RESEARCH ARTICLE

Hydroponics: How mainstreaming the technology for agricultural futures can address rural poverty and hunger

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Mainstreaming hydroponics technology in rural farming communities as part of the agricultural future takes on a trajectory of positive change, driven by the role of agriculturist students who have undergone lectures on the knowledge, methodology, and technical requirements essential to their efforts to introduce soilless farming to their communities.

This study delves into the role of agricultural students as agents of positive change, delivering technical expertise in hydroponic farming to their farming families and communities through a social intervention to address rural poverty and hunger, which is central to the whole-of-nation approach to achieving the UN SDGs. Using descriptive research design, this article looked into the mainstreaming potentials of the hydroponics technology by means of agriculture students of JHCSC who have attended series of lectures on hydroponics provided by their professors in addition to their agriculture curriculum cum career counseling, providing them with the technical knowledge about hydroponics.

These interventions are designed to support agricultural futures by bridging gaps from academia to the community, from knowledge to collaboration, which are central to addressing rural poverty

Key Words: *Hydroponics; Technology; Futures thinking; Rural poverty; Hunger*

INTRODUCTION

Hydroponics, as an agricultural technology, was relatively introduced in the Philippines anew and behind other agricultural countries in Asia, thus the concept in itself is very new to the farmers, especially in rural areas of the country. It follows the principles of 'water culture' or shifting from traditional agriculture that used soil, hydroponics is soilless and water-based, and to some extent, 'solution culture' [1].

Thus, mainstreaming this technology to agricultural students in the JH Cerilles State College through regular lectures on the technology basics, methodology, and applicability in rural settings is imperative. Students in agricultural programs are included in this mainstreaming because, sooner, they will embark on a career in agriculture and bring with them the possibilities and potentials for hydroponics, which may, one day, lead them to revolutionize the way rural farming is pursued in the Second Congressional district of Zamboanga del Sur.

Zamboanga del Sur is an agricultural province that is located South of the Zamboanga Peninsula, bordered by Zamboanga del Norte in the North, Misamis Occidental and Lanao del Norte in the East, and Zamboanga Sibugay in the West. Principally, rice farming is a long-held agricultural career in some municipalities in the second district, including Kumalarang, Guipos, Dinas, Lapuyan, Vincenzo Sagun, San Pablo, and Dumalinao.

Guiding the students too in the process and ensuring that they were able to imbibe the technology in their immediate family and communities will also be a promise, a step closer to addressing rural hunger, which corresponds to the United Nations Sustainable Development Goals (SDGs). Piggybacking the hydroponic lectures with their agriculture curriculum, this methodology will ensure that they become active partners of agricultural futures, and direct the destiny of rural agriculture from the potentials and acceptability of the technology in the community, when these students will also model the technology at the community level.

It is their role in the community as agriculture students of the state college that rural farmers will have an informal introduction to the hydroponic technology, encouraging awareness in the community and showcasing the hydroponic model, which allows members of the community to experience hydroponics first-hand.

Coupled with the concept of modern farming, hydroponics represents innovative practices and a sustainable way to do agriculture in limited spaces. When based on natural solutions that are traditionally abundant in the community, the technology will be low-maintenance. As part of the innovation, hydroponic systems too can introduce fish as a combination of aquaculture and hydroponics, where the waste of fish can nourish the growth of vegetables, and harvest fish too for sale in the fish market [2-4].

This new possibilities in pursuing agricultural futures in the rural setting brought about by students of the agriculture program in the state college is a promising exercise of the academy because it brings new information to the communities from the experiences of the students inside the academic community and through the facilitation and guidance of experts in hydroponics from the state college, it portends a huge potential for improved yield for hydroponic vegetables which are considered high value crops and mainstream the technology to the community who relied heavily on traditional farming and who viewed agricultural technology as an expensive project or enterprise.

United Nations SDGs

Data from the United Nations indicated that by 2030, around 600 million people worldwide will face hunger, with the cost of food continuing to rise each year. At least 1 in every 3 people in the world struggles with moderate to severe social insecurity. This study is situated around the global issue of hunger and aims to make a contribution in Zamboanga del Sur by addressing rural poverty.

Disturbingly, according to the 2023 Philippine Statistics Authority (PSA) data, Zamboanga Peninsula, including Zamboanga del Sur, registered a high poverty incidence with 30% of the population living below the poverty line. In sum, at the end of every year, a family of five should earn at least Php 13,873 per month to stay above poverty levels and meet their food and non-food needs. In Zamboanga Peninsula alone, the poverty incidence in the family was at 24.2% in 2023.

