Transdisciplinary research on local community based sago forest development model for food security and marginal land utilization in the coastal area

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Abstract. The most important issue in food security in Indonesia is limited land area which suitable for food crops. While production already reached its highest potency. Eastern part of Indonesia seems to have hidden answer for the food security issues. Sago plant is origin from Indonesia. Sulawesi is known by its unique semi-cultivated system in food production. This paper will describe the transdisciplinary approach in developing a model of sago plant development based on local community. The model is derived based on the research findings related to characteristic of semi-cultivation of sago plant as follows: (a) Sago in Tana Luwu only 3463,36 ha, most of the land already converted to fishpond, and plantation (b) Semi cultivated sago forest produce 24 tons dry sago/year, 4 times than paddy in dryland, (c) Transdisciplinary research method enables the triple helix collaboration of University, Industry and Government, and (d) Collaborative action is a key to bind the stakeholders, in this case the Plan and Design of Sago Science techno park worked effectively. (e) Several government regulations and local community activities have been born at different level.

1. Introduction

Food security is the most important issue in the world. Indonesia as a country with population of 258,704,900 in 2016 [1] is now struggling to increase food production. Efforts in increasing rice production are come to the limit and government of Indonesia exploring alternative foods. Land for food crop always compete with other land use and directly affecting the size of forest land. Growing sago in semi-cultivated method means producing food in parallel with increasing forest area.

Sago palm (*Metroxylon sagu* Rottb.) is mainly distributed in swamp area with a high temperature and abundant sunshine located at latitude between 10•‹ North and South, and it can grow up to an elevation of 700m [2]. According to Stanton [3] one of the first to advocate sago palm research, the advantages of the crop are that it is: (1) economically acceptable; (2) relatively sustainable; (3) environmentally friendly; (4) uniquely versatile; (5) vigorous, and (6) promotes socially stable agroforestry systems.

Sago starch traditionally is staple food for most of people in eastern part of Indonesia. If we use assumption that Indonesian people consume food in form of rice 600kg/year for a family with 6 family members, then the necessary food is equal to 3 or 4 sago trunks. This is one of the reasons why the sago plants in Papua is underutilized. If productive sago forest in Papua is about 400000 hectare, it can feed 240 million people the same number with population of Indonesia. Abundant food source forgotten by the policy makers in the country [4].

Tana Luwu is a region which is originally a royal territory under a King called Datu Luwu. The area was much larger including several more regencies in South Sulawesi and South East Sulawesi. Now Tana Luwu consists of one city (Palopo City) and three (3) regencies (Kabupaten Luwu, Kabupaten Luwu Utara and Kabupaten Luwu Timur) in South Sulawesi Province. For people of Tana Luwu Sago is not just as an important staple food but also customs, culture and tradition are very much related. The existence of the King (Datu Luwu) is a strong bond for the community, however sago function as staple food is fading away along with the popularity of rice as the symbol of prosperity.

Even though in this official data is mentioned that sago in Sumatera and Riau is classified as semi cultivated but it is believed that recently most of them are plantation type mainly for industry. Sago in Sulawesi is a true semi cultivation, still has forest ecology which make it has its own unique environment. Different with sago plantation for industry, planting sago in semi-cultivation way has many positive impacts both for (alternative) food production and forest function. Starch productivity of sago palms cultivated on Semi cultivated forest area, however, is poorly documented.

Transdisciplinary research is defined as research efforts conducted by investigators from different disciplines working jointly to create new conceptual, theoretical, methodological, and translational innovations that integrate and move beyond discipline-specific approaches to address a common problem. This approach also recognized intangible knowledge as data which has the same quality with tangible knowledge. Recently transdisciplinary research is introduced as a new research method which is simultaneously encourage local community to become a main actor in finding solution for the issues. Issues here are how to maintain the sago forest area and increasing the sago plants.

This study aims to develop a model of sustainable sago forest for food security. Local community's initiative is a must when we talk about sustainability, because they live there and the effects or impact will affect them, positively or negatively. Enabling the local community to take initiative will enrich both community and researchers. In a specific environment such as sago forest, abundant knowledge was accumulative and digging the intangible knowledge and make it work for the future prosperity is a task of transdisciplinary research team.

Objective of this study are:

- Re-discover the benefit and merit of sago as staple food and
- Support sago farmers to become main actors in sago development
- Description of the traditional intangible knowledge on sago cultivation and sago forest
- Description of roles and function of stakeholders

2. Methods

The research was conducted in Tana Luwu, administratively means Kota Palopo, Kabupaten Luwu, Kabupaten Luwu Utara and Kabupaten Luwu Timur of South Sulawesi.

