The integration of social forestry, science and local community in the collaborative Muna teak (*Tectona grandis*) development

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Abstract. The demand for teak wood in Indonesia reached 7 million m3, however, only 10% can be produced. One of the best teak producers in Indonesia was Muna, Southeast Sulawesi which once has a golden period but now experiencing degradation and losing genetic resources. How to restore Muna teak and its genetic resource became the question of the research. This study uses descriptive qualitative research using data from interviews with relevant stakeholders and secondary data. The result of the study shows that the issuance of Business Permit for the Utilization of Timber Forest Product-in Community Forest for three Forest Farmer’s Cooperatives in 2017 on the area of 1,817 hectares through the Social Forestry scheme has made a positive contribution to the restoration of Muna teak forest. The management of the three cooperatives in partnership with a private company, and the government’s financial support by initiating a tissue culture laboratory and genetic engineering as an effort to propagate the Muna teak using mutation breeding techniques to obtain superior clones. Through multi parties, involvement, and support, the integration of government policies and science, in synergy with individual effort and local community movement, effort indicates a hope to restore Muna teak.

1. Introduction

Teak is one of the most globally and commercially used timbers that grows in tropical and sub-tropical countries [1,2]. The teak forest covers about 43-45 million hectares, spread over three countries, i.e. Myanmar (14 million hectares), India (9 million hectares), and Laos (20 million hectares) [3,4].

Many farmers in the tropics have adopted small-scale teak forests for subsistence and commercial purposes [4] under the agroforestry systems [3,4]. However, the supply of teak timbers is still insufficient for countries’ demands in Asian, European, and American regions [3,4].

In Indonesia, Teak that was introduced by Hindu priests from India for economic and religious reasons in the 14th century [3] or about 400 to 600 years ago in Java [1]. Furthermore, the Dutch colonial government began to develop teak commercially in Muna Regency, Southeast Sulawesi Province, in 1911, and local people called it “Kulidawa wuna”, which means “a tree brought from Java” [5]. Teak flourished and was suitable in Muna area due to its suitable soil types, soil pH, and climate. Optimal
growth and good quality are Jati Muna’s advantages, characterized by the dark colour, beautiful fibre texture, and generally straight trunks [6].

Currently, the golden age of Jati Muna has passed due to the rapid destruction of the forest and its critical condition. The latest data shows that the teak forest area now covers only around 1,000 hectares out of the last 30,000 hectares [6]. The current condition of Muna Teak is scarce, there are only a few Muna Teak trees aged over 60 years, and they are insufficient to be used as a source of seeds.

Previous studies report three interrelated factors in the destruction of teak forests in Muna: changes in government regimes, shifts in forest exploitation policies, and community culture in forest use [5,7]. The main actors in the teak forest conflict in Muna involved the community and local government, who competed for the commercial teak commodity. Although the teak forest area in Muna has been decreasing since 2013, the conflict between the two parties over this commodity continues [7].

Other studies mention that external and internal factors caused the destruction of teak forests in Muna. The external factors are unemployment, a deficit of agricultural land ownership, low income of the agricultural sector, deficit of food sources, deficit of firewood, deficit of sources of green fodder, theft of teak wood and the rise of Timber Forest Product Processing Industry (IPHHK). At the same time, the internal factors include the lack of quality and quantity of human resources, the unclear division of duty and management authority, and the relatively high target of Locally Generated Revenue (PAD) from the forestry sector [8].

Thus, efforts to accelerate recovery need to be carried out immediately. One of the efforts, among others, is to transfer the abandoned and critical production forest in Muna Regency to people who want to manage the abandoned forest. In this context, the Social Forestry (PS) scheme is one solution to resolve land-based conflicts, reduce environmental conflicts and encourage community participation in sustainable forest management [9,10]. Social Forestry aims to reduce poverty, unemployment and unequal management/utilisation of forest areas through efforts to provide legal access to local communities in managing forest areas [11].

Furthermore, there is still a gap between the practice and the goal of social forestry [12]. Social forestry encourages communities to gain legal access to forest management, but it has not been equal to supporting their implementation [13]. In the context of teak commodities, several issues that are an integral part of the development of Social Forestry schemes are often overlooked, such as technical knowledge of silviculture, the need for high-quality seeds with relatively rapid harvest, and seed management planning. Another issue is the institution that provides seeds, funding and related institutional support to restore the Muna teak forest quickly and on a large scale. For this purpose, collaboration in Social Forestry is important to be encouraged in order to achieve the objectives of forest sustainability [9,10,12] and benefit sharing to local communities [14] in Muna Regency.

