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Boosting the economic value of communities living near forests through training in arrowroot cultivation and processing

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ABSTRACT

The communities living around forests, such as those in Banyurip Village in Sragen, are facing diverse agricultural challenges. One of these problems is poor land utilization, compounded by recent droughts happened within the village. These conditions have led to low productivity in the community due to limited agricultural activities. Utilizing land under forest canopies has become an option for the Banyurip Village as a source of livelihood, with one of the suitable crops for cultivation is the arrowroot tuber. The cultivation of arrowroot tubers for local food production is potentially developed in Banyurip Village, therefore, this community service aims to optimize the forest area for non-timber forest products. The methods used in this community service were the training of the cultivation and processing of arrowroot (Maranta arundinacea). This activity increased farmers' knowledge from 29 percent on the pre-test to 64 percent in crop cultivation and 50 percent in product processing, respectively. This community empowerment initiative concluded that the activities positively impacted the community's knowledge of garut plant cultivation techniques and product processing. Moreover, this initiative can boost the community's creative economy through multi-product enterprises derived from agroforestry activities.

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1. INTRODUCTION

Sragen Regency had the highest poverty rate in Central Java based on data from the 2024 National Socioeconomic Survey (Susenas) (BPS, 2024). Banyurip Village, which located in Sragen Regency, is surrounded with forest and is classified as a red zone for poverty. Several social factors affect the economics activities around the forest area, including limited market information, low entrepreneurial awareness, underdeveloped businesses, reliance on forest areas for livelihood, limited social interaction, and other social factors (Magalhaes, 2020). In addition to these, environmental factors also contribute to poverty in the form of an ongoing drought, which exacerbates the poverty conditions of communities living around the forest, especially in Banyurip Village.

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Drought and the lack of clean water sources in Banyurip Village are lowering the community productivity, since most of the residents are working as farmers and livestock breeders. Moreover, the lack of agricultural product development also significantly hinders economic growth potential. Consequently, an adaptive mitigating approaches are needed to address the problems, specifically, selecting drought-resistant crops to further processing higher-value agricultural products. Therefore, initiating cooperation and collaboration with other parties are needed to strengthen and expand the impact of this approach.

Non-timber forest products (NTFPs) refer to agricultural products that can be planted in forest areas to improve the welfare of surrounding communities. One form of NTFP produced in Banyurip Village is tubers, including arrowroot tubers (Supriyadi et al., 2023). Arrowroot (*Maranta arundinacea*) has high cultivation potential as it can grow in less fertile soil, does not require as much direct sunlight as many other plants, and can therefore be cultivated in shaded areas. In addition, it can be processed into various products, making it a potentially suitable crop for cultivation in areas surrounding forest stands (Setyaningrum & Adi, 2022).

Arrowroot can also grow well alongside other plants, including trees. Teak trees offer a potentially suitable environment for arrowroot cultivation because they provide partial shade while allowing sufficient light to reach the understory. This approach is consistent with an agroforestry system, in which trees are cultivated alongside other crops that can coexist without significantly interfering with each other. Djaafar and Pustika (2010) support this approach by stating that arrowroot can adapt to shaded conditions and grow on marginal land.

When cultivating arrowroot under tree canopies, planting density and spacing must be carefully considered. Listyowati et al. (2012) found that planting distance affects arrowroot rhizome production due to competition for sunlight and nutrients. In addition, leaf litter from trees can contribute organic matter to the soil and potentially benefit companion crops. Teak trees shed the leaves when they mature and dry, and this leaf litter can serve as a source of natural organic matter for crops (Izwar et al., 2023). These findings indicate that crop arrangement in agroforestry systems should be carefully planned to optimize land productivity.

