

Empowering Youth to Enhance the Productivity of Hydroponic Horticultural Crops in Sungai Duren Village Jambi Luar Kota District

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Abstract

Young people have a strategic role in agricultural development through the adoption of modern technologies and innovative practices. In Sungai Duren Village, agricultural activities are predominantly carried out by farmers aged 45–60 years, highlighting the need to strengthen youth participation in agriculture. This community empowerment program aimed to improve youth skills in hydroponic horticulture while developing entrepreneurial opportunities through product diversification and digital marketing. The program involved practical training, construction of a hydroponic house, NFT-based cultivation of chili and long bean, horticultural product processing, digital marketing training, and continuous mentoring. Participants were directly involved in seedling preparation, nutrient management, plant maintenance, and harvesting. The harvested commodities were processed into value-added products, namely Kacapa (Kacang Panjang Pangsit) and Chiliku (Cabai Bubukku). The program demonstrated that integrating hydroponic cultivation, product diversification, and digital marketing can strengthen youth technical skills, entrepreneurial capacity, and awareness of environmentally responsible agricultural practices. The program also established a foundation for developing Kacapa and Chiliku as potential innovative village products and supporting the sustainability of youth-based agricultural activities in Sungai Duren Village.

Keywords: Community Development, Horticultural Crops, Hydroponics, Product Diversification, Youth Empowerment

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INTRODUCTION

Agriculture plays a fundamental role in ensuring food security, sustaining rural livelihoods, and supporting local economic development. However, agricultural systems are facing increasing pressures associated with climate change, resource constraints, environmental degradation, and the need to improve production efficiency. These challenges require not only technological innovation but also the development of human resources capable of adapting to changes in agricultural systems. In this context, young people represent an important human resource for the transformation of agrifood systems because they can contribute new knowledge, technological competencies, innovative ideas, and entrepreneurial perspectives. The Food and Agriculture Organization (FAO)

emphasizes that youth should be actively included in agrifood systems through greater access to skills, resources, employment, entrepreneurship, and digital technologies. Strengthening youth participation is therefore an important component of efforts to promote resilient and sustainable agrifood systems across generations (Kovshov et al., 2024).

The importance of youth participation is closely related to the challenge of farmer regeneration. The declining attractiveness of agriculture among younger generations can create a gap between the existing agricultural workforce and the future availability of farmers. Addressing this issue requires more than encouraging young people to enter agriculture; it requires transforming agriculture into an activity associated with technological innovation, entrepreneurship, and economically viable livelihoods (Kusuma et al., 2026). In Indonesia, this agenda is reflected in the Youth Entrepreneurship and Employment Support Services (YESS) program, implemented through collaboration between the Ministry of Agriculture and the International Fund for Agricultural Development (IFAD). The program focuses on increasing the capacity of rural youth, developing young agricultural entrepreneurs, facilitating access to capital, and creating an enabling environment for rural youth entrepreneurship (Pandey et al., 2025). These approaches demonstrate that farmer regeneration is increasingly connected to the development of agricultural skills, entrepreneurship, and modernization rather than simply the transfer of farming activities from one generation to another (Pagano et al., 2025).

Sungai Duren Village is in Jambi Luar Kota District, Muaro Jambi Regency, Jambi Province. Historically, the village was part of the Mestong customary territory before becoming a definitive village. Sungai Duren was initially led by a local leader known as Pasira, named Sulaiman Quris. In 1940, village leadership was subsequently held by a penghulu until approximately 1970, while Sungai Duren is estimated to have attained definitive village status around 1982–1983. Geographically, the village covers approximately 814 ha and is located at an elevation of approximately 13 m above sea level. The village has approximately 4,445 inhabitants and is administratively divided into 14 neighborhood units (RT) and three hamlets, namely Dusun Tuo, Dusun Pasir Raya, and Dusun Baru. These characteristics indicate that Sungai Duren has a substantial population and local resources that can serve as a basis for developing community-based agricultural and entrepreneurial activities.