This research aims to find out how these issues could be realised by integrating technical matters. The integration includes the mutation breeding techniques and clone tests and mass propagation by vegetative propagation, short crop duration Muna Teak seeds, and large quantities to incorporate the restoration of the degraded Teak Forest into the Social Forestry scheme.

2. Study area and methods
2.1. Study area
Geographically, Muna Regency is located in the Southeast of Sulawesi Island, bordering in the north by Spelman Strait, south by Central Buton Regency, east by North Buton Regency, and west by West Muna Regency (Figure 1). The population of Muna Regency in 2019 was 265,000 people distributed in 22 districts and 150 villages [15].

Muna's topography is generally lowland with an average height of fewer than 100 m.asl., starting from east to south of the Municipality of Raha and continues to the west. The higher area is in the northern part of Buton Island, consisting of mountain ranges with an altitude between 300-800 m.asl [15].
Buton Island has mediterrania, rendzina and lithosols soil types, while the soil in Muna Island region consists of red and yellow podzolic. The large rivers with a high-water debit, namely, Kahari River with a flow rate of 670 litres/sec., Wadorso River with a 689 litres/sec flow rate, Lanoumbo River 400 litres/sec. and Tabangka Balano River 1,270 litres/sec [16]. Other significant rivers in Muna Regency, namely the Kambara River and Maligano River.

Of 235,759 hectares of state forest in Muna Regency, it is divided into permanent production forests covering 39,685 hectares, limited production forests covering 11,693 hectares, protection forests covering 46,363 hectares, and tourism forests 82,009 hectares and convertible forests covering 56,009 hectares [17]. Hitherto the forest is significant for Muna's community. It has contributed to the region's development and its community for livelihoods, income sources, employment, industrial raw materials, and environmental services. One of the prized natural wealth of the Muna people's is the Teak Forest.

Social Forestry in Muna Regency was started on January 26, 2017, in a forest area of 1,817 hectares with a community plantation forest (Hutan Tanaman Rakyat – HTR) model. It is divided into 3 (three) HTR permits to 3 (three) farmer cooperatives, namely:

1) Plantation Forest Cooperative (Koptanhut) "Mondono Ghoera", covering Lambiku Village and Langkumampo Village in Muna Regency. Legally permitted by Decree of the Minister of Environment and Forestry number SK.188/MENLHK/PSKL/PKSP/PSL.0/1/2017, covering 617 hectares.

2) Plantation Forest Cooperative (Koptanhut) "Kulidawa Wuna", covering Langkumampo Village and Kombungo Village in Muna Regency, and Umba Village, in West Muna Regency. The Legal permit underlying this is the Decree of the Minister of Environment and Forestry number SK.187/MENLHK PSKL/PKSP/PSL.0/1/2017 dated January 26, 2017, covering 692 hectares.

3) Plantation Forest Cooperative (Koptanhut) "Antocevalus Cadamba", covering Langkumampo Village, Matarawa Village, Kombungo Village and Bangunsari Village in Muna Regency, and Umba Village in West Muna Regency. Legally permitted by Decree of the Minister of Environment and
Forestry number SK.186/MENLHK PSKL/PKSP/PSL.0/I/2017 dated January 26, 2017, covering 508 hectares.

2.2. Data collection
The study implements qualitative descriptive method based on a case study. A case study is research that develops in-depth analysis of a case constrained by time and activity [18]. Therefore, a qualitative approach is used to obtain data and analyze the latest developments after issuing the Business Permit for Utilization of Timber Forest Products in Community Forests (IUPHHK-HTR) to 3 (three) cooperatives in Muna Regency.

The research focuses on farmer perception in planting Muna Teak using vegetative propagation and tissue culture on HTR land in Lambiku Village, Napabalano District, Muna Regency, Southeast Sulawesi Province. This location is located within the area of Muna Island Forest Management Unit (KPH) Region VI.

Data collection was carried out in October 2018 through observation, interviews with questionnaires and in-depth interviews. This study uses key questions and interview guides to ensure the adequacy of data and a focused interview process [19,20].

An interview with questionnaires is conducted with 29 farmers who are cooperative member, both male and female. Furthermore, in-depth interviews are conducted with several key informants, namely community leaders and other local key people who organize farmers in Lambiku Village in the social forestry program. Socio-economic data collection is carried out with cooperative managers to determine the business model used in developing Jati Muna and collect data related to institutions such as the rules, division of labours and network.

