of change caused by education.

In light of the dynamic problems and potential benefits associated with hydroponic technology, the notion of enhancing contemporary agricultural output through educational initiatives focused on hydroponics emerges as a compelling remedy (Asaari et al., 2020; Ekawati et al., 2022). The integration of education with hydroponic technology serves as a transformative force, empowering contemporary farmers with the necessary expertise and abilities to adopt progressive methodologies (Korgitet, 2019; Safuri et al., 2022). Education program for farmers is one form of community education (Hasan & Nurhayati, 2012; Nurhayati, 2021). The education program on community takes multiple forms such as training, councelling, socialization, direct education and also guidance programs (Hidayat & Nurhayati, 2023; Jabar & Nurhayati, 2021; Nurmawati et al., 2021; Qudsi & Nurhayati, 2023; Sulaimawan & Nurhayati, 2023; Syafrudin & Nurhayati, 2020). The efficacy of community education programs in increasing community empowerment have been reported in many previous researchs (Hudri & Nurhayati, 2020; Intadiyah et al., 2021; Musa et al., 2022; Nurhayati, 2018; Nurhayati et al., 2022; Nurhayati & Rosita, 2020). Through the provision of knowledge and understanding regarding the fundamental principles of hydroponics, the complexities of nutrient management, and the complexity of controlled environments, education empowers farmers to optimise their agricultural productivity.

By using hydroponic technology, emphasising education, and conducting thorough research, contemporary farmers have the potential to surpass conventional constraints, so enhancing productivity, attaining economic sustainability, and promoting ecologically conscientious practises. This project aims to investigate the potential impact of education on the future of contemporary agriculture by examining the confluence between these two domains. The following parts will explore the complexities of hydroponic education, its influence on productivity, and the approaches to bridging the divide between theory and application. Through this research endeavour, the aim is to make a valuable contribution to academic dialogue and the practical use of cutting-edge agricultural techniques that have the potential to revolutionise the field in a time characterised by rapid transformations.

RESEARCH METHOD

The study utilised a qualitative approach for understanding intricate phenomena, such as the impact of hydroponic instruction on the adoption of technology and the productivity of contemporary farmers. The study utilised qualitative methodologies in order to obtain comprehensive and contextually specific data that explored the intricacies of participants' cognitive processes and actions. The employed research methodology was the descriptive approach, to examine the patterns of adoption among contemporary farmers and the subsequent changes in production. The participants of the study consisted of ten contemporary farmers residing in Desa Sukamanah Pangalengan. The selection of participants was conducted purposively to achieve a broad representation across various factors, including geographic location, farm size, and demographic features. Qualitative data was collected through the utilisation of in-depth semi-structured interviews. The interviews served as a medium for participants to discuss their previous experiences, perspectives, and understandings pertaining to hydroponic education, the adoption of technology, and its influence on productivity. The interviews were carried out using either in-person

or virtual methods, depending on the preferences and accessibility of the participants. The researchers acquired observational data by immersing themselves in the individuals' farming practises, in addition to conducting interviews. The study involved the observation of hydroponic systems, methodologies, and the dynamics between farmers and their education-oriented approaches.

The analysis of collected data was conducted, encompassing pertinent items such as educational resources, training modules, and reports derived from hydroponic education programmes. The aforementioned documents provided additional information regarding the structure, substance, and goals of the educational endeavours. Data analysis techniques refer to the methods and procedures employed to examine and interpret data in a systematic and rigorous manner. These techniques are utilised to derive meaningful insights, identify patterns, and draw conclusions from the data. Thematic analysis was utilised as a methodological approach to examine and interpret qualitative data derived from in-depth interviews and observations. The process encompassed the identification of repeating themes, patterns, and concepts within the tales provided by the participants. The data underwent a thorough process of coding and categorization in order to uncover significant discoveries pertaining to education, the use of technology, and productivity.

