



# Increasing community food security through aquaponic and aeroponic cultivation

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ARTICLE INFO	ABSTRACT
<p>Article history            Received: 2022-10-01            Revised: 2022-10-14            Accepted: 2022-10-24            Published: 2022-12-02</p> <p>Keywords            Community partnership program            Aeroponics            Aquaponics            Food security</p>	<p>The topographical conditions in Bulu-Bulu Village, Jeneponto Regency, South Sulawesi, tend to be bumpy and rocky, which is the main problem in farming. Locals exclusively use growing methods because there is little public awareness about cultivation technologies. The community employs a number of different fish farming systems. Additionally, the cost of fish feed has a tendency to change, making it harder for people to satisfy their needs for the primary protein source. The community can be counseled on land use by using aquaponic and aeroponic systems as a possible solution to the issue. Regardless of climatic conditions or current land characteristics, aquaponic technology is recognized as a substitute for integrated farming systems. By providing counseling, instruction, and hands-on support to the residents of Bulu-Bulu Village, the strategy is put into action. The results of this action take the shape of autonomous aquaponic and aeroponic installations that grow food crops and fish in the same space to reduce production costs and increase earnings. Every family in the community is intended to be able to benefit from this activity and use the farming technology in order to reinforce and encourage long-term improvements in the nation of Indonesia's food security.</p>
<p>Kata kunci            Program kemitraan masyarakat            Aeroponik            Aquaponik            Ketahanan pangan</p>	<p>Meningkatkan ketahanan pangan masyarakat melalui budidaya akuaponik dan aeroponik. Kondisi topografi di Desa Bulu-Bulu, Kabupaten Jeneponto, Sulawesi Selatan cenderung bergelombang dan berbatu yang menjadi kendala utama dalam bercocok tanam. Penduduk setempat secara eksklusif menggunakan metode penanaman karena sedikitnya kesadaran masyarakat tentang teknologi budidaya. Masyarakat menggunakan sejumlah sistem budidaya ikan yang berbeda. Selain itu, harga pakan ikan cenderung berubah sehingga semakin sulit bagi masyarakat untuk memenuhi kebutuhan sumber protein utama. Masyarakat dapat diberi penyuluhan tentang penggunaan lahan dengan menggunakan sistem akuaponik dan aeroponik sebagai solusi yang mungkin untuk masalah tersebut. Terlepas dari kondisi iklim atau karakteristik lahan saat ini, teknologi akuaponik diakui sebagai pengganti sistem pertanian terpadu. Dengan memberikan penyuluhan, pengarahan, dan pendampingan langsung kepada warga Desa Bulu-Bulu, strategi tersebut dapat dijalankan. Hasil dari tindakan ini berupa instalasi akuaponik dan aeroponik otonom yang menanam tanaman pangan dan ikan di ruang yang sama untuk mengurangi biaya produksi dan meningkatkan pendapatan. Setiap keluarga di masyarakat diharapkan dapat memanfaatkan kegiatan ini dan menggunakan teknologi pertanian untuk memperkuat dan mendorong perbaikan jangka panjang ketahanan pangan bangsa Indonesia.</p>
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## INTRODUCTION

One of the challenges of agro-industry in this 4.0 era is the limited land for agriculture. The number of Indonesian citizens being recruited each year is increasing, which is a threat to the growth of the settlement demand. Jeneponto Regency, South Sulawesi is the sole example. The distance between Makassar City and Jeneponto Regency, which is approximately 93 km, is located in the western end of the area of the province of Sulawesi Selatan. There are 114 village, 11 district, and 749,79 km<sup>2</sup> of land in Jeneponto Regency. West Bangkala District is the most populous village in Jeneponto, comprising 15.269 hectares or 20.40% of the village's total land area, while Arungkeke District is the village with the smallest amount of land, including 2.991 ha or 3.99% of the village's total land area (Ternando, 2021).

The population is increasingly dense, causing the conversion of agricultural land to residential areas. In addition, the improvement of infrastructure such as roads is also one of the factors in reducing the allocation of agricultural land. Therefore, urban farming (hydroponics, aquaponics, aeroponics, and vertical farming) is an alternative that can be used to increase the amount of food production. The relatively flat to undulating topography in the cultivated area is ideal for the development of various types of commodities or in other words, slope problems will not be an inhibiting factor that reduces the suitability of land for various types of commodities. On the other hand, areas with steep topography (slope > 25%), covering an area of 29,745 ha (about 37.40% of the total area of Jeneponto Regency), need extra attention so that food crop cultivation activities do not reach this area, or if this happens, soil and water conservation efforts absolutely must be implemented. If this condition is forced, then the results of direct planting (planted in the ground) will not really provide maximum cultivation results. Agricultural land is being turned into residential areas as a result of the growing population (Fuadina et al., 2021).