Secondary data collection is carried out by collecting village profile, sub-districts profile, and other supporting documents.

2.3. Data analysis
The consensus of perception of respondents about Teak’s vegetative propagation and tissue culture are analyzed using Likert Scale [21] in four levels, namely: “strongly disagree” (STS, score 1), “disagree” (TS, score 2), “agree” (S, score 3), and “strongly agree” (SS, score 4). The total score is calculated using the following formula:

\[ \text{Total Score} = \text{Score} \times \sum \text{Respondents} \]
\[ \text{Average Score} = \text{Total Score} / \sum \text{Questionnaire Statements} \]

Furthermore, concensus is analyzed by the rating scale (Figure 2) according to [22] and verify it with observations and in-depth interviews [21]. All data are presented in descriptive narrative form with an emphasis on discussing cases to provide a comprehensive understanding of the context [23].

3. Results
3.1. Muna teak collaborative management model
Three cooperatives holding HTR permits in Muna receive financial support from the Forest Development Financing Program from the central government (BLU Pusat P2H) to develop Muna teak
plantations with a profit-sharing scheme. The three cooperatives are managed by Jati Wuna Lestari Inc (holding company) and cooperate with smallholder plantations. Profit-sharing for farmers at harvest time is 5% and 28% (for cooperative unit) so the farmers will get the profit share twice, as a farmer and as a member of the cooperative.

Some of the applied rules in the collaboration include social management fund of 10% of company profits. As cooperative members, farmers can use the space between teak saplings for intercropping, thus providing them direct benefits for the first three years.

Jati Wuna Lestari Inc also acts as a companion partner for cooperatives that facilitates and strengthens farmer groups' capacity. Organizing activities related to business and cooperative management, member interactions, and networking of stakeholders. Furthermore, Muna Island Forest Management Unit (KPH) Region VI also provides institutional support due to the cooperative's land is a production forest area under the management of KPH Region VI.

Findings show a relationship between the stakeholder in a "collaborative" community forest plantation management (HTR). The integration process involves science (vegetative propagation and tissue culture) to accelerate harvesting, farmers with social forestry business units and support from stakeholder in the success of the social forestry program. Figure 3 present the integration model in Muna teak HTR activities

![Figure 3](image)

**Figure 3.** Integration of social forestry, science and local communities

### 3.2. Opportunities from Social Forestry

There are two schemes in the development of Plantations by the community, namely community plantations forest (HTR), plantations built by communities on the state forest, and plantation forest built on the community’ owned land, known as private forests (HR).

The main objectives of HTR are to provide community access to forest resources (economic functions) and rehabilitate critical forest areas (ecological functions). The granting of a Timber production Permit on Plantation Forest (IUPHHKHTR) by the state aims to provide legal access for the community, access to financial institutions and broader market access in utilizing the state-owned production forests.

Currently, the development of Community Plantation Forests (HTR) has an opportunity due to the extent of production forests damaged by mismanagement, timber encroachment, fires, and the negative
impact of the euphoria of regional autonomy, which has resulted in a large number of abandoned lands without clear “ownership”.

HTR is a plantation forest in a production forest developed by community groups to increase the potential and quality of production forests by applying silviculture methods to ensure the preservation of forest resources. HTR is one of many alternatives to support the revitalization of forestry sector, which needs acceleration to increase its contribution to economic growth and unemployment reduction, and poverty alleviation [24].

In addition, the Minister of Environment and Forestry Regulation (PermenLHK) number P.09/2021 concerning Social Forestry and P.11/2020 concerning Community Plantation Forest has provided a legal basis for the implementation of HTR. Furthermore, several policies to support the implementation of HTR have been established, such as PermenLHK number P.13/2016 concerning Guidelines for Verification of Timber Production Permits in Community Plantation Forests (IUPHHK-HTR) and Permen LHK number P.16/2016 concerning Village Forest Management Plans (HD), Community Forest Business Plans (IUPHKm) and Community Plantation Forest Business Plans (IUPHHK-HTR).

3.3. Innovative solution for rapid propagation of teak

Tissue culture is one of vegetative propagation techniques conducted by isolating plant parts such as cells or plant tissue that are grown aseptically to multiply and grow into whole plants [25]. Three micropropagation techniques are often used to produce plant seeds, namely bud culture, organogenesis, and somatic embryogenesis. Bud culture is propagation of plants by stimulating (proliferation) axillary or lateral shoots that has already existed in explants. Generally, there are four stages in bud culture techniques, including shoot initiation stages, bud multiplication, rooting induction, and acclimatization. The micropropagation technique often used for commercial seed production is the bud culture technique [26].