The research methodology employed in this study involved the use of content analysis to extract pertinent information from the documents that were collected. The utilisation of this approach enabled the discernment of fundamental themes, objectives, and techniques implemented within hydroponic education programmes. To enhance the validity and reliability of the findings, various strategies were employed, including member checking, researcher triangulation, and the use of detailed descriptions. These parameters enhanced the reliability and validity of the findings of the study. The research was carried out in Desa Sukamanah Pangalengan, which was selected because to its typical rural environment and the significance of hydroponic technology adoption in relation to local agricultural practises. The qualitative data that was gathered provided a detailed comprehension of the complexities associated with educational initiatives aimed at promoting hydroponics in the particular area under investigation, spanning from January to May 2023.

RESULTS AND DISCUSSIONS

Based on the data from the interview and observation, it was determined that the implementation of hydroponic technology education in Desa Sukamanah yielded significant insights, highlighting the profound influence of these educational initiatives on contemporary agricultural methods. The incorporation of a complete curriculum, a variety of training techniques, and strategic resources significantly influenced the development of a dynamic learning experience for farmers.

The essential factor contributing to the achievement was the curriculum-based methodology, which afforded learners a systematic framework for comprehending hydroponic technology. The programme covered a wide array of subjects, including foundational hydroponic principles as well as more complex areas such as system design, nutrient management, crop care techniques, pest control strategies, and post-harvest handling. The comprehensive curriculum served as a supportive structure, guaranteeing that participants not only acquired theoretical information but also assimilated the practical complexities necessary for achieving proficiency in hydroponic practises. The comprehensive curriculum on hydroponic technology serve as the knowledge capital for increasing modern farmers' productivity (Sarah Kaddu & Eric Nelson Haumba, 2018).

The components of the programme were meticulously crafted to provide a comprehensive understanding of hydroponic practises. The components of the curriculum were carefully crafted to provide participants with a thorough understanding of hydroponic practises, encompassing The core principles: The curriculum commenced with introducing participants to the fundamental principles of hydroponics, providing an overview of its core concepts, advantages, and its significance in contemporary agricultural practises. The participants engaged in an in-depth examination of the design and setup of hydroponic systems, investigating various approaches and configurations. The programme provided comprehensive instruction on nutrition management, with a particular focus on nutrient solutions. Participants were educated on the process of

formulating well-balanced nutrient combinations, which are essential for promoting optimal plant growth. The workshop focused on Crop Care and procedures, where attendees were educated on effective crop selection tactics, optimal planting procedures, and various approaches to promote and maintain healthy growth. The curriculum was supplemented by modules on pest control and post-harvest handling, which provided comprehensive insights into the hydroponic cycle. These modules aimed to enhance the students' awareness of strategies for managing pests and effectively handling produce after harvest. Through a methodical approach of introducing participants to a wide range of aspects, it facilitated the development of a comprehensive understanding. Commencing with fundamental principles and advancing towards more sophisticated methodologies, the curriculum's sequential structure guaranteed that participants were equipped with the necessary skills to effectively navigate the intricacies of hydroponics. The comprehensive strategy employed in this programme ensured that participants were adequately prepared to adopt hydroponic technology, instilling them with the necessary knowledge and skills to effectively tackle obstacles and optimise their systems.

The choice of training methodologies and instructional resources was designed to accommodate diverse learning preferences. Theoretical foundations of hydroponic technology were conveyed through workshops and lectures, facilitating participants' understanding of fundamental ideas. Nevertheless, it was the practical lessons that effectively reinforced the educational encounter. The participants actively engaged in hands-on demonstrations, which encompassed the setup of hydroponic systems, the preparation of nutrient solutions, and the maintenance of crops. In addition, the training was enhanced with the inclusion of instructional films, informative posters, and hydroponic kits, which provided participants with visual aids and physical instruments to facilitate their understanding and application of the material. The active training methods chosen because research showed that active training is very efficient for trainees' learning and increasing their cognitive knowledge (Elsaghir & Alzaeem Almonajid, 2021; Nurhayati, 2015; Nurmawati et al., 2021).