The regional development system of Jeneponto Regency is an integral part of national development. Especially with high enough economic growth, various policies can be implemented, these policies can be in the form of giving priority to economic sectors that are able to act as the main drivers of the regional economy and have the ability to increase people's income, community employment opportunities, linkages and driving force with other sectors, as well as gross value added.

The agriculture industry is one of the crucial areas in economic development, according to Jeneponto Regency's priorities for regional development. The agricultural sector is a cornerstone of the national economy due to its significant direct and indirect contributions to the attainment of development objectives, particularly the improvement of food security, the reduction of poverty, the creation of jobs, and an increase in the income and welfare of the populace (Widianingsih et al., 2015). In an effort to end hunger, achieve food security and decent nutrition, and support sustainable agriculture, the second Sustainable Development Goal (SDG) includes a goal for food security (Anandhiya et al., 2021; Farikhotin et al., 2022; Nawir et al., 2022).

Most of the community's livelihoods still depend on natural resources, such as fishermen, fish cage businesses, timber, working in the service sector, and other informal sectors. The livelihoods of the people in Bulu-Bulu Village, Arungkeke District are not much different from the livelihoods of other communities. Agricultural fields in the form of rice fields or fields are found in Bulu-Bulu Village, Ba'do Village and Kalumpang Loe Village, while fish cage businesses are most commonly found in Kampala and Palajau villages. Efforts to increase daily needs as additional family nutrition are needed through the utilization of available resources and yards whose functions have not been maximized. Population growth that affects the availability of agricultural materials. As a result, it has an impact on the decline in productive land. Along with the development of technology, humans can find solutions so that a narrow yard can be used to support family needs. It also encourages people to be more creative, independent and financially advanced in their household economy (Khomah & Fajarningsih, 2016). The yard is an open space area located around the area of a house building that can be used as a place for plant production and can also be used as a place for livestock and fish ponds depending on the size of the yard area (Dwi et al., 2021). Community activities carried out in the yard include planting trees and kale (These lands have the potential to provide family food, reduce household spending on food purchases and increase farmer household incomes. There is no need to cultivate the soil like conventional plant cultivation in the garden, it can be done in your spare time, and the maintenance is also easy.

The ease of farming cultivation systems can take advantage of several alternative technologies. Aquaponic technology is known as an alternative to integrated farming systems regardless of climatic conditions or existing land conditions. Aquaponics is a combination of fish cultivation systems and plant cultivation without dependence on soil as a plant growing medium (Sastro, 2016). Aquaponics is not widely known in the community, in contrast to hydroponics which some people already know. Hydroponics is only devoted to vegetable or flower plants grown on non-soil media and for the fulfillment of nutrients supplied through liquid fertilizers or chemical substances as nutrients. Aquaponics for obtaining vegetable nutrients is more emphasized on the use of water sources from fish farming, because the residual water of manure and fish feed can be used as nutrients for vegetables so that with this system it can save space, water and even costs and of course it is healthier by producing organic products.

Aquaponic cultivation ensures water oxygen levels and suppresses toxic ammonia produced from fish waste (Rizal et al., 2018). Combining hydroponics and fish farming will approach a natural system between plant or fish cultivation. The

two systems complement each other where fish produce ammonia which is a nutrient for plants. Plants function as mineralization or reduce ammonia which can poison fish. Oxygen levels are maintained by ongoing recycling of water through the existing system.

The benefits of this aquaponics system on a small scale can be useful for meeting household needs, but on a large scale it can be useful for meeting commercial needs. Although in general the people in Petak Bahandang Village are very familiar with farming and farming methods, combining vegetable cultivation with fish rearing is still a new thing and in Petak Bahandang Village floods often occur so that the land for farming is sometimes submerged and cannot be used so that activities Community service to introduce aquaponic farming is still very necessary because the aquaponic system can be carried out even on limited land.