Increased forest productivity is determined by several factors: superior quality seeds, specific and intensive silviculture, and social management. In general, species developed in both production and community forests have low genetic diversity due to the difficulty of selecting superior seeds/clones [27]. The fastest way to increase the genetic diversity of a plant is by mutation. There are several types of mutations, such as gene mutations, genome mutations and chromosome mutations. In terms of selection, gene mutations are considered the most important in plant breeding because they involve evolution, recombination and selection. Mutation selection is defined as deliberate manufacture of mutations and is used to produce new varieties.

Nowadays, there have been much researches on plant breeding with mutation breeding techniques. Mutation events are reflected in the emergence of plant genetic diversity, which then goes through a selection and further testing to obtain a superior variety of plants.

Research on mutation induction in forest plant species is generally carried out by irradiating seeds, callus and plantlets with gamma rays. Low dose irradiation (5 Gy) in Suren toon (Toona surenti) seeds has increased the growth of 6-month-old seedlings by 300% for the height and 200% for the diameter. Ironwood (Fagraea fragrans) seed irradiated at a dose of 5 Gy produces the highest number of sprouts (3,100,000 sprouts/Kg). The increase in the diameter and height of the ironwood seedlings are obtained from irradiation of 30 Gy. Irradiation of White paperbark (Malaleuca leucadendra) seeds at 2.5 Gy and storing the seeds for 2 months produce the highest sprouts (4,750,000 sprouts / gram). Pine (Pinus merkusii) seeds which have decreased viability (<25%), irradiated at a dose of 1-2.5 b Gy increase the number of normal seedlings (at the age of 3 months). Magnolia champaca (Michelia champaca) seeds irradiated by 10 - 15 Gy increase the viability of seedlings [28].

In Indonesia, the mutation technique in teak has been tested by the Indonesian Institute of Sciences (LIPI). The LIPI Platinum Teak results from mutation induction in a 5-year teak plant and has qualified teak wood. It is indicated by the value of MOR (Modulus of Rupture), MOE (Modulus of Elasticity), and wood density which is almost equivalent to ordinary teak with the aged of 20-30 years. The LIPI Platinum Teak is considered to develop and has a good prospect [29].
Mutation technique for teak is also performed on the Solomon Teak plantlet. The gamma rays that are needed to keep the plantlet alive is 7.8-24.5 Gy. Gamma-ray irradiation on teak plantlets can increase mutant plantlet diversity [30]. In addition to manipulation through gamma rays, teak could also be mutated through ploidy manipulation through tissue culture. Platinum Teak, which is mutated using an oryzalin compound with a doubled chromosome number \((2n = 4x = 72)\), that is also called tetraploid teak, is resistant to drought stress compared to diploid teak \((2n = 2x = 36)\) [31].

Mutation breeding in Muna Teak has been carried out since 2015 by the Research and Development Center for Forest Plant Seed Technology (BP2TPTH) through irradiation of seeds originating from Muna with gamma rays. The irradiated seeds (mutants) are then grown and propagated through tissue culture and macro cutting methods. The 11-clone test is carried out in the permitted area (IUPHHK-HTR) of Mondono Ghoera in Muna (planted in March 2018). Due to the production process, the Muna Teak from mutation breeding is known in the community as “nuclear teak”.

3.4. Perception and level of community/members of cooperatives acceptance

Table 1 presents the community’s perception of social forestry and the level of community acceptance of Teak Muna replanting seeds produced by mutation breeding and tissue culture in Lambiku Village, Napabalano District, Muna Regency. The average perception score is 96.91, with a “very good” category.

Farmers perceive that planting Jati Muna in HTR areas provides social and economic benefits such as providing new job opportunities (clearing land, building fences and huts) and increasing income from the intercropping system on teak forest land. Income from the intercropping system is gained during the first three years before harvesting in the eighth year.

Positive perceptions (Agree and Strongly Agree) are evenly distributed in aspects of knowledge about the Social Forestry program, perceptions of Social Forestry benefits, norms and rules applied in planting and maintaining the Teak’s Mutation Breeding and Tissue Culture, social implications and personal motivation of farmers.

All respondents agree (65.5%) and strongly agree (34.5%) with Jati Muna planting program on Social Forestry land and are very enthusiastic after understanding that they could manage it legally. Previously, farmers did not even dare to enter the forest area because it was considered illegal.