Despite this potential, the regeneration of agricultural actors represents an important concern in Sungai Duren Village. Local population data indicate that farmers in the village are predominantly within the 45–60-year age group, suggesting that agricultural activities are still largely undertaken by the older generation. This condition creates an opportunity to strengthen the involvement of younger community members as future agricultural actors. Youth empowerment should therefore move beyond positioning young people as agricultural laborers and instead develop their capacity to become technology users, innovators, and agricultural entrepreneurs (Al-Shammary et al., 2024). Previous community empowerment initiatives have demonstrated that hydroponic cultivation can be used as a practical means of introducing modern agriculture to young people while simultaneously increasing their knowledge and skills. For example, a community empowerment program involving youth in hydroponic farming demonstrated the relevance of hydroponic cultivation as a learning medium for developing youth capacity in modern agriculture (Yang et al., 2024).

One technological approach with potential to address these challenges is hydroponic cultivation. Hydroponics is a soilless cultivation system in which plants obtain water and essential nutrients through a nutrient solution (Almamun et al., 2003). The system enables greater control over plant-growing conditions and can provide an alternative to conventional soil-based cultivation, particularly where land availability or soil conditions constrain agricultural production. Evidence from a global meta-analysis of 68 publications and 499 observations indicates that hydroponic systems have considerable potential for vegetable production, although productivity varies according to crop type, production environment, and cultivation system. Thus, hydroponics should not be viewed simply as a substitute for conventional farming but as a technological platform through which agricultural production can be controlled, monitored, and adapted to local conditions (Eprilianto et al., 2023).

The Nutrient Film Technique (NFT) was selected as the hydroponic approach in this program because it provides a practical system for introducing controlled nutrient and water management. In NFT, a shallow film of nutrient solution continuously flows through cultivation channels and encounters plant roots, providing water and nutrients while maintaining oxygen availability (Geza et al., 2022). The recirculation of nutrient solution can contribute to efficient water and nutrient use, although its effectiveness depends on system configuration, crop characteristics, environmental conditions, and nutrient management. Recent research has emphasized that NFT is increasingly studied as a cultivation approach for sustainable food production because of its potential to optimize water and nutrient use. At the same time, fluctuations in pH, dissolved oxygen, temperature, and nutrient concentration require appropriate monitoring and management. Therefore, training in NFT cultivation should emphasize not only system assembly but also practical competencies in nutrient preparation, monitoring, plant maintenance, and troubleshooting (Saikanth et al., 2023).

However, technical training alone is insufficient to achieve comprehensive youth empowerment. Empowerment in the agricultural sector should also address economic capacity and environmental awareness. From a technical perspective, young people need to develop practical competencies in hydroponic system selection, nutrient management, crop maintenance, and production planning (Nurmahmudah et al., 2024). From an economic perspective, agricultural production needs to be connected with product diversification, entrepreneurship, and market access so that agricultural activities can generate greater economic value (Ngadi et al., 2023). From an environmental perspective, young people need to understand the importance of efficient resource use and sustainable production practices. Community empowerment studies have shown that hydroponic training can be integrated with entrepreneurship and economic development, allowing participants to develop both cultivation skills and opportunities for income generation (Wati & Alisalman, 2025). This integrated perspective positions youth not merely as recipients of technological knowledge but as active actors in local agricultural development.

The economic dimension of the program is further strengthened through product diversification and digital marketing. Horticultural production can generate greater economic value when agricultural commodities are processed into products with higher added value rather than being marketed solely as fresh produce. In the present program, long beans and chili were selected as horticultural commodities and subsequently processed into Kacapa (Kacang Panjang Pangsit) and Chiliku (Cabai Bubukku), respectively. Product processing, packaging, branding,

and marketing can provide additional opportunities for value creation and entrepreneurship. Furthermore, digital marketing enables agricultural products to reach consumers beyond conventional local marketing channels. Previous community empowerment programs have demonstrated that digital marketing training can improve participants' capacity to create promotional content and utilize social media and digital platforms for product marketing (Wulandari et al., [2022](#)).

Accordingly, the empowerment program in Sungai Duren Village was designed as an integrated youth empowerment intervention rather than a stand-alone hydroponic training activity. The program combined hydroponic cultivation, hands-on technical training, mentoring, horticultural product processing, and digital marketing. This approach integrates three interconnected dimensions of empowerment: technical capacity, through the development of hydroponic cultivation skills; economic capacity, through horticultural production, product diversification, and entrepreneurial opportunities; and environmental capacity, through the introduction of resource-efficient and more sustainable cultivation practices (Cabacungan et al., [2024](#)). Such an integrated approach is particularly relevant because existing youth-focused agricultural programs increasingly emphasize the combination of agricultural skills, entrepreneurship, access to technology, and market opportunities as foundations for rural youth participation in agrifood systems (Gunawan et al., [2022](#); Maswadi et al., [2025](#)).