While aeroponics can also be a solution to the problems of community plant cultivation in Bulu-Bulu Village, Arungkeke District. The application of aeroponic techniques can be an alternative method that can be used to overcome land limitations. In addition, this technique can also be used to increase the productivity of these plants. Aeroponics is one type of hydroponics because water containing a nutrient solution is sprayed in the form of a mist to hit the plant roots. One of the key advantages of aeroponics is the oxygenation of each fine mist of nutrient solution so that root respiration is smooth and produces a lot of energy.

Through the community partnership program, where this activity includes counseling, training and mentoring, it is hoped that it can increase cultivation yields and make it easier for the community to grow crops by implementing aquaponic and aeroponic (Lakhiar, 2020; Khan, 2020) cultivation systems so that the welfare of the people in Bulu-Bulu Village, Arungkeke District can be further improved. However, communal plant growing in Bulu-Bulu Village, Arungkeke District, has certain issues that aeroponics can help with as well. To get over the limits of the land, one alternate approach is to use aeroponic technology. The yield of these plants can also be increased by using this strategy. One sort of hydroponics is aeroponics, which involves misting the roots of the plants with water containing a nutritional solution. Aeroponics has many benefits, one of which is that each tiny mist of nutritional solution is oxygenated, ensuring that root respiration is easy and efficient in terms of energy production. It is hoped that by implementing aquaponic and aeroponic cultivation systems through the community partnership program, which includes counseling, training, and mentoring, it will be possible to increase crop yields and make it simpler for the community to grow them in order to further enhance community welfare (Aripriharta et al., 2022; Hakim, 2020) especially those who reside in Bulu-Bulu Village and Arungkeke District.

The topographical conditions in Bulu-Bulu Village which tend to be bumpy and rocky are the main problems in farming. In addition, knowledge of cultivation technology is still very minimal, so that local people only rely on traditional cultivation systems that have been used for many years. Although the results obtained are not optimal, this conventional cultivation habit must be carried out in order to meet daily needs. The community in Bulu-Bulu Village still lacks knowledge about farming which is more efficient and profitable by implementing a cultivation technology system, even though this appropriate technology system is very useful if applied because it can improve the welfare of the local community.

Based on the survey conducted, it was found that a number of obstacles related to social, cultural, and economic problems were still encountered in the yard land use program, including the lack of intensive cultivation of yard plants, still part-time and not yet market-oriented, lack of availability of yard-specific cultivation technology, and inadequate assistance from officers. Soil quality has also declined due to the excessive use of synthetic fertilizers and pesticides. Likewise, groundwater reserves are depleted due to agricultural exploitation, even though the peak of the green revolution has passed, various agricultural innovations continue to be developed by humans to keep pace with the population speed. Therefore, careful planning and cross-sectoral support are needed in the utilization of home gardens so that they can be more optimal. in supporting food security.

Another problem found during the initial survey was the community's ability to look for alternative protein sources if the weather was bad at any time so it was difficult for fishermen to go to sea, in this condition, the price of fish increased and this situation made it increasingly difficult for the community to meet their protein needs. There are several fish farming systems carried out by the community, but sometimes the capital for making fish ponds with the results obtained is not balanced, so many people do not continue their fish cultivation anymore. In addition to making ponds, the price of fish feed (pellets) also tends to fluctuate so that even this situation makes it increasingly difficult for people to use this as the main protein source.

In general, the constraints that the villagers of Bulu-Bulu Village, Jeneponto Regency, confront are as follows: (1) There is still a severe lack of public awareness of acceptable technology, resulting in the continued use of conventional techniques that rely on soil as a planting medium. (2) The community finds it challenging to practice conventional agriculture due to the topography's rough and uneven terrain. The development of horticulture and food crops in the area does not fully meet the intended standards for soil quality. (3) People are compelled to exclusively eat marine fish since rearing freshwater fish is so expensive. However, during severe weather, the cost of fish at neighborhood traditional markets may rise, leaving people with no other choice to eat enough protein. (4) The local populace is unaware of the appropriate technology that can be used to increase agricultural cultivation yields and lower the cost of

freshwater fish farming as a substitute for marine fish in the event that the price of fish ever becomes unaffordable on the market.

The goal of this community service is to provide the community with information on technology-based farming that can address the issues in Bulu-bulu Village. As for the contribution, (1) anyone who wants to start their own firm in the horticulture and food industries can leverage the application of this technology as a business opportunity in the future. (2) The community can raise freshwater fish with low production costs, eliminating its previous reliance on marine fish, which had been the main source of protein. (3) Each family head is expected to be able to use this activity to learn the agriculture technology in order to achieve food independence at the village level. (4) It is intended that with this counseling, training, and help to the community, there won't be any more issues with food, horticulture, or the accessibility of fish for human consumption for the people of Bulu-Bulu Village in particular and Arungkeke District, Jeneponto Regency in general. As a result, it is anticipated to support Indonesia's long-term food security and independence.