With the replanting program, while waiting for the distribution of seedlings and raising the planted seedlings, farmers can plant intercrops, such as sweet corn \((Zea mays convar. saccharata var. rugosa)\). Therefore, 72.4% of respondents agree that 27.6% of respondents strongly agree that they have economically benefitted directly from the Social Forestry program in this initial period. In this context, 79.3% of respondents agree, and 20.7% strongly agree that the selection of sweet corn and vegetables is more profitable and has a short time to harvest. Meanwhile, 82.7% agree, and 17.3% strongly agree about the sanctions for farmers who ignore the regulations.

Regarding the rights and obligations of farmers, whether they are in line with expectations and not adding burden to farmers; the percentage who agree that they are in line with expectation is 86.2%, while 13.8% strongly agree, the percentage that agree that the obligation is not burdensome is 79.3% while 20.7% strongly agree. Regarding the cooperative manager's communication to the farmer members, 65.5% said that it was going well, and 34.5% said that it went very well.

The involvement of communities as members of cooperatives and gaining access to forest management has impacted the wider community. As many as 86.2% of farmers agree, 13.8% strongly agree that the program has a good impact on social relations and built strong bonds between farmers.

The socialization of Muna Teak's mutation breeding and tissue culture has running very well by developing a demonstration plot of Jati Muna in the front yard of the regent's office which is located on Muna highway close to common Muna Teak. Muna Teak's mutation breeding and tissue culture have straight trunks with large diameters and fewer branches. On the other hand, the common Muna Teak is generally small in diameter and has many branches.
Table 1. The community perception on the social forestry program and the teak’s vegetative propagation and tissue culture initiative.

| No | Statement                                                                                           | Statistics | Respondent’s Answer | Total Score |
|----|------------------------------------------------------------------------------------------------------|------------|---------------------|-------------|
| 1  | The community/members of cooperatives know about the area for Muna Teak plantation from the Social Forestry Program. | n          | 0 0 19 10            | 97          |
|    |                                                                                                     | %          | 0 0 65.5 34.5        |             |
| 2  | The community/members of cooperatives gain considerable benefits from Muna Teak area of the Social Forestry Program. | n          | 0 0 21 8             | 95          |
|    |                                                                                                     | %          | 0 0 72.4 27.6        |             |
| 3  | The regulation on what plants can be grown benefits the community/members of cooperatives who also work in the Social Forestry Program. | n          | 0 0 23 6             | 93          |
|    |                                                                                                     | %          | 0 0 79.3 20.7        |             |
| 4  | The sanction for breaches of regulation is normal and acceptable.                                   | n          | 0 0 24 5             | 92          |
|    |                                                                                                     | %          | 0 0 82.7 17.3        |             |
| 5  | The rights granted to the community/members of cooperatives who also work in the Social Forestry Program are in line with expectations. | n          | 0 0 25 4             | 91          |
|    |                                                                                                     | %          | 0 0 86.2 13.8        |             |
| 6  | The obligation of the community/members of cooperatives regarding their work on the arable land does not encumber them. | n          | 0 0 23 6             | 93          |
|    |                                                                                                     | %          | 0 0 79.3 20.7        |             |
| 7  | Communication of the managers of cooperatives (PT Jati Wuna Lestari) to the community/cooperatives members has been effective. | n          | 0 0 19 10            | 97          |
|    |                                                                                                     | %          | 0 0 65.5 34.5        |             |
| 8  | The existing Muna Teak area in the Social Forestry Program and its intercropping is beneficial economically. | n          | 0 0 21 8             | 95          |
|    |                                                                                                     | %          | 0 0 72.4 27.6        |             |
| 9  | The work in the Muna Teak area of the Social Forestry Program impacts improving the social relation between communities/cooperatives members. | n          | 0 0 25 4             | 91          |
|    |                                                                                                     | %          | 0 0 86.2 13.8        |             |
| 10 | The engagement of the community/cooperatives members in working on Muna Teak area does not cause jealousy among other communities who do not get the opportunity. | n          | 0 9 19 1             | 79          |
|    |                                                                                                     | %          | 0 31.3 65.5 3.2      |             |
| 11 | The community/cooperatives members are very interested in getting the opportunity to plant and grow Muna Teak produced from tissue culture/nuclear teak. | n          | 0 0 19 10            | 97          |
|    |                                                                                                     | %          | 0 0 65.5 34.5        |             |
| 12 | The access of the community/cooperative’s members to superior clones of Muna Teak from tissue culture must be more accessible and cheaper. | n          | 0 0 18 11            | 98          |
|    |                                                                                                     | %          | 0 0 62.1 37.9        |             |

Total Score 1,118
Average Score 93.16
Rating Scale (Criteria) Very Good

Legend: STS=Strongly Disagree. TS=Disagree, S=Agree, SS=Strongly Agree
Source: Primary data, 2019

These results provide evidence and influence the community's perceptions of the type of teak wood whose seeds are produced based on advanced technology. As a result, public interest in planting Muna...
Teak’s mutation breeding and tissue culture will increase. In this case, the availability of superior Jati Muna seeds must be ensured so that people can access them easily and cheaply.