Based on these conditions, this community empowerment program, entitled "Youth Empowerment to Enhance Horticultural Crop Productivity through Hydroponic Cultivation in Sungai Duren Village, Jambi Luar Kota District," aimed to strengthen the capacity and participation of local youth in modern horticultural agriculture. Specifically, the program aimed to (1) improve youth knowledge and practical skills in hydroponic cultivation, particularly through the NFT system; (2) strengthen entrepreneurial capacity through horticultural product diversification and digital marketing; and (3) increase awareness of efficient and environmentally responsible agricultural practices. Through the integration of production, value addition, and marketing, the program was designed to provide young people with a broader pathway for participating in agricultural development and developing agriculture-based economic opportunities within their community.

METHODS

1. Community Empowerment Approach

The community empowerment program was implemented in Sungai Duren Village, Jambi Luar Kota District, Muaro Jambi Regency, Jambi Province, with a primary focus on strengthening the capacity of local youth in modern horticultural cultivation. The program adopted a participatory empowerment approach, in which community members were actively involved in the planning, construction, implementation, and maintenance of the hydroponic cultivation system (Gong et al., [2023](#)). The approach was designed not only to transfer technical knowledge but also to develop participants' practical skills and encourage their active involvement in agricultural activities.

2. Practical Training

The training was conducted through a combination of socialization, theoretical explanation, demonstration, and hands-on practice. The initial session introduced participants to the principles of hydroponic cultivation, the advantages and limitations of soilless farming, and the basic operation of the NFT system. Participants were subsequently involved directly in preparing the hydroponic growing system, seeding horticultural crops, managing nutrient solutions, and maintaining plant growth.

In addition to hydroponic cultivation, participants received training and mentoring in processing horticultural crops into value-added products. The commodities cultivated in the program included long beans (*Vigna unguiculata* subsp. *sesquipedalis*) and chili (*Capsicum* spp.). These commodities were subsequently processed into value-added products, namely Kacapa (Kacang Panjang Pangsit) and Chiliku (Cabai Bubukku). The training was intended to broaden participants' understanding of agricultural value creation beyond primary production.

3. Provision of Infrastructure and Production Facilities

To support the implementation of the program, the community empowerment team provided the facilities and materials required for hydroponic cultivation, including a hydroponic house, cultivation channels, water reservoirs, water circulation pipes, planting containers, growing media, seeds, and nutrient solutions. The hydroponic house also functioned as a community-based learning facility where participants could practice and monitor the cultivation process.

The hydroponic house was constructed using a wooden frame measuring approximately 15 × 5 m. The roof was covered with UV plastic to reduce direct exposure to sunlight, while netting was installed around the structure to reduce the entry of pests and animals. Bamboo fencing was also installed around the facility. Bamboo was selected as the cultivation channel because of its availability and suitability for constructing a simple, locally adaptable hydroponic system. Bamboo sections approximately 4 m in length were prepared as cultivation channels by creating planting holes along their central surface. For chili, planting holes were spaced approximately 35 cm apart, resulting in approximately 40 planting sites per 4-m bamboo channel. For long beans, planting holes were spaced approximately 30 cm apart, resulting in approximately 48 planting sites per channel. Four bamboo channels were prepared for each crop, resulting in a total planned capacity of 88 planting sites within the hydroponic house.

The bamboo cultivation channels were placed on supporting tables with a slope of approximately 3–5° to facilitate the flow of the nutrient solution. A ½-inch pipe was installed to distribute the nutrient solution from the reservoir to the cultivation channels. The nutrient solution was subsequently returned to the reservoir, allowing the water to circulate continuously through the system. This recirculating configuration was designed to facilitate efficient water and nutrient management within the hydroponic system.

4. Seed Germination and Seedling Preparation

Two horticultural crops, namely chili and long beans, were cultivated during the program. Seed germination was initially conducted using cocopeat as the growing medium. The cocopeat was placed in a germination container and moistened with water until it expanded and reached an appropriate moisture level. The seeds were then placed on the moist cocopeat.