Arrowroot plants have potential economic value through the sale of various products, such as arrowroot starch with a selling price of around IDR 50,000/kg, which requires 6-7 kg of arrowroot to produce 1 kg of arrowroot starch (Handayani et al., 2024). In addition to its promising cultivation potential for economics and land management, arrowroot plants offer opportunities for the community to produce various food products. One of them is low-glycemic tubers, which can be used as an alternative staple food for people with diabetes mellitus. In addition, arrowroot also contains bioactive compounds that can lower blood sugar levels, such as fiber and water-soluble polysaccharides (Setyaningrum & Adi, 2022). Another potential processed product from arrowroot starch is a snack bar (Prasetyo et al., 2025).

Taken together, this community service program aims to: 1) increase the community's knowledge of arrowroot cultivation practices; and 2) enhance the community's capacity to process arrowroot into value-added products. The program targets the community of Banyurip Village, Jenar District, Sragen Regency, particularly farmers and owners of Micro, Small, and Medium Enterprises (MSMEs).

The community service program includes the training on arrowroot cultivation techniques and the production of processed arrowroot products, making it relevant to the needs of the local community. In addition to supporting the development of existing MSMEs, training in producing contemporary arrowroot-based products provides an opportunity to develop innovative MSME products and create new sources of income.

Table 1. Activities timeline

Session 1	**Introduction**
	Time: 27th of February, 2025 Activities: - Program orientation and introduction of community service team members. - The community service team initiated a collaboration with the village authorities. - Exploring the village potential Objectives: - To provide the collaboration between two parties - To provide the sustainable use of local raw materials
Session 2	**Discussion with Village Authorities**
	Time: 7th of May, 2025 Activities: - Examining village potential and developing the material agreed upon for presentation Objectives: - To provide the integration of various potentials that can add value to local processed products
Session 3	**Trial**
	Time: 8th of May, 2025 Activities: - Product development trial Objectives: - To provide the product development that can easily applied by the community
Session 4	**Event Rehearsal**
	Time: 16th of May, 2025 Activities: - Activity preparations including selecting the planting site and preparing the equipment to be used for the workshop. Objectives: - To provide the place that suitable for the arrowroot planting - To thoroughly prepare for the workshop process
Session 5	**Mentoring**
	Time: 17th of May, 2025 Activities: - Arrowroot cultivation mentoring - Arrowroot food product development Objectives: - To inform the arrowroot cultivation technic and predicting potential failures so that they can be prevented - To inform the arrowroot several food products developments, product potential, marketing, and the regulations in force in Indonesia regarding SME products
Session 6	**Workshop**
	Time: 17th of May, 2025 Activities: - Arrowroot food product development Objectives: - To provide the processing arrowroot starch into a snack bar by incorporating *sacha inchi* and red cane sugar, which are locally sourced ingredients.
Session 7	**Evaluation**
	Time: 17th of May, 2025 Activities: - Arrowroot cultivation evaluation - Arrowroot food product development evaluation Objectives: - To evaluate the arrowroot cultivation mentoring before and after event - To evaluate the arrowroot food product development before and after event

2. METHODS

Location, Time, and Participants of the Activity

The training was conducted in Banyurip Village, Jenar District, Sragen Regency, Central Java, starting from February to May 2025, using mentoring and a practical workshop on making processed arrowroot products. The detailed information on community services activities is shown in Table 1.

A total of 50 residents of Banyurip Village actively participated in this community service. A questionnaire was completed before the activity to determine the community's understanding of arrowroot cultivation techniques and the processing of processed products. The questionnaire was completed again at the end of the mentoring and workshop sessions to assess the event's impact on community understanding.

Materials and Tools

The materials used in cultivating arrowroot plants are soil and arrowroot plant seeds, while the materials used in processing arrowroot plants are arrowroot starch, *sacha inchi* peanuts, raisins, powdered milk, cane sugar, margarine, and water. The tools used in cultivating arrowroot plants include polybags, hoes, and nameplates, while those used in processing include basins, cutting boards, knives, plastic gloves, baking pans, blenders, and ovens.