The implementation process was carried out with meticulous attention to detail to optimise the educational outcomes by employing a range of diverse instructional techniques. 1) The educational programme incorporated a combination of lectures and hands-on practical workshops, effectively integrating theoretical knowledge with applied learning opportunities. Theoretical information was imparted, then followed by the immediate application of concepts through practical, hands-on exercises. The participants acquired the necessary skills and knowledge to effectively manage hydroponic systems, nutrient solutions, and crop care practises through the process of experiential learning. 2) Field Visits: The inclusion of field visits to operating hydroponic farms afforded participants with practical experience and a contextual understanding of the subject matter. The participants were able to examine successful hydroponic systems, interact with knowledgeable farmers, and witness the real-world application of the curriculum principles. 3) Provision of Training Materials: Participants were furnished with training materials, encompassing the curriculum handbook, instructional films, and hydroponic kits. This facilitated ongoing learning beyond the workshop sessions, enabling participants to revisit and strengthen their comprehension.

The educational programmes were assessed by gathering input from participants and observing measurable changes in farming practises. Farmers have demonstrated increased levels of confidence in hydroponic techniques, citing the curriculum and training methods as influential factors in their acquisition of knowledge. The adoption of hydroponic techniques on their agricultural lands served as a tangible demonstration of the efficacy of the training programme. In summary, the results of the study highlight the substantial influence of education on the implementation of hydroponic technology in Desa Sukamanah. The comprehensive curriculum, effective training techniques, and rigors implementation process all facilitated a profound educational experience. Through the acquisition of a comprehensive comprehension of hydroponic methodologies, individuals were enabled to enhance their agricultural techniques, so augmenting both the productivity and sustainability of their farming endeavours.

The integration of hydroponic technology and education presents numerous benefits that enhance the productivity of modern farmers. This category encompasses several advantages, including the utilisation of precision and control techniques in hydroponics, as well as the sharing of

knowledge. These factors contribute to the enhancement of plant growth, better yields, and improved crop quality. 2) Enhanced Resource Utilisation Efficiency: Education empowers farmers with the necessary knowledge and abilities to proficiently allocate resources, hence minimising waste and maximising efficiency within hydroponic systems. The integration of hydroponic education enables farmers to overcome the limitations imposed by seasonal fluctuations, so facilitating a consistent and uninterrupted production cycle throughout the entirety of the year. The attainment of education empowers farmers to employ hydroponic techniques, hence facilitating cultivation in restricted spaces and urban environments. 5) The Economic Viability and Diversification: Farmers who have attained a higher level of education are more likely to have the opportunity to enter premium markets that place a high value on superior-quality agricultural products. This allows individuals to expand their sources of revenue and establish economic resiliency. The integration of hydroponic education fosters a cognitive framework that promotes ingenuity and flexibility among agricultural practitioners, enabling them to adeptly address changing agricultural landscapes and embrace advancements in technology.