The containers were covered with plastic wrap and placed in a location without direct sunlight during the initial germination stage. After approximately one week, the plastic covering was removed and the seedlings were exposed to light to support subsequent growth. After approximately two weeks of seedling development, the seedlings were considered ready for transplantation into the hydroponic system. The seedlings were transferred into net pots and positioned in the bamboo cultivation channels. Foam was used to support the seedlings and maintain the position of the stems, while additional support was provided where necessary to prevent the seedlings from being displaced during water circulation.

5. Plant Maintenance and Nutrient Management

Plant maintenance included monitoring nutrient circulation, nutrient availability, plant growth, and structural support. An AB-mix nutrient solution was used as the primary nutrient source. The nutrient solution was prepared according to the concentration applied during the cultivation process. The circulation of the nutrient solution was monitored daily to ensure that water flowed properly through the cultivation channels and returned to the reservoir. Nutrient concentration and water availability were adjusted periodically according to plant requirements and nutrient uptake. Additional nutrients or water replacement were provided when necessary based on plant growth conditions. This monitoring was important because nutrient availability and solution conditions directly affect plant development in hydroponic cultivation.

Crop-specific maintenance was also conducted. Long bean plants were provided with additional supports to facilitate climbing and allow the developing pods to hang downward. These supports were introduced when the plants reached approximately two months of age. Chili plants, which develop relatively sturdy but potentially top-heavy stems, were supported using stakes (*ajir*) to maintain upright growth and reduce the risk of stem damage. Additional fertilizer or corrective treatment was applied when symptoms of nutrient deficiency or other plant growth problems were observed. Thus, plant maintenance was conducted through routine observation and adjustment according to the physiological condition of the crops.

6. Mentoring and Monitoring

Mentoring and monitoring were conducted throughout the cultivation process to ensure that participants were able to apply the techniques introduced during the training. The empowerment team provided guidance on hydroponic system operation, nutrient management, crop maintenance, and problem identification. Participants were encouraged to take an active role in monitoring the condition of the cultivation system rather than relying entirely on the intervention team.

Monitoring focused on the functioning of the water circulation system, nutrient availability, plant growth, and the occurrence of pests or other cultivation problems. When problems were identified, the team and participants discussed possible causes and appropriate corrective actions. This process was intended to gradually increase participants' independence in managing the hydroponic cultivation system. Mentoring was also extended to the processing and marketing stages. Participants were introduced to the processing of harvested horticultural commodities into value-added products and to the use of digital marketing as a means of promoting and expanding

market access for the resulting products. Thus, the empowerment process covered not only the production stage but also subsequent value-creation activities.

RESULTS AND DISCUSSION

The youth empowerment program in Sungai Duren Village was implemented through an integrated series of activities covering hydroponic cultivation, horticultural product processing, digital marketing, and continuous mentoring. The program was designed to strengthen the capacity of young people to participate in agricultural activities by combining practical agricultural skills with entrepreneurial and environmental perspectives. The implementation emphasized direct participation, allowing participants to become actively involved in the preparation of the hydroponic house, seedling production, plant maintenance, nutrient management, harvesting, and processing of horticultural commodities. This participatory approach is important in community empowerment programs because the adoption of new agricultural technologies is more likely to be sustained when beneficiaries are directly involved in learning and practicing the technology rather than receiving information through one-way instruction (Wahyuni, 2026). Previous community empowerment programs have similarly demonstrated that a combination of training, hands-on practice, mentoring, and evaluation can strengthen participants' capacity to adopt hydroponic cultivation as an alternative agricultural activity (Hilmawan et al., 2023; Sanyaolu et al., 2024). The construction process of the hydroponic house is presented in Figure 1. The activity involved local youth in the preparation and construction of the facility as a practical component of the community empowerment program.