Activity Implementation Method

Mentoring

Mentoring refers to non-formal educational activity aimed at increasing community knowledge to carry out a positive, productive, and creative cultivation and business practices (Suprayitno, 2019). Mentoring on arrowroot cultivation techniques is conducted through presentations to provide knowledge to the community about several aspects of planting arrowroot around standing plants, such as factors that affect growth, planting methods, and care or fertilization of arrowroot plants. This mentoring session on arrowroot cultivation was conducted by inviting an expert in the field, Prof. Dr. Ir. Supriyono, M.S., on 17th of May, 2025.

Another mentoring session was done on arrowroot product processing, which is also counducted through presentations to provide an overview of processing arrowroot plants into arrowroot starch, which can then be processed into products with higher selling value, an introduction to product types based on current market share, and appropriate packaging techniques for processed arrowroot products. This session was also conducted by inviting an expert in the field, Ir. Bambang Sigit Amanto M.Si. on 17th of May, 2025.

Workshop

The workshop aimed to demonstrate product-making through practical application. It was conducted as a short training session designed to enhance the participants' knowledge and practical skills (Permatasari et al., 2022). In this activity, the training focused on the practical application of arrowroot starch in the production of snack bars supplemented with *sacha inchi* peanuts.

The arrowroot starch was produced locally by the Banyurip Village community, while *sacha inchi* peanuts were used as another local product of the village. In addition, locally produced solid cane sugar was used as a sweetener. Other ingredients included powdered milk, dried raisins, margarine,

and mineral water purchased from the local market. The workshop used various tools, including scales, knives, cutting boards, blenders, basins, spoons, baking sheets, parchment paper, and an electric oven. The steps for producing the arrowroot-based snack bars are as shown in Figure 1.