The intensive survey to make profile of semi cultivated sago forest was conducted in Village (Desa) Waelawi in subdistrict (Kecamatan) Malangke Barat of District (Kabupaten) Luwu Utara in South Sulawesi Province. This village is chosen because the sago forest in this village is still exist and based on the preliminary survey, the largest sago forest area is in subdistrict (Kecamatan) Malangke Barat. Several plots size of 50 m x 50 m. is used to define the profile of semi-cultivated sago forest. Number of clumps is counted and distribution of clumps is plotted by coordinates using GPS.

The Transdisciplinary team including agronomist, soil scientist, hydrologist, public health scientist, social economist cooperate with sago farmers, local community and local government to define a concept of Development of Sago Forest based on local community.

3. Result and Discussion

3.1. Profile of Semi-cultivated Sago Forest

Semi-cultivated sago forest has its own unique profile, very much different with plantation style where the interval between trees or clumps is orderly prepared, the plant spacing in semi cultivated sago forest defined naturally by the suckers which will form new clumps. There is an argument that the suckers will extended until it found a favorable point to emerge. Sunshine maybe the dominant factor in this case. It is means that the empty space will be naturally enable new suckers to emerge. According to Pasolon *et al.* [5], vegetative grow and dry starch production were lower in dry soil condition, except with molar sago in Laosu. Sago palms growing on dry land had higher root density maximum root depth of 50-70 cm.

3.1.1. Clumps distribution. The clumps position is plotted by coordinates. Averages of 136 clumps is counted in a hectare. The distribution in plot is shown in fig 1. *This distribution is equal to the average clumps spacing of* $D = \sqrt{10000/136} = 8.57$ *m.*

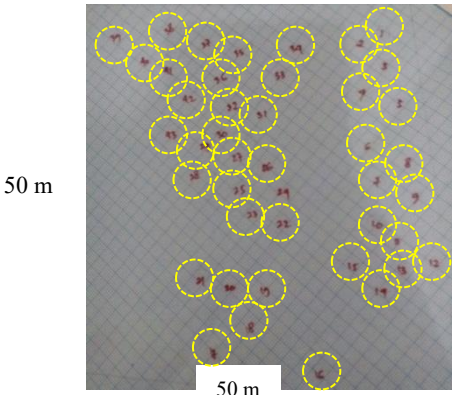

Figure 1. Distribution of sago clumps in research plot.

3.1.2. Sago clump. Sago clump consist of several suckers, with at least one sucker is starting trunk formation. It is not easy to differentiate clumps in sago forest. The existence of trunk formation stage sucker is a use to indicate an independent clump.

Table 1 shows that in average we can find 24 suckers, showed that no pruning or maintenance has been done by farmers. Traditional way of leaf-sheath in fact is giving pruning impact for plants. Yiu-Liong, *et.al.* [6] reported that the overall mean number of clumps were found to be 239. This gave an average of about 8 young suckers per clump. Number of large suckers at about trunk formation stage decreased nearly ten-fold to only 203 per hectare. Immature palms with trunk and mature, harvestable palms averaged 77 and 42 per hectare respectively.

Table 1. Age and harvesting year estimation of plants in a clump

	Average age of suckers/plants	Number of suckers	Year of harvesting
1.	6 years	1	2021
2.	5 years	1	2022
3.	1 year	5	2027
4.	2 months	6	2028
5.	1 month	8	2028
6.	1 week	3	2028
Total number of suckers in a clump		24	

3.2. Productivity of Semi-Cultivated Sago Forest.

The criteria by which sago palms are selected for cutting are the most poorly documented aspect of sago processing. The starch reserves are apparently at their maximum just before flowering and fruiting deplete these reserves, but scientifically little more is known of the timing of starch build-up. Most sago-using peoples cut palms at varying stages of maturity [7]. Among 136 clumps in one hectare of sago forest research plots, in average there are 280 sago plants which ages more than 6 years, means these trunks have potency to be harvested in 5 years ahead. In average will be 56 trunks per/year. Based on the direct observation in the field, a trunk can produce 20 tumangs (basket made from sago leaves) with content of 20 kg wet sago starch, means total of 400kg wet sago from one trunk. Production of sago starch could be estimate as =56 trunks x 400 kg wet sago = 22400 kg wet sago or 22.4 ton ha^{-1} $year^{-1}$ of wet sago. Dry sago starch calculation = 60% of wet sago equal to 13.44 ton $ha^{-1}year^{-1}$ of dry sago

As comparison we can refer the condition in Sarawak as Yiu-Liong, *et al.* [6] mentioned the range for every category of palms varied widely from plot to plot. Harvestable palms varied from 6 to 144 per hectare while the number of immature palms with trunks ranged from 6 to 250 per hectare. The numbers of young suckers, palms at trunk formation stage and dead palms were in the range of 288-4,925, 13-475 and 0-131 per hectare respectively. According to Novarianto *et al.* [8] the productivity of sago Duri in average is 226.34 kg per trunk. Sago Duri originate from Kabupaten Kepulauan Meranti, Provinsi Riau in Indonesia is officially recognized as National Superior sago variety under the name of Selatpanjang Meranti. Natural sago forest has lower productivity. This is caused by uncontrolled growth of palnts, competition between suckers and with other plants, irregular plant spacing, and difficulties during harvesting. Plants management is necessary to increase the potency of sago in natural sago forest. The potency of sago production in Indonesia is 12.8 ton ha^{-1} $year^{-1}$, but after better management and maintenance the potency will increase up to 64.3 ton ha^{-1} $year^{-1}$ [9].