Figure 1. Inauguration of the hydroponic house with members of the Karang Taruna in Sungai Duren Village

One of the main outcomes of the program was the establishment of a hydroponic production facility that functioned not only as a cultivation site but also as a practical learning facility for local youth. The hydroponic house measured approximately 15 × 5 m and was constructed using locally available materials, including wooden frames, UV plastic roofing, protective netting, and bamboo cultivation channels. The use of bamboo as the main cultivation

channel provided relatively simple and locally adaptable technology that could be maintained by the community without requiring sophisticated infrastructure. The cultivation system consisted of four channels for chili and four channels for long beans, resulting in a total of 88 planting sites. The channels were positioned on tables with a slope of approximately 3–5° to facilitate the circulation of nutrient solution. This configuration introduced participants to the basic principles of the Nutrient Film Technique (NFT), in which a shallow flow of nutrient solution moves through cultivation channels and supplies water and nutrients directly to plant roots. The NFT system has received considerable attention as a hydroponic technology because of its potential for efficient water and nutrient management, although its performance remains dependent on system configuration, crop characteristics, environmental conditions, and appropriate monitoring of nutrient solution parameters (Karim et al., [2023](#)).

The practical training also provided participants with direct experience in seedling preparation, which represents an important stage in hydroponic cultivation. Chili and long bean seeds were germinated using moistened cocopeat as the growing medium. The seeds were initially maintained under dark conditions to facilitate germination and were subsequently exposed to sunlight after approximately one week. After approximately two weeks, the seedlings were transferred into the hydroponic channels using net pots and supporting materials. This process enabled participants to understand that successful hydroponic cultivation begins before plants are introduced into the production system. Proper seedling preparation is particularly important because weak or poorly developed seedlings can reduce the efficiency of subsequent cultivation. Through direct practice, participants were able to develop practical competencies in preparing growing media, germinating seeds, identifying suitable seedlings, and transferring seedlings into the hydroponic system. Such hands-on learning is consistent with findings from previous community-based hydroponic programs, which indicate that practical demonstration and direct involvement can facilitate the acquisition of cultivation skills among participants with limited previous experience in modern agricultural technologies (Girdziute et al., [2022](#); Fathidarehnijeh et al., [2023](#)).

The cultivation phase further strengthened participants' understanding of nutrient and plant management. The participants were introduced to the use of AB mix as the main nutrient source and were trained to monitor the condition of the nutrient solution and plants during the cultivation period. In addition to nutrient management, participants learned to provide physical support for plant growth. Long bean plants were provided with climbing structures so that the vines could develop properly and the pods could hang downward, while chili plants were supported using stakes to maintain plant stability. Participants were also encouraged to identify visible plant problems and determine appropriate corrective actions. These activities were particularly important because NFT hydroponic cultivation requires continuous attention to water and nutrient conditions. Research on NFT systems emphasizes that parameters such as nutrient concentration, pH, temperature, and dissolved oxygen can influence plant performance, making monitoring and management essential components of successful hydroponic production (Bathaei et al., [2023](#)). Thus, the training did not merely introduce participants to the construction of a hydroponic system but also developed their capacity to operate and maintain the system independently.

The implementation of the cultivation activities also demonstrated the potential of hydroponics as a means of introducing younger community members to technology-based agriculture. This aspect is particularly relevant in Sungai Duren Village, where agricultural activities are reportedly dominated by farmers in the 45–60-year age

group. The involvement of youth in the establishment and management of the hydroponic facility created an opportunity to introduce agriculture as an activity that requires technological knowledge, problem-solving skills, and entrepreneurial thinking. This is consistent with the broader agenda of agricultural regeneration, in which youth participation is increasingly associated with technological innovation, entrepreneurship, digital access, and the development of new livelihood opportunities. FAO emphasizes that the long-term resilience of agrifood systems depends partly on generational renewal and investment in young people's knowledge, skills, resources, innovation, and entrepreneurship. Similarly, Indonesia's YESS program places emphasis on developing the capacity and entrepreneurship of rural youth as part of efforts to strengthen their participation in the agricultural sector (Hilmawan et al., 2023; Chowdhury et al., 2024).

An additional outcome of the program was the introduction of horticultural product diversification through the processing of harvested commodities. Rather than positioning chili and long beans exclusively as fresh agricultural products, the program introduced participants to processing activities that could provide additional economic value. Long beans were processed into Kacapa (Kacang Panjang Pangsit), while chili was processed into Chiliku (Cabai Bubukku). The activities involved participants in the stages of processing, product preparation, packaging, and product presentation. This approach broadened the meaning of agricultural productivity from simply producing crops to creating additional value from agricultural commodities. Product diversification is particularly relevant to community empowerment because agricultural income can be influenced not only by production volume but also by the ability of producers to develop products that respond to consumer preferences and access wider markets (Hidayah et al., 2024). Therefore, the processing component of the program provided an initial pathway for youth to view horticultural cultivation as a potential entrepreneurial activity rather than solely as a subsistence or production activity.