Positive results at the level of perception indicate the great potential to restore the golden age of Muna Teak in the future because farmers are the backbone of the enrichment and restoration of Muna Teak forests in a sustainable manner.

4. Discussion
After the issuance of the Timber Production Permit on Community Plantation Forest (IUPHHK-HTR) by the Social Forestry Program for three cooperatives in Muna and West Muna Regencies, gradually, the community access for forest resources is restored. Communities and farmers who were once sidelined and did not have access to forests management now begin to plant legally.

Adhering to conventional schemes in growing forest plants will not yield satisfying results and require a long time. Therefore, breakthrough and new ways of silviculture for forest plants are demanded. Research on Muna Teak Plant plant breeding using mutation breeding techniques has been carried out for several years, and currently, superior plant varieties have been produced. Plant mutations can quickly be applied through mutagen material (chemistry) or irradiation techniques with gamma rays (physics).

Furthermore, the propagation of superior Muna teak clones with vegetative breeding technology, both with tissue culture and macro cutting, greatly supports planting forest land by communities in Muna. Therefore, the interest to replant Muna Teak is highly increasing as the efforts begin to yield results. The capacity of the manufacturing laboratory is estimated to reach 3 million seedlings per year, which is equivalent to a planting area of 6,000 hectares (a planting range of 4 x 5 m²). This effort presents new opportunities for the dissemination and development of Teak genetic resources on a large scale, linking propagation work directly with plant testing and breeding programmes [32].

Techno logical approach of Muna Teak supports faster harvest, starting from the age of 9 years to 15 years, with diameters ranging from 30-40 cm. Although the value of teak increases in that range of diameter (size A3), the current price for that quality is IDR 7 million per cubic meter.

The number of members of the three cooperatives is 321 persons, respectively: Mondono Ghoera has 93 members, Kulidawa Wuna has 94 members, and Anthocevalus Cadamba has 134 members. Most of their arable land is located in Muna Regency, and the remaining is in West Muna Regency. By planting Muna Teak on the Social Forestry area, cooperative members also utilize the land with the intercropping system. This system provides economic benefits and food security [33] to cooperative members by planting food crops between the main trees [34]. In addition, it also increases land productivity [35], improves soil [36] and increases the quality of ecosystem services [34].

Cooperative members can carry out the intercropping system until the teak is 2.5-3 years old due to the canopy of the teak plants will block the sunlight, so the undergrowth cannot survive. At the age of 1 year, Muna Teak clones (staple crops) that have been planted will have reached 4 - 6 m high, with an average diameter of 4 cm. It indicates that the clones planted are fast-growing teak varieties, generally ready harvested at 12-15 years, with an average volume of 0.7 m³ per stem.

The common intercropping plant is corn, peanuts and cassava. However, the yields are not optimum yet because the management is not intensive due to the cooperative member’s daily income obtained by working at Jati Wuna Lestari Inc. Types of work carried out by the farmers at Jati Wuna Lestari Inc is land clearing and maturation, production and transportation of seedlings on the site, weeding and fertilizing, observation of pests/diseases, forest monitoring and security, and others.

Based on the agreement between the cooperatives and the Forest Development Financing Service (BLU), the cooperative can use social management funds (10% of total funding) to increase land productivity. By self-organizing in a cooperative and getting direct assistance from both the company and the BLU, farmers-members of the cooperative enhance their social and institutional cohesion through many events such as comprehensive personal communication, frequent meetings and discussions on the existing problems regarding the farmer’ managed plant.
This finding shows better results in collaboration model and division of stakeholder roles than in a study result of the Joint Forest Management (JFM) in Central Java. The JFM study on teak commodities in Central Java shows positive economic benefits through benefit-sharing between private companies and farmer groups. However, in improving the livelihoods of poor households and forest sustainability (forest disturbances), it still has not achieved significant results. [37]. Furthermore, in the context of social forestry, [12] states several challenges to the effectiveness of social forestry management, namely 1) many administrative and bureaucratic procedures; 2) differences in understanding and interests of the stakeholders; 3) the unfair distribution of rights and responsibilities to the forest leads to the issues of compensation and unfair benefit-sharing between the stakeholder.