## METHOD

Implementation of this community partnership program is aimed at the Housewife Group in Bulu-Bulu Village, Jeneponto Regency by providing counseling, training and assistance on the manufacture and application of appropriate technology to the community regarding aquaponics and aeroponics cultivation as well as training community skills to be able to make products independently. so that the manufacture of aquaponic and aeroponic cultivation products can be carried out in a sustainable manner. In addition, there are parties involved in this service activity, namely the Bulu-Bulu Village Apparatus, Arungkeke District, Jeneponto Regency and Makassar State University Lecturers and Students who act as implementers and resource persons. The following flow chart (Figure 1) outlines the processes for launching this workflow.

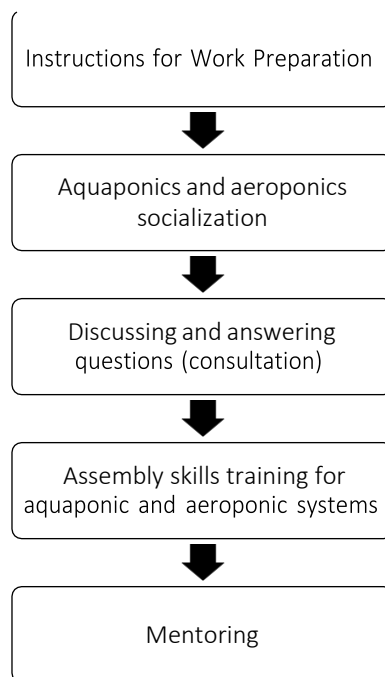


Figure 1. Community service program workflow

The partnership program implementation process is divided into 6 parts, including: (1) Setting up the work guidelines is crucial to ensuring that each stage goes off without a hitch. Consequently, it takes a month to prepare the instructions, which include those for producing items using the aquaponic and aeroponic technologies. (2) Community groups in Bulu-Bulu village, Arungkeke sub-district, Jeneponto district, were socialized as part of an information-delivery and hands-on demonstration of aquaponic and aeroponic gardening. (3) Discussion and question-and-answer sessions (consultations), which are required to conduct in order to apply the right technology for aquaponic and aeroponic cultivation and provide people the chance to ask questions and debate the production of aquaponic and aeroponic cultivation products. (4) The community is given skills training so they may produce goods on their own, allowing for the ongoing or sustainable production of aquaponic and aeroponic farming items. (5) Mentoring is given both before and during the socialization process so that the implementing team may evaluate the success and determine how well the trainees have grasped the skills being taught. Additionally, if this cultivation is maintained for a home-based business, it

might boost the local economy. An instrument in the form of a questionnaire on the participants' knowledge level, which comprises 6 (six) indicators, can be used to gauge the program's success. These indications are: (1) Knowledge of Traditional Farming Methods. (2) Knowledge Associated with Cutting-Edge Cultivation Technology 3. Knowledge of plant nutrition. (4) Knowledge Concerning Freshwater Fish Maintenance (5) Knowledge Concerning Aquaponics (6) Knowledge Relating to Aeroponics

## RESULTS AND DISCUSSION

The community partnership program activity carried out in Bulu-bulu Village, Arungkeke District, Jeneponto Regency in partnership with the Housewife Group through Aquaponic and Aeroponic farming techniques to Improve Food Security and Community Economy in Bulu-Bulu Village, Jeneponto Regency is a service that aims to providing information delivery and direct demonstration to the community regarding aquaponic and aeroponic cultivation as well as training community skills to be able to make products independently so that the manufacture of aquaponic and aeroponic cultivation products can be carried out sustainably in Bulu-Bulu village, Arungkeke district, Jeneponto district. The community in Bulu-bulu Village is projected to gain more knowledge and expertise in integrated aquaponics and aeroponics agriculture as a result of the predicted results and accomplishments, which should boost the community's food security and self-reliance. A one-month work schedule is created based on the results of the survey that was conducted. The cooperation program steps in Bulu-bulu Village are anticipated to begin with the introduction of this well-organized work program. As seen in the following, the subsequent phase is to engage in socialization exercises in Bulu-bulu Village (Figure 2).