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This study seeks to address UN SDGs No. 1 and No. 2, respectively, in addressing poverty and zero hunger. By mainstreaming hydroponics as a viable, affordable, and reliable agriculture futures using innovative technologies, coupled with aquaculture, it will sufficiently lift up families below the poverty threshold and address rural hunger and poverty.

Considering that this is anchored in the curriculum of the BSA in the JH Cerilles State College, it is considered that the gains for this mainstreaming program greatly sustained the gains in addressing this disparity and collectively contribute to the attainment of the SDG goals.

Hydroponic technology in the Philippines

The power of hydroponics technology enables rural farmers to shift their orientation from being soil-space-dependent to cultivators of water-culture agriculture, which requires less space. The spatial requirement for hydroponic technology is not so much that other public lands can be sufficiently used for other viable commercial ventures that may also benefit the farming community. It has been proven that the hydroponic system can be used to grow high-value crops, such as lettuce, and, in some instances, recently, potatoes using potato tubers. Agricultural futures carry with them innovation essential to addressing food security, as the agricultural ecosystem is rapidly changing, including the high cost of farm implements and fertilizers traditionally required in soil-based farming. A study on potatoes being farmed using hydroponic technology is widely used in India as an alternative to traditional farming methods [5].

In the Philippine agricultural legal landscape, a legislative proposal to mainstream aeroponics and hydroponics is introduced in Congress by Cong. Brian Daniel Poe Llamanzares filed House Bill 3172 on August 6, 2025, to be known as the Soilless Agricultural Production Act. This study aligns with this vision in congress and aims to prepare a new generation of agriculturists among the college students in JHCSC to fill the gap of experts in hydroponic technology in Mindanao and the Zamboanga Peninsula. This envisions that by providing a regular lecture on hydroponics and encouraging agriculture students to consider the agricultural futures by implementing this technology in their respective communities, we hasten the movement in rural agriculture to adapt to the needs of agricultural production technologies such as hydroponics.

In Nueva Ecija, a case study was pursued using hydroponic technology, and it revealed that "success in hydroponics is not solely dependent on low investment and reduced labor. It hinges on the acquisition of essential skills and knowledge, encompassing both technical and managerial expertise. The findings emphasize the significance of various business elements, including organizational efficiency, technical proficiency in hydroponic systems, a comprehensive understanding of market dynamics, and robust financial acumen. These elements are crucial for ensuring the profitability and long-term sustainability of hydroponic ventures, highlighting the need for continuous learning and professional development within the sector" [6].

Crucial to this is the role of agricultural youths, who have an important impact on rural communities, especially since they are seen as role models of innovation as university students. They become agents of positive change in the rural communities. Driven by youth development, these agriculture students acquire social, emotional, and cognitive abilities while in school, and substantiating these with basic principles of hydroponics, a new agricultural technology that can be mainstreamed in their communities, opens endless possibilities. According to Jiawei Ren, these lectures done as part of education aims not only for personal success but also for the general prosperity and the fortitude of the youths from rural provinces. As agents of positive change, these youths can be invested in becoming hydroponic entrepreneurs [7] and social investments in them are imperative for the adaptation of this technology in their agricultural communities. And, for them, this is an empowering experience [8,9].

Agriculture futures and technology

This study delves into the inseparable role of youth as agents of the modern agricultural idea, which can influence their communities in rural settings. From their knowledge acquisition in the higher education system and ecosystem, they were already exposed to technology and innovation that can also be an important part of the mainstreaming of hydroponics as a technology within the agriculture futures that is also being pushed by innovative higher education institutions.

Hydroponics uses technology to regulate the substrates and nutrients remotely, providing environmental conditions by introducing smart agriculture solutions that enable real-time monitoring of the hydroponics and provide data-driven decision-making at the level of the farmer [10].

This agricultural innovation is compatible with Mindanao as its tropical climate sustains it. As Yogita Ranade and Nidhi Chaudhari opined that in tropical areas, hydroponics is steadily gaining momentum as urban farming, sustainable agriculture, and food security become more and more important. Vegetables, spices, medicinal plants, herbs, ornamental plants, and fodder are just a few of the many crops that have been successfully grown hydroponically in tropical nations in recent years. The high upfront expenditures, lack of technical expertise, insufficient regulatory support, and sociocultural opposition to non-traditional agricultural practices, however, continue to restrict its implementation. Commercial hydroponics is making strides in countries like Malaysia, but other tropical countries struggle with infrastructure, climate control, and market acceptance. To improve adoption, these countries need to make targeted investments, implement educational initiatives, and have supportive regulatory frameworks.

Hydroponics technology is suitable for Zamboanga del Sur as it was also successfully mainstreamed in cities such as Dipolog in Zamboanga del Norte and Zamboanga city, where investments in hydroponics made farmers in urban and peri-urban centers look at its possibilities and embrace it.