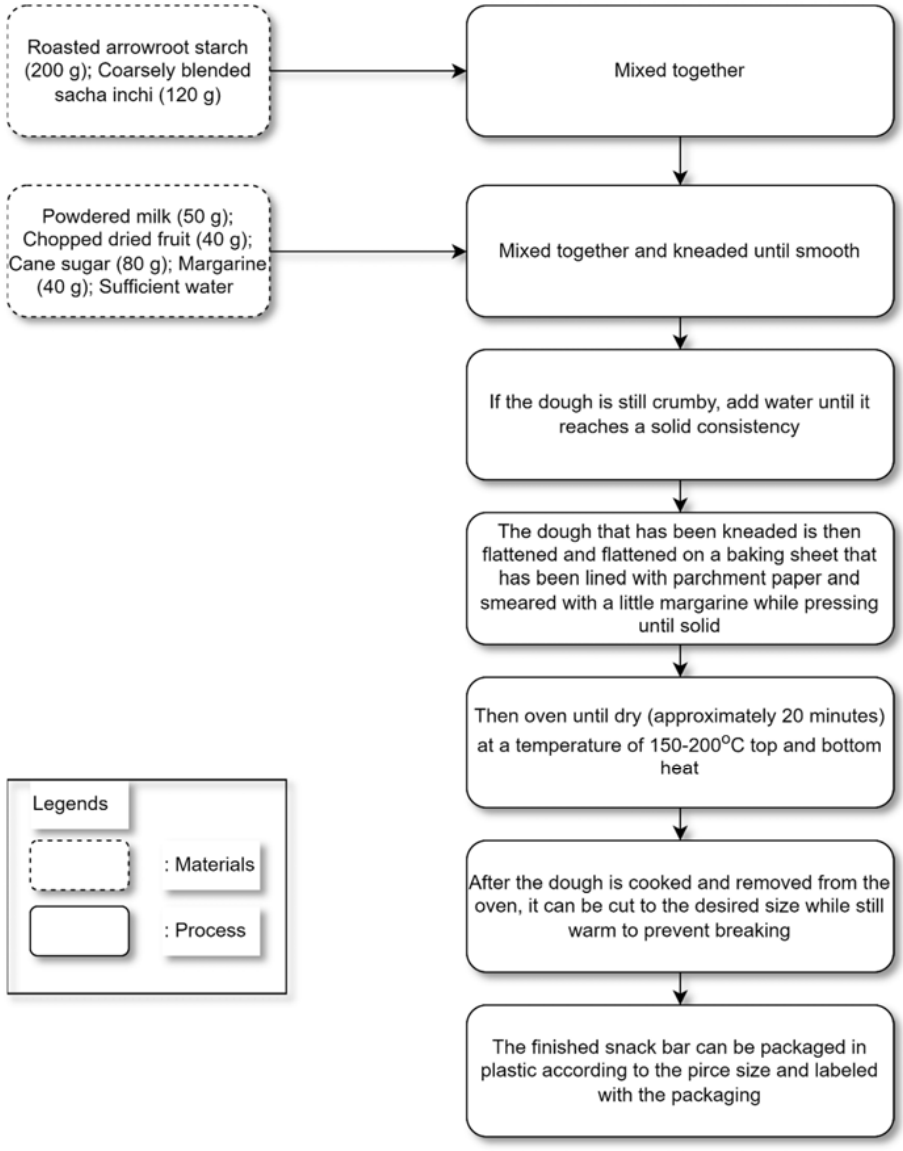


Figure 1. How to make a snack bar product

Activity Evaluation

Evaluation of the activity results was conducted by analyzing questionnaire data before and after the mentoring and workshop using Microsoft Excel with a list of questions as in Tables 2 and 3. The data analysis results are used to illustrate the success of this activity. The community activity was considered successful in increasing community business capacity when the percentage of respondents responding after the activity was higher than before the mentoring and workshop activities.

Table 2. List of questions on arrowroot cultivation techniques

No	Questions
1.1	Are you familiar with arrowroot plants?
1.2	Are you aware that arrowroot plants are beneficial for diabetes sufferers?
1.3	Do you know the appropriate amount of fertilizer to use when planting arrowroot?
1.4	Do you know the appropriate planting distance for arrowroot plants?
1.5	Do you know the effect of planting arrowroot plants under teak trees?
1.6	Do you know the optimal planting hole depth for arrowroot plants?
1.7	Do you know the benefits of using fertilizer for arrowroot plants?
1.8	Do you know the uses of urea, KCl, and SP36 for arrowroot plant fertilizer?
1.9	Do you know the benefits of using a good planting hole for arrowroot plants?

Table 3. List of questions about arrowroot processed products

No	Questions
2.1	Do you know the nutritional content of arrowroot?
2.2	Do you know how to make arrowroot starch?
2.3	Do you know the benefits of arrowroot flour?
2.4	Do you know about arrowroot starch-based products other than arrowroot porridge?
2.5	Do you know what a snack bar is?
2.6	Do you know how to make arrowroot-based products into snack bars?
2.7	Do you know what ingredients can be added to make arrowroot snack bars?
2.8	Do you know how to package arrowroot flour/starch products?
2.9	Do you know why packaging should consider the characteristics of the food?

3. RESULTS AND DISCUSSION

Mentoring

This activity was actively attended by 50 participants from the community around Banyurip Village, Jenar District, Sragen Regency, Central Java. The training covered arrowroot cultivation techniques, as well as the processing, packaging, and marketing of arrowroot products (Figure 2). Two speakers specializing in plant cultivation and food crop processing, particularly tubers, presented the material. The material can be accessed through this following link: https://uns.id/Arrowroot.



Figure 2. Mentoring of plant cultivation techniques and processing of arrowroot products

Arrowroot cultivation is a crucial highlight considering that Banyurip Village is a forested area where natural resource utilization is strictly regulated by the government. Furthermore, Banyurip Village is a dry area, meaning the area pose some challenges for agriculture activities. Arrowroot plants, however, can grow in dry areas with 25 percent dry land capacity, with a tuber weight of over 500 grams. This plant can also grow under standing crops such as trees reserved for forest conservation (Oktafani et al., 2017). Therefore, the offered mentoring is suitable for Banyurip Village as an innovative cultivation method for limited land area and utilization.