Figure 2. Socialization of the Partnership Program in Bulu-Bulu. Village community groups

Twenty people participated in the social activity, which was held at the village office for Bulu-bulu (partner communities). Participants heard information from a resource who is the Chair and proposer of the community partnership initiative (Figure 2). People in Bulu-Bulu village, Arungkeke sub-district, Jeneponto district, were personally informed about aquaponics and aeroponic farming. Because this farming approach is creative and solves the issue of limited land by making use of the potential of the neighborhood's home yards, participants were quite enthused about the information presented. Participants offer a number of questions that will be covered in the discussion activities when they have a basic understanding of the aquaponic and aeroponic growing systems.

The community's discussion and lead lecturer of the proposer's directed questions and answers went well (Figure 3). The community is given the chance to ask questions and debate how aquaponic and aeroponic farming goods are made in order to implement the proper technology. The precision of this horticulture will enable Bulu-bulu Village residents to find the best answers to their difficulties. Training in creating aeroponic and aquaponic systems will allow participants to directly apply the knowledge they have received from the activities they have completed. The community's discussion and lead lecturer of the proposer's directed questions and answers went well (Figure 4). The community is given the chance to ask questions and debate how aquaponic and aeroponic farming goods are made in order to implement the proper technology. The precision of this horticulture will enable Bulu-bulu Village residents to find the best answers to their difficulties. Training in creating aeroponic and aquaponic systems will allow participants to directly apply the knowledge they have received from the activities they have completed.



**Figure 3.** Discussion and Questions and Answers (Consultation) for the manufacture of aquaponic and aeroponic cultivation installations.



**Figure 4.** Training on Integrated Aquaponics and Aeroponics Installation Skills

Teaching on Integrated Aquaponic and Aeroponic Installation Making Skills is done by lecturers and students. This activity is carried out to enable the local population to produce goods on their own, enabling the ongoing or sustainable production of items derived from aquaponic and aeroponic gardening. In order for the community to concurrently grow food crops and fish, sustainability of this activity is anticipated to be able to establish community independence in the application of integrated aquaponics and aeroponic horticulture. Naturally, when this technique is used, production costs will be lower and profits will be higher.



Figure 5. Community Assistance in Bulu-Bulo Village

The mentoring procedure (Figure 5) is crucial both during and after the socialization process so that the implementation team may assess its performance and determine how well the trainees have grasped the skills being taught. Additionally, the community's economy can be improved if this cultivation is continued by submitting an integrated aquaponics and aeroponic installation (Figure 6) at a home industrial size.



Figure 6. Delivery of Integrated Aquaponics and Aeroponics Installations to the Bulu-Bulo Village Community

Through the delivery of integrated aquaponics and aeroponic installations, it is also hoped that the understanding that has been obtained by the community can be applicable. The understanding of the people of Bulu-bulo Village is one indication of the achievement of the targets of this community partnership program. The understanding of the people of Bulu-bulo Village about integrated aquaponics and aeroponics is presented in Table 1.

The Bulu-bulo Village Community has a solid comprehension of combined aquaponics and aeroponics, according to the measurement results, which contain 6 (six) indications of such understanding. Despite Bulu-bulo Village's unfavorable terrain, this is a strong suggestion of how to develop community independence in carrying out novel and useful agriculture systems to realize food improvement. However, the community may help the community overcome the issues that exist in Bulu-bulo Village in the food sector by installing integrated aquaponics and aeroponics.

The aquaponics system is one of the best solutions for agricultural production in areas with rising land costs, scarce water supplies, extensive land conversion, and the problem of climate change brought on by global warming. (Handayani, 2018; Saputra, 2019; Dirgantara, 2022). In Bulu-Bulo Village, Jeneponto Regency, increasing communal food security will start with the yields from aquaponic growing methods.