The economic empowerment component was further strengthened through the introduction of digital marketing. Participants were introduced to the use of digital platforms as a means of promoting horticultural products and processed products developed during the program. The training encouraged participants to understand the relationship between product quality, packaging, product information, promotional content, and consumer access. Digital marketing is increasingly relevant for agricultural communities because digital platforms can expand market reach beyond conventional face-to-face transactions and provide opportunities for small producers to communicate directly with potential consumers. Previous community empowerment research has shown that digital marketing training can improve participants' knowledge and ability to utilize digital platforms for promoting and marketing agricultural and processed products (Rahman et al., 2024). In this context, digital marketing complemented hydroponic cultivation and product processing activities by connecting production capacity with potential market opportunities.

The program therefore generated outcomes across three interconnected dimensions of youth empowerment. The first dimension was technical empowerment, reflected in participants' involvement in hydroponic system construction, seed germination, seedling transfer, nutrient management, plant maintenance, and harvesting. The second was economic empowerment, reflected in the development of value-added horticultural products and the introduction of digital marketing as a means of expanding market access. The third

was environmental empowerment, reflected in the introduction of a cultivation system that emphasizes controlled use and recirculation of water and nutrients. These three dimensions are important because youth participation in agriculture cannot be strengthened solely through technical training. FAO's recent work on youth in agrifood systems highlights the importance of combining skills development with access to technology, entrepreneurship, resources, and economic opportunities. The integration of these components can create a more attractive pathway for young people to engage in agriculture while contributing to the transformation and resilience of local agrifood systems (Rahmania et al., 2024; Pagano et al., 2025).

The mentoring and monitoring activities were also important in supporting the sustainability of the program. Continuous assistance allowed participants to discuss problems encountered during cultivation and receive guidance in responding to plant and system conditions. This component addressed a common limitation of short-term community training programs, in which participants may understand the basic technology during training but experience difficulties when they begin operating the system independently. Mentoring therefore served as a mechanism for transferring responsibility gradually from the implementing team to the youth participants. Previous community empowerment studies have emphasized that sustained mentoring and follow-up are important for maintaining the adoption of hydroponic technology and strengthening participants' confidence in managing the system independently (Gunawan et al., 2022; Wang et al., 2026).

Overall, the results indicate that the empowerment program provided a broader intervention than conventional hydroponic training. The establishment of the hydroponic house created a practical production and learning environment, while the cultivation activities developed participants' technical competencies. The processing of long beans and chili into Kacapa and Chiliku expanded the economic dimension of the program, and digital marketing introduced participants to potential market access beyond direct sales. The integration of these activities is important because previous agricultural youth programs have increasingly emphasized the combination of agricultural skills, technology, entrepreneurship, and market opportunities as mechanisms for strengthening youth participation in agrifood systems. In Sungai Duren Village, this integrated approach provides an initial foundation for positioning young people not merely as recipients of agricultural knowledge but as potential producers, processors, and entrepreneurs who can contribute to the continuity of local agricultural activities.

CONCLUSION

The youth empowerment program in Sungai Duren Village demonstrated the potential of hydroponic-based horticultural cultivation to strengthen youth participation in modern agriculture while supporting economic and environmental empowerment. Through practical training and continuous mentoring, participants developed skills in hydroponic cultivation, including seedling preparation, nutrient management, plant maintenance, and harvesting, while also gaining experience in processing horticultural commodities into value-added products such as Kacapa from long beans and Chiliku from chili. The integration of cultivation, product diversification, and digital marketing provided young people with opportunities to develop not only technical agricultural competencies but also entrepreneurial capacities. Continued mentoring, improvement of product quality and packaging,

strengthening of branding, and expansion of digital marketing are expected to support the development of Kacapa and Chiliku as potential innovative village products of Sungai Duren and contribute to the sustainability of youth-based agricultural activities in the village.

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- Author Contribution : ES: Conceptualization, Methodology, Writing – Original Draft
 QL: Investigation, Formal Analysis
 SA: Validation, Writing – Review & Editing
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