The mentoring also covers the processing of arrowroot into higher-value food products. Arrowroot is a food product widely used for its starch. Simple processing of arrowroot tubers into arrowroot starch has been previously implemented in Banyurip Village, while other food products has not yet been carried out. Arrowroot starch can also be used to produce snack bars, which are flour- or starch-based food products. With its low glycemic index, arrowroot starch is a local food ingredient with potential for development as an ingredient in foods suitable for individuals with diabetes. The addition of other ingredients, such as nuts, provides an opportunity to innovate in the production of arrowroot-based snack bars (Indrastati & Anjani, 2016).

Food product packaging was one of the topics presented in this community service activity. Packaging serves as a container or wrapper for food products. Over time, packaging has become a key marketing strategy for food products, as it attracts consumers to buy the products. Due to these developments, packaging has become a crucial aspect for branding food products, including the product name, product type, product information, ingredients, expiration date, a brief description, and other relevant information. Consequently, the packaging itself would also serve as an informative medium for product promotion (Muslimin et al., 2022). Therefore, packaging is a crucial topic to address in this activity.

The development of a product or brand name, which is an important aspect of marketing, was also carried out as part of this activity. Arrowroot-based products produced in the forest area were initially branded as "WANA". The existed product name was then developed by proposing the name "SMART," derived from "Sebelas Maret.". Since this activity was supported by Universitas Sebelas Maret (UNS), Surakarta, as part of a series of activities commemorating the university's 49th anniversary. To strengthen the product's identity, the snack bar developed through this activity was branded as "WANA-SMART BAR." The name represents a collaboration between the forest-dependent community of Banyurip Village and Universitas Sebelas Maret, Surakarta. This branding is expected to serve as a distinctive selling point and strengthen the product's identity on its packaging.

The program received enthusiastic responses from the participants, as evidenced by numerous questions about the material presented, including those about the effects of teak plants and leaves on arrowroot crops. Another question was about a formula that can be used as a sugar substitute for diabetics when processing arrowroot products. This demonstrated the community's interest in the speakers' information and their desire to learn how to improve their current knowledge.

Workshop

A short workshop session was conducted to provide the community with knowledge regarding the innovative processing of arrowroot starch into processed products with a higher sales value than the raw material (Table 4). The short training included demonstrations by community service members, with the community directly participating in the production of processed arrowroot starch products (Figure 3). The training demonstrated community enthusiasm, as evidenced by their willingness to participate in snack bar production.

Table 4. Snack bar innovation ingredients

	Ingredients
	• Arrowroot starch (33%) • *Sacha inchi* (20%) • Cane sugar (13%) • Water (12%) • Powdered milk (8%) • Dried fruit (7%) • Margarine (7%)

The processing of arrowroot starch into snack bars also incorporates several processed products already produced in Banyurip Village. Processed cane sugar and roasted *sacha inchi* are additional ingredients that support the innovation of Banyurip's signature products. The product development process resulted in a snack bar, as shown in Figure 4. This combination is expected to provide greater opportunities to process products from local ingredients abundantly available in the area surrounding Banyurip Village.





Figure 3. Processed arrowroot product manufacturing practice
Figure 4. Arrowroot snack bar

Impact of Community Service Activities

This activity had a positive impact on the Banyurip Village community. This can be seen from the results of questionnaires completed before and after the activity. The questionnaire was divided into two topics: arrowroot cultivation and the manufacture of processed arrowroot products and included basic knowledge questions with yes/no answers. The success of the community service activity can be assessed by the increase in the percentage of responses from the pre-test to the post-test (Wulandari et al., 2022). The greater the difference between the two values, the greater the impact of the community service activity on improving participants' knowledge.

The data from the questionnaire is presented in Table 3. Based on the table, the question 1.1 "Do you know the existence of arrowroot plants?" and in topic 2 is question 2.2 "Do you know how to make arrowroot starch?" has the least differences between pre-test and post-test. In topic A, "Cultivation of Arrowroot Plants", the local community has quite good knowledge about arrowroot plants, including their characteristics, because many respondents have known about them from the beginning. In topic B, "Making Processed Arrowroot Products", the local community has good knowledge of how to make arrowroot starch, one of the processed arrowroot products, as seen from the number of respondents who have known how to make it from the beginning.