**Table 1.** Table of Community Understanding of Integrated Aquaponics and Aeroponics

No	Indicator	Percentage			
		Very understand	Understand	Not really understand	Do not understand
1	Knowledge of Traditional Farming Methods.	85%	15%	0%	0%
2	Knowledge Associated with Cutting-Edge Cultivation Technology	60%	40%	0%	0%
3	Knowledge of plant nutrition.	50%	50%	0%	0%
4	Knowledge Concerning Freshwater Fish Maintenance	65%	35%	0%	0%
5	Knowledge Concerning Aquaponics	70%	30%	0%	0%
6	Knowledge Relating to Aeroponics	55%	45%	0%	0%

Because it empowers groups of housewives in the usage of home yards, the growth in community food security promotes the SDGs program, namely the goals of food security and achieving gender equality. The use of yards in this case obviously refers to a yard that is managed through an integrated strategy of various types of plants, livestock, and fish, in order to assure the continuous and independent availability of diverse food items to meet nutrition and family food needs (Djamali, 2022). The role of women (housewives) as home managers and upholding family food security is very crucial and very strategically important in order to be able to maximize the function of this yard. Real housewives may contribute significantly to the accomplishment of national food security by leveraging the strength of family food security. Together, the community can create an aquaponic growing system that doesn't need a lot of space, use it for their personal needs and as a commercial opportunity, and boost the economy and food security. (Sari, 2022). Especially by using aquaponic farming methods.

Aquaponics can be summed up as a combination of hydroponic (plant/vegetable production without soil media) and aquaculture (fish farming) systems. Aquaponic systems adopt an ecological system in a natural environment, where there is a symbiotic relationship of mutualism between fish and plants (Rokhmah, 2014). There are two essential components to aquaponics. Water for rearing aquatic animals and hydroponics for plant growth make up the two basic components. Fish can get poisoned from garbage that builds up in the water during aquaculture. The trash is made up of leftover fish feed as well as fish excrement and pee. However, these wastes are full of nutrients that can be used as a source of nutrients and are quite helpful for plant growth. In this watery environment, fish are typically kept as aquatic animals. Plankton that grows in the system, including zooplankton and phytoplankton, and artificial fish feed are the sources of food for fish. The body of the fish will then digest the fish food. Crops can be grown using an aeroponic system. (Slameto, 2022). The restrictions that the people in Bulo-Bulo Village, Jenepono Regency, faces may present a chance for sustainable horticulture to be empowered.

Growing veggies that you can sell or consume yourself can be one of many economic opportunities that can come from farming as a pastime. The role of housewives is very strategic in increasing productivity and has the potential to increase income and food security (Shooliha, 2022). With this mindset, food independence on a household scale can be attained. Using the home yard for food crops can also be employed as part of a lifestyle in fulfilling household food needs. (Yani, 2020). By using aeroponic cultivation methods, one can achieve food independence and bolster food security.

Since aeroponics cultivation methods don't utilize soil media and can be set up in a home's yard, they are advantageous for farmers who lack acreage for traditional farming. Styrofoam is typically used as the planting medium since it allows plant roots to hang in the air. Regarding quality, vegetables grown using aeroponic systems will taste cleaner, crispier, and more recent. In the meantime, the issues with communal plant growing in Bulo-bulo village may also be resolved through aeroponics. Aeroponics comes from the word *aero* which means air and *ponus* which means power. Aeroponics is empowering the air or growing crops in the air. Aeroponics is actually a type of hydroponics (empowering water) because (Setiawan, 2021). Aeroponics' ability to oxygenate each small mist of nutritional solution ensures that root respiration is smooth and efficient, producing a lot of energy (Irawan, 2021).

The implementing team first conducts a theoretical explanation (socialization) before beginning field activities so that partners are familiar with the equipment, supplies, and work systems utilized in aquaponics and aeroponics. Following that, installations for aeroponic and aquaponic systems were built. Although both of them use water as a medium for plant growth, there are distinct variances between them, and the community must decide which one to use for their future cultivation methods.



## CONCLUSION

The conclusions of this activity are as follows: (1) The community has knowledge of technology -based cultivation that can be a solution to the problems faced in the area. (2) The application of this technology can later be used as a business opportunity for the community if anyone wants to become an entrepreneur in the field of food and horticulture. (3) The community can cultivate freshwater fish with minimal production costs without relying on marine fish anymore which has been the main hope for protein fulfillment. (4) Through this dissemination, each family coconut is expected to be able to utilize this cultivation technology so that food independence at the RT/RW level can be fulfilled. (5) With this counseling, training and assistance to the community, it is hoped that there will be no more problems in the fields of food, horticulture and the availability of consumption fish for the people in Bulu-Bulu Village, Arungkeke District, Jenepono Regency. Through this community partnership program, it is hoped that it can inspire other community partnership programs in the development of integrated acuaponics and aeroponics so that they can improve the future food security of the Indonesian nation in a sustainable manner.

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