The integration between social forestry, forest farmer cooperatives, and science (mutation techniques and tissue culture) can be seen in Figure 3. Community perception shows a good relationship between stakeholders, and the collaboration process is possible due to the integration of these three things (Table 1). Community acceptance of social forestry and technology transfer and adaptation has empowered the local community’s confidence in planting teak as their best investment for the future. Along with the increase in communities’ welfare, damages to the forest and the environment will be reduced.

5. Conclusion
The Social Forestry Program in Muna Regency impacts increasing local community income. It proves that providing forest access to local communities through the Utilization of Timber Forest Products in Community Forests (IUPHHK-HTR) conducted by forest farmer cooperatives can lead to community empowerment and improve social cohesion. In addition, technological interventions on wood commodities provide an opportunity for economic and environmental recovery when the inventions are used appropriately and responsibly. All efforts that various parties have made in the context of reforesting Muna Island with teak must continue to be supported to improve the community’s welfare and restore the glory of Muna Teak.

References
[1] Pandey D and Brown C 2000 Teak: A Global Overview. An International Journal of Forestry and Forest Industries 51 pp 2000-2002.
[2] Palanisamy K, Hedge M, Yi J S 2009 Teak (Tectona grandis Linn.f.): A Renowned Commercial Timber Species Journal of Forest Science 25 1 pp 1-24
[3] Behaghel I 1999 The State of Teak (Tectona Grandis L.F) Plantations in the Worlds Synopsis. Bois et Forets Des Tropiques 4 264
[4] Kollert W L and Cherubini 2012 Teak resources and market assessment 2010 (Tectona grandis Linn.F.) (Rome: Food and Agriculture Organization)
[5] Topojers L O 2013 Menebang Jati Mengejar Rupiah Studi Etnografi Hutan Muna Teak [Dissertation] (Yogyakarta: Universitas Gadjah Mada)
[6] Azhar M A 2007 Kerusakan Ekologis Hutan Jati di Kabupaten Muna (Potret Pemujaan Pendekatan Anthroposentris) Jurnal Ilmu Sosial dan Ilmu Politik 11 2 pp 227-245
[7] Jers L O T 2016 Resistensi Kelompok Masyarakat Lokal atas Pengelolaan Sumberdaya Hutan di Kabupaten Muna Jurnal Etnoreflika 5 pp 185-197
[8] Mando L O A and Purwanto R H 2015 Potensi Hutan Tanaman Jati dalam Perencanaan Pembangunan Wilayah Kabupaten Muna Ecogreen 1 1 pp 65 – 78 ISSN: 2407 - 9049
[9] Asmin F, Darusman D, Ichwandi I, Suharjito D 2019 Mainstreaming community-based forest management in West Sumatra: Social forestry arguments, support, and implementation Forest and Society 3 1 pp 77–96 Doi: 10.24259/fs.v3i1.4047
[10] Erbaugh J T 2019 Responsibilization and social forestry in Indonesia Forest Policy and Economics 109 102019 Doi: 10.1016/j.forpol.2019.102019
[11] [MoEF] Ministry of Environment and Forestry, Republic of Indonesia 2019 Peraturan Menteri Lingkungan Hidup dan Kehutanan No. P.83/MENLHK/SETJEN/KUM.1/10/2016 tentang
Perhutanan Sosial.

[12] Rakatama A and Pandit R 2020 Reviewing social forestry schemes in Indonesia: Opportunities and challenges Forest Policy and Economics 11 Doi: 10.1016/j.forpol.2019.102052

[13] Resosudarmo I A P, Tacconi L, Sloan S, Hamdani F A U, Subarudi, Alviya I, Muttaqin M Z 2019 Indonesia’s land reform: Implications for local livelihoods and climate change Forest Policy and Economics 108 101903 Doi: 10.1016/j.forpol.2019.04.007

[14] Desmiwati D, Veriasta T O, Aminah A, Safitri A D, Wisudayati T A, Hendarto K A, Royani H, Dewi K H, Raharjo S N I, Sari D R 2021 Contribution of Agroforestry Systems to Farmer Income in State Forest Areas: A Case Study of Parungpanjang, Indonesia. Forest and Society 5 1 pp 109-119 Doi: 10.24259/fs.v5i1.11223

[15] [BPS] Badan Pusat Statistik 2021 Kabupaten Muna dalam Angka 2021 ISSN: 0215-6717

[16] [BPS] Badan Pusat Statistik 2021 Kabupaten Muna dalam Angka 2008

[17] Hardiyanto Y 2010 Mengembalikan Identitas Muna Sebagai Pulau Jati http://taek-investation.blogspot.com/2010/04/mengembalikan-identitas-muna-sebagai.html Accessed on 15 Februari 2019.