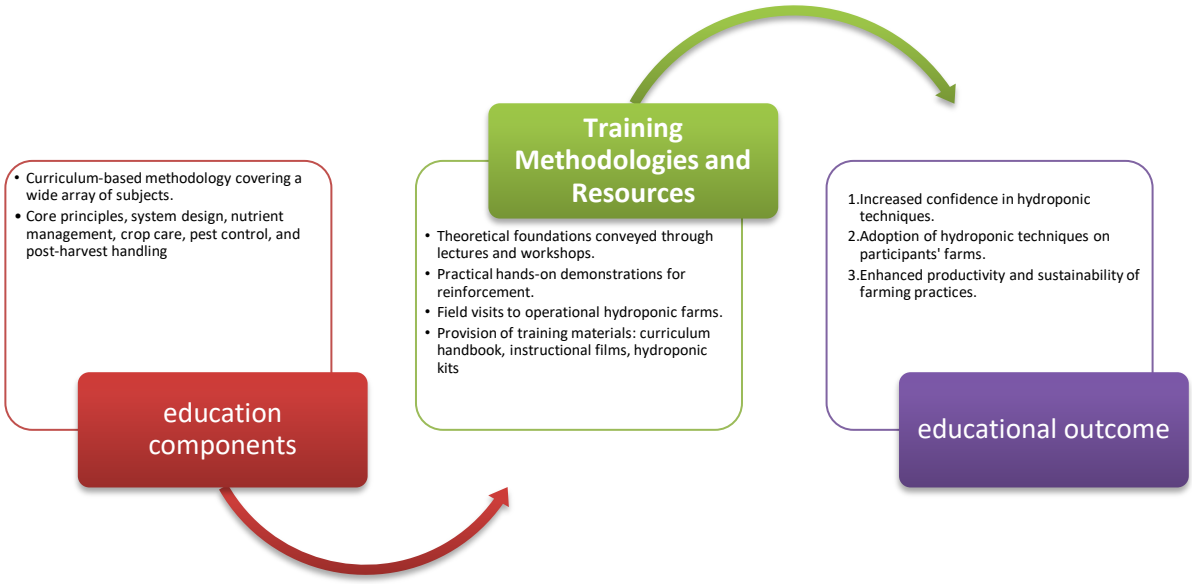

Figure 1. Data analysis results and illustrations
Source: empirical data 2023

The results of the study unveiled a significant and profound influence of hydroponic education on contemporary farmers. The participants underwent a transformation in their comprehension of hydroponic technology, switching from traditional agricultural techniques to novel and progressive approaches. The instructional methodology, which was centred around the curriculum, was enhanced by the inclusion of experiential learning activities and trips to real-world settings. This approach enabled participants to not only grasp theoretical concepts but also understand how they may be used in practical situations. The successful implementation of the course was highlighted by the participants' increasing confidence in hydroponic techniques and their subsequent integration of these practises into their own farms. This view underscores the efficacy of the curriculum, instructional techniques, and educational resources in precipitating a paradigm shift in farmers' knowledge acquisition.

The results are consistent with other research that emphasises the importance of education in driving changes in farming methods. Owoade (2020) found that education can make farmers better and take them out of subsistence agriculture. Research has indicated that the utilisation of experiential learning and hands-on training plays a crucial role in augmenting farmers' comprehension of novel technologies (Anugrahwanto & Nurhayati, 2020; Mutmainah et al., 2019; Nurhayati, 2018; Tran & Rodela, 2019). The integration of academic knowledge and practical application, as exemplified in this study, aligns with the suggestions put out by experts in the field of

agricultural education (Cahyo Mardiyanto & Reni Prastuti, 2016; Nalwade & Mote, 2017; Safuri et al., 2022). The scholarly discourse in the fields of agricultural science and education highlights the existence of a favourable association between education, the acquisition of information, and the enhancement of practices (Arniati et al., 2022; Cahyo Mardiyanto & Reni Prastuti, 2016; Sabandi et al., 2021; Safuri et al., 2022).

The results indicate that increasing the scope of these educational programmes may contribute to the wider adoption of hydroponic techniques throughout various farming communities. The establishment of a strong network that efficiently disseminates hydroponic knowledge could be achieved by collaboration among educational institutions, agricultural extension organisations, and experts. In addition, the utilisation of digital platforms and mobile applications has the potential to enhance remote learning, hence increasing the accessibility of hydroponic education to a broader range of individuals.

CONCLUSION

In brief, the implementation of hydroponic technology education in Desa Sukamanah has unequivocally exhibited its capacity for driving agricultural advancements. By use of a carefully designed curriculum, a variety of training methods, and precise execution, this effort has provided farmers with an extensive comprehension of hydroponic techniques. Consequently, the participants have acquired not only academic information but have also developed practical abilities essential for achieving proficiency in hydroponic gardening. The efficacy of this instructional initiative is apparent in the notable increase in farmers' self-assurance and the concrete assimilation of hydroponic techniques into their agricultural regimens.

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