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RESEARCH ARTICLE

Mix Farming Based on Sago Palm in Meranti Island District, Riau Province, Indonesia

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ABSTRACT

Sago can be used as raw material for sugar and bioenergy on a national scale because Indonesia has huge sago area especially in the eastern part of Indonesia. Sago can grow well in peat soil. The aim of this research is to develop peat soil optimally at Tanjung Peranap Village, Meranti Island District, Riau Province. The research involved land owner in the region burned down in 2016, extension service and local government. Research form activities indicates that the local people income increase because they harvested cayenne chili, big red chili, sweet corn, baby corn, corn kernel, green kale and watermelon. Their income was Rp 7200000, Rp 2625000, Rp 2774400, Rp 4368000, Rp 2995230, Rp 5400000 and Rp 4900000 respectively. Various income from mixed cropping can change the farmer mind. They realize that mixed cropping can be reliable as an income source and change their activity from destroyed the forest and mangrove to cultivated mixed cropping. It can minimalize the environmental damage.

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Introduction

Sago is a palm plant that has high starch production potential as well wide area. Production of sago starch reaches 200-400 kg palm^{-1} (Bintoro et al., 2010). Indonesia is the country that has the widest sago area in the world, which is 5.5 million ha (Bintoro et al., 2016). Of these areas, most are in Papua Province and West Papua of 5.2 million ha (Djoefrie et al., 2