Many residents of Banyurip Village, most of whom are farmers, have planted arrowroot in their gardens. However, this planting remains unfocused and lacks optimal spacing. This is reflected in the questionnaire results, where question 1.4, "Do you know the proper planting distance for arrowroot?", showed that many respondents initially did not understand the proper spacing for arrowroot. However, after mentoring and training, many residents finally understood the proper spacing.

Table 3. Percentage of participants' answers

No	Pre-Test (%)	Post-Test (%)	Difference (%)
	A. **Arrowroot Cultivation Techniques**		
1.1	88	92	4
1.2	38	82	44
1.3	12	38	26
1.4	18	72	54
1.5	30	70	40
1.6	22	64	42
1.7	14	46	32
1.8	32	60	28
1.9	10	50	40
	B. **Processing of Arrowroot Products**		
2.1	30	52	22
2.2	70	78	8
2.3	36	58	22
2.4	52	62	10
2.5	12	38	26
2.6	6	32	26
2.7	6	34	28
2.8	24	52	28
2.9	24	48	24

The production of processed snack bars from arrowroot tubers remains unpopular in Banyurip Village. In the questionnaire, the question "Do you know what ingredients can be added to make a snack bar from arrowroot?" (question 2.7) was asked, and respondents' "Yes" answers showed a greater difference than in other questions. Which indicates that, before the training was conducted, many people were unaware of the ingredients used in arrowroot-starch snack bars. After the training, more respondents answered "Yes" to the same question, indicating that the community became aware of the ingredients used to make contemporary snack bars.

Question 2.8 "Do you know how to package processed arrowroot flour/starch?" is also the question with the highest difference in "Yes" answers in topic 2. This indicates that good packaging for processed arrowroot products is still not widely known and implemented by the public. Through this training, the community gained knowledge about good packaging of arrowroot plant products that comply with applicable standards. In addition to good packaging, good branding and marketing were also presented as materials, including the information that should be included on the packaging to help market the product. Marketing products through packaging is one strategy used to attract consumer interest.

This training had a positive impact on the community's understanding of arrowroot cultivation and the production of processed arrowroot products. Based on Figure 5, there was an increase in positive responses from the participants regarding their understanding of both topics. These results indicate that the training activities were effective in improving the community's knowledge and understanding. It is expected that the knowledge gained during the training will be applied in their daily activities, particularly in arrowroot cultivation and the production of processed arrowroot products.

The material selection and cleaning process was conducted to help participants understand the requirements and criteria for the materials used in the training. This process was important because the quality of the materials can directly affect the quality of the final products. Figure 3 presents the preparation activities involving the materials used during the training.

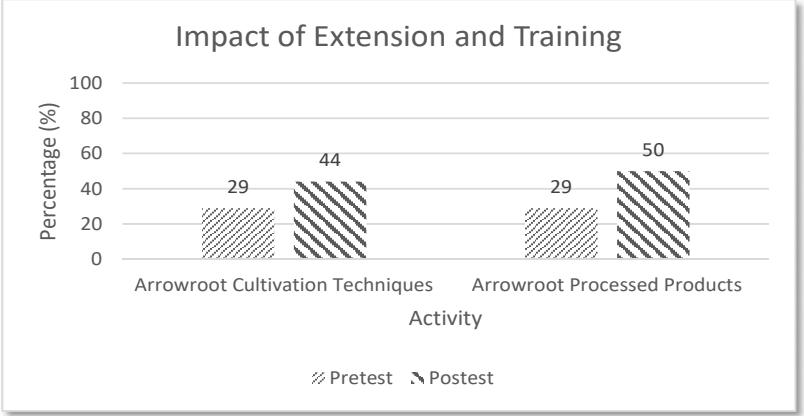


Figure 5. Impact of extension and training on community understanding

According to Magalhaes (2020), poverty in forest communities stems from the prohibition on community participation in managing forest plants, a measure intended to prevent overexploitation of forest products. This issue deserves collective attention, as forest communities retain the right to utilize resources to meet their daily needs. One appropriate approach without violating government regulations is to utilize non-timber forest products for further development and exploration. This community service activity aligned with this goal, by promoting arrowroot cultivation, which has the potential to be planted under standing crops while also does not disrupt government programs to protect forests. Furthermore, utilizing crops such as arrowroot as a local food source supports government programs to achieve progressive goals.