3.3. Local Community-Based Sago Development Model.

3.3.1. First step: Formation of research team. The research team is formed based on the rules of transdisciplinary which is require interdisciplinary team. The team consist of scientist focus on hydrology, soil science, agronomy, public health, medicine, forestry, food technology, law, architecture, urban planning, sociology etc including also local government staff, NGO and sago farmers

3.3.2. Second step: Collaboration between scientist team and local community. Local community-based sago development is a concept where sago farmers of local community is the main actor in initiating the sago development. Basically, they have all the indigenous knowledge in plant propagation and sago starch processing. First step of supporting them to be a confident initiator is to acknowledge their knowledge and skill. The best ways are:

- collaborate in inventory of sago forest condition,
- analyse recent issues, and
- discuss the solution to put it in the real context.
- collaborate in scientific measurement
- feedback of scientific findings to the community

This process will convert intangible knowledge into tangible form, in more communicative format. In parallel, local community aware about their local resources and its potency. This new understanding related to their pride and confident.

3.3.3. Third step: Inclusion of Local Government. The result and findings of collaboration work between local community and research team is reported and consulted with local government. In this step government become more aware and ensured about the urgency of sago development make response to follow up the result. In this study, research team and local government agree to prepare the outline of sago science techno-park. Basic design is prepared by research team. In this step intensive discussion and consultation between research team and government are expected.

3.3.4. Fourth step: Follow up action of local government. Local government of Kota Palopo make progress of follow up the concept of science technopark by initiating detail design and procurement of land, Kabupaten Luwu Utara make preparation on Sago conservation regulation and village government also prepare regulation at village level. Kabupaten Luwu also initiating the regulation.

3.3.5. Fifth step: Embracing the private company and industry. Concept of science techno-park then introduced to the private sector to get suggestion and make it more realistic and implementable plan. One of the suggestion to the private sector is to challenge the sago plant utilization for post-mining land rehabilitation. Kabupaten Luwu Timur has an urgency to the rehabilitation of this kind of land, and the related company already agreed to implement this plan, and started to prepare the plan

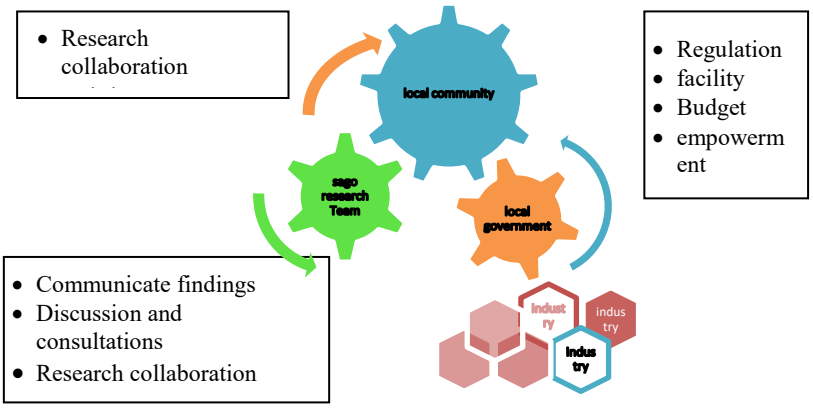

Figure 2. Local Community based Sago Forest Development Model

4. Conclusion

- Sago in Tana Luwu only 3463,36 ha, most of the land already converted to fishpond, orange, and recently to cacao and palm oil.
- Semi cultivated sago forest produce 14 ton dry sago/year. This means 4 times than paddy in dryland or marginal land. And still twice than irrigated paddy field.

- Sago forest conservation depends on active participation of local community and regulation made by government
- Transdisciplinary research method enables the triple helix collaboration of University, Industry and Government, based on solid collaboration between scientist researchers and local community as research member. Identification, description and documentation of local wisdom is a suitable topic to build up transdisciplinary research because it is triggered the active participation, trust and confidence of local community
- Collaboration action is a key to bind the stakeholders, in this case the Plan and Design of Sago Science techno park worked effectively.
- Several government regulations and local community activities have been born at different level.

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