This study involved agricultural students as active agents of positive change in their rural communities, introducing the hydroponics concept to their farming communities and bringing the technology closer to their families, relatives, and barangay leaders, who will listen to them as agricultural innovators. This is a novel attempt by JH Cerilles State College to also benchmark hydroponics in communities through a series of lectures detailing its principles, methodology, and technological know-how, in the hopes of creating a positive impact among farmers to adopt soilless farming.

This technology is also referred to as vertical farming in many scholarly papers. Soojin Oh and Chungui Lu wrote that "Methods of growing plants without soil and soilless cultivation have been widely used in protected agriculture and horticulture, and reduced sources of both water and nutrients since the initial application of these approaches. Along with the subsystem development, numerous research articles have been published highlighting technology developments in the optimum growing conditions for indoor vertical farming."

The promise of hydroponics technology in rural development that addresses hunger and poverty also corresponds to the whole-of-nation approach in addressing the targets of the UN Sustainable Development Goals (SDGs) and this study rely on the power of positive change brought about by the agriculture students in the State College to carry out this immense technological advantage as part of the agricultural futures that will shape the direction of rural development. This intervention, too, from the academic institution offering agriculture programs, indicates strong institutional support, from knowledge to collaboration, in the farming community, with students as conduits of these efforts. This was already done in the Global South [11], where formal knowledge in colleges and universities is processed through collaborative interventions using transdisciplinary approaches. In this study, it used the semi-academic lectures as a supplement to the technical knowledge of the agriculture students which are useful in their mainstreaming to the rural farming communities that they belong, in hopes that in the long run, this will reshape the possibilities and prospects of agricultural futures that will help alter the rural poverty and improve poverty incidence in the family and augment its income to also be able to attain zero hunger.

MATERIALS AND METHODS

The study used descriptive method, in which a directed self-survey questionnaire is routed to all student participants at the end of the lecture

conducted by the researcher. This study involved 146 Bachelor of Science in agriculture students of JH Cerilles State College. Delivering hydroponics lectures at the smart farm redirected students' orientation towards the endless possibilities of agricultural futures. The lecture was facilitated by a tandem of professors from the SAFES. After each lecture, the students are asked to complete a brief survey on hydroponics and how the technology, as an agricultural future, serves as a methodology for addressing rural hunger among Filipino children. The lectures commenced in March and ran through April 2026. The student participants in this study, who are currently enrolled in the Bachelor of Science in Agriculture, were randomly assigned to groups for the 1-hour lecture. The SAFES professors and researchers delivered 6 lectures over 4 weeks.

The students involved were third and fourth year students only as the researcher included only students who were enrolled in almost all major subjects in the BSA curriculum. The simple random stratified sampling was used to ensure that each grade level was proportionately represented in the final analysis of the data. The researcher identified the participants from the available sample frame.

During the distribution of the questionnaire, the participants were informed of the purpose of the evaluation. An informed consent was included in the questionnaire. The participants were given the options to proceed answering the questionnaire or they will not pursue the participation in the research undertaking. The participants were ensured of the confidentiality of the data. The collected data were analyzed and interpreted using the mean, frequency and percentage distribution. The five-point Likert scale was used as responses of the items in the questionnaire.

RESULTS AND DISCUSSION

Demographics

The study involved students who are presently enrolled in their third and fourth years in their BSA program with JHCSC. They are within the 18-25 age bracket (100%). There are 41 males and 105 female participants. Of these, 92 reported farming or gardening experience, and 54 said they have none. Being agriculture students, they reported that they are involved in agriculture (Table 1).

TABLE 1
Demographic profile of respondents (N=146)

Variables	Category	Frequency	Percentage
Age	18-25 years	146	100
Sex	Male	41	28.1
	Female	105	71.9
Year level	BSA - III	83	56.84
	BSA - IV	63	43.16
Farming/Gardening experience	With experience	92	63
	No experience	54	37

Perception of these students on hydroponic technology. Students who participated in the study were informed through a survey conducted after every lecture that they were familiar with the basic concepts of hydroponics technology. This is the result of an enhanced experiential curriculum that integrated hydroponics into students' educational experience. To some scholars and authors, this meant confidence and pleasantness brought about by the experience and that the expertise they gained from the lectures and exposure often lead them to view hydroponics favorably [12].

Sustainability: The participants in the study considered hydroponics a sustainable agricultural method. The context in which this technology becomes a sustainable agriculture project is its relationship with technology and the Internet of Things (IoT) concepts, which are very suitable for younger generations of farmers. Their generation, mostly aged 18-25, is technology-savvy and aware of the importance of technology in mainstreaming hydroponics, even in rural areas.