Utilizing agricultural products in local food-based products supports the Sustainable Development Goals (SDGs) launched by the Indonesian government. SDGs point 2.3 states that activities to double agricultural productivity and incomes of small-scale food producers, especially women, indigenous communities, family farmers, pastoralists, and fishers, including through secure and equal access to land, productive resources, and other inputs, knowledge, financial services, markets, and value-added opportunities, and non-farm employment (BAPPENAS, 2016a). This activity is supporting the Sustainable Development Goal Target 2.3 by utilizing local food into products with added value to alleviate poverty and hunger.

In addition, SDG Target 12.2 promotes activities aimed at achieving sustainable management and efficient utilization of natural resources (BAPPENAS, 2016b). Therefore, this activity is also relevant to SDG 12.2 by encouraging the proper utilization of natural resources while supporting forest conservation efforts maintained by the government.

Discussions

The community service activities in Banyurip Village are going from the limited land resources managed by the community, thus making agroforestry a viable approach. Agroforestry plays a crucial

role in increasing land productivity and the economic value for the community. One influential factor is the selection of plant species for agroforestry; species that can tolerate partial shade are needed, and one promising option is the arrowroot. Furthermore, combining teak trees with *sacha inchi* (*Plukenetia volubilis*) (Murhofiq et al., 2022) is also included in this community service.

The cultivation of crops under teak stands has been widely practiced by previous studies, including with *Coffea arabica, Dimocarpus longan, Persea americana, Kaempferia galanga,* and *Piper ningrum* (Atmanto et al., 2023). This community service initiative is a follow-up to the arrowroot cultivation activities already undertaken by the residents of Banyurip Village. Through training program on arrowroot cultivation and processing, land productivity and economic value can be increased by selling finished or semi-finished products rather than raw materials. The success of the activities was measured using questionnaires administered during pre-tests and post-tests. One indicator of the success of the community service project is that the community gained a better understanding of the subject matter. Although at a later stage, the community will be able to independently carry out business activities on a sustainable basis.

The community service activities employed mentoring efforts to develop small-scale industries that provide economic value to the community of Banyurip Village, in line with the study by Kusumandari et al. (2016). Further initiatives are needed to ensure that arrowroot processing does not remain limited to household consumption but is developed into production activities that can improve the economic welfare of rural communities. This is supported by the community service program conducted by Paramita et al. (2018), which demonstrated that product processing mentoring can increase the economic value of local resources for the community.

4. CONCLUSION AND RECOMMENDATIONS

This community service activity has helped improve understanding among communities living near forests by cultivating arrowroot plants through agroforestry practices. Furthermore, the community received information on producing processed arrowroot products to enhance the creative economy's value. The success of the community service activity was measured by comparing the knowledge before and after the implementation of mentoring sessions and workshops. A direct increase in the community's economic value is not yet measured, as this community service initiative focused on training activities rather than directly calculating the value of products marketed, which would be a follow-up activity once the community has a thorough understanding of cultivation and product processing.

Economic opportunities were provided to training participants through arrowroot cultivation and a home-based industry producing arrowroot-processed foods. Futther analysis and material adjustments are needed to ensure these opportunities are effectively utilized by training participants. Shelf-life testing of products should also be considered to expand product marketing. Packaging design, including packaging type, packaging visualization, and packaging layers, needs to be analyzed and redeveloped for broader marketing and the potential for higher production sustainability.

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