[18] Crewell J W 2016 Research Design: Pendekatan Metode Kualitatif, Kuantitatif dan Campuran (Yogyakarta: Penerbit Pustaka Pelajar)

[19] Padgett D K 2008 Qualitative Methods in Social Work Research (2nd ed.) (Thousand Oaks, CA: Sage)

[20] Ostrom E 2007 A diagnostic Approach for Going Beyond Panaceas Proceedings of the National Academy of Sciences 104 39 pp 15181-15187

[21] Tastle W J and Wierman M J 2007 Consensus and dissention: A measure of ordinal dispersion International Journal of Approximate Reasoning 45 pp 531–545 Doi: 10.1016/j.ijar.2006.06.024

[22] Sugiyono 2014 Metode Penelitian Kuantitatif Kualitatif dan R & D (Bandung: Alfabeta)

[23] Stangor C 2015 Research Methods for The Behavioral Sciences (5th ed.) (USA: CENGAGE Learning)

[24] Fauzi Hamdan 2010 Kehutanan Masyarakat Teori dan Implementasi (1st ed.) (Banjarmasin: Pustaka Banua)

[25] Zulkarnain 2011 Kultur Jaringan Tanaman (Jakarta: Bumi Aksara)

[26] Sulistiani E and Ahmad Y 2012 Produksi Bibit Tanaman dengan Menggunakan Teknik Kultur Jaringan (Bogor: SEAMEO Biotrop)

[27] Zanzibar M 2009 Teknik Peningkatan Produktivitas Jenis-Jenis Hutan Rakyat Prosiding Teknologi Perbenihan (Bogor: BP2TPH)

[28] Zanzibar M 2013 Mutation Breeding pada Jenis-Jenis Tanaman Hutan (Bogor: BP2TPH)

[29] Adi D S, Sudarmanto, Imsadi M G, Darmawan T, Amin, Y W 2016. Evaluation of The Wood Quality of Platinum Teak Wood Teknologi Indonesia 39 1 pp 36–44

[30] Parlaongan A 2017 Induksi Keragaman Genetik Planlet Jati (Tectona grandis Linn.F.) dengan Irradiasi Sinar Gamma (Bogor: Institut Pertanian Bogor)

[31] Ridwan, Handayani T, Riastiwi I, Witjaksono D 2018 Tetraploid Teak Seedling was More Tolerant to Drought Stress than Its Diploid Seedling Jurnal Penelitian Kehutanan Wallacea 7 1 pp 1–11.

[32] Goh D K S, Chaix G, Baill.res, Monteuuis O 2007 Mass production and quality control of teak clones for tropical plantations: the Yayasan Sabah Group and CIRAD. Joint project as a case study Bois Forest Tropiq 293 pp 65–77.

[33] Wulandari C, Budiono P, Yuwono S. B & Herwanti S 2014 Adoption of agro-forestry patterns and crop systems around Register 19 Forest Park, Lampung Province, Indonesia Jurnal Manajemen Hutan Tropika 20 2 pp 86-93.

[34] Shin S, Soe K T, Lee H, Kim T H, Lee S, Park M S 2020 A systematic map of agroforestry research focusing on ecosystem Services in the Asia-Pacific region. Forests 11 368 pp 1-23. https://doi.org/10.3390/f11040368
[35] Suryanto P, Widiyatno, Prianto S D A, Permadi D B, Affianto A, Adriana 2013 Compatibility of private agroforestry management and managing forest with community program in Central Java, Indonesia Journal of Management and Sustainability 3 1 pp 178-185.

[36] Mulyono A, Suriadikusumah A, Harriyanto R, Djuwansah M R 2019 Soil quality under agroforestry trees pattern in Upper Citarum watershed, Indonesia Journal of Ecological Engineering 20 1 pp 203–213. https://doi.org/10.12911/22998993/93942

[37] Wasito, Sumarwan J, Ananto E E, Sunarti E, Dharmawan A H 2011 Livelihood of poor farmers and Teaks Forest sustainability in Blora District, Central Java Jurnal Penelitian Sosial dan Ekonomi Kehutanan 8 1 pp 71-92

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