Applicability and replicability: The respondents in the study believed they could easily build their hydroponic agriculture system at home and in the barangay. This is an important indicator for mainstreaming the technology, based on the experience of the OJT students, who are considered agents of positive change and bringers of technology to their barangays. After listening to the lectures and being exposed to the actual construction process and the technological innovations that accompany it, they opined that they can easily replicate it in their communities, bringing the promise of replicability, which is central to the mainstreaming of hydroponic technology.

Addressing hunger: The study revealed that all participants believed that mainstreaming hydroponics, even in rural communities, could address hunger. They strongly believed that introducing agricultural technology, such as hydroponics, in the communities would have a direct, positive impact on the community's efforts to address hunger. This indicates the youth's concern for food security in their rural communities, and this project, such as vertical and even horizontal hydroponics that include youths and women in the communities, will essentially address rural poverty and hunger among school-aged children. Scholars suggested mainstreaming this with community empowerment tools, such as collective gardening, sustained training, and lectures on hydroponics in the communities [13].

Sustained need for technical assistance and guidance: The participants in the study also indicated that they strongly value sustained, regular access to lectures and training on hydroponic technology because they believe they and their community vitally need it. This is how important the role of state agricultural colleges is in augmenting the technical delivery from the department of agriculture to the municipality and, eventually, to rural farming communities. Here, the opportunities are higher for OJT students who will soon earn their BSA degrees. They will become agents of positive change and technical experts in hydroponics, replicating and expanding the training base for hydroponic technology, making it relevant and accessible to rural farmers and their families.

Hydroponics as a viable agribusiness model: The participants in this study agreed that hydroponics is a new agribusiness model (mean=4.04). In the same context, participants also highlighted the potential of the hydroponics business, agreeing that hydroponics is an agribusiness that can be pursued on a small scale to address rural poverty. Getting into the small-scale hydroponics business will push the farmer-entrepreneurs towards a farming community that elevates its economic status by encouraging more sources of income. The income potential for hydroponics will be higher when it is mainstreamed with aquaculture, with infrastructure that allows tilapia to be grown beneath the hydroponic system, thereby providing an organic farming ecosystem that yields more economic returns to farmers who can harvest tilapia and hydroponic vegetables at the same time.

Research findings from both the Philippines and international context characterize hydroponics as a highly viable and innovative agribusiness

model capable of addressing modern agricultural challenges [13]. In the Philippines, specifically within the regions like Nueva Ecija, the declining productivity of traditional onion farming due to climate change and pest infestations has prompted to a shift toward these systems. Pascual et al. emphasize that hydroponics represents a new agribusiness model because it replaces soil with nutrient-rich water solutions, allowing controlled environments that mitigate risks associated with extreme weather and soil degradation. The model is viewed as a sustainable alternative because it enables year-round production and significantly reduces the need for traditional inputs like pesticides and herbicides (Table 2). This highlights a strategic transition from conventional, labor-intensive tilling to technology-driven, high-yield agricultural practices [14].

TABLE 2
Students' perceptions toward hydroponics technology (n=146)

Indicators	Mean	Standard deviation	Interpretation
Familiarity with hydroponics	5	0	Strongly agree
Hydroponics is sustainable	4.69	0.53	Strongly agree
Can be replicated at home/community	4.66	0.72	Strongly agree
Can address hunger	5	0	Strongly agree
Hydroponics is a viable	4.04	0.57	Agree
Hydroponics can reduce rural poverty	3.97	0.48	Agree
Overall mean	4.56	0.38	Strongly agree

Note: 4.21–5.00: Strongly agree; 3.41–4.20: Agree; 2.61–3.40: Neutral; 1.81–2.60: Disagree; 1.00–1.80: Strongly disagree

CONCLUSION

Based on the study's results, the potential for mainstreaming hydroponics and using agricultural youths (BSA students in this case) as agents of positive change in their rural communities will significantly impact poverty alleviation initiatives at the municipal level. The heightened interest of agriculture students who are trained to become hydroponics experts and idea germinators in their rural farming communities will hasten efforts to institutionalize hydroponics as an agricultural future, ahead of the passage of the law that will implement hydroponics and aquaculture in the Philippines. The study revealed the students' readiness to serve as conduits for information sharing, training, and expert guidance for interested farmer-entrepreneurs who may wish to mainstream hydroponics to increase their family's income, address rural poverty, and provide food security for their family and the community. In this, the academe and the department of agriculture, through the municipal agricultural officers, may jointly institutionalize the mainstreaming of hydroponics to empower agriculture students to take on the role of impactful agents of change in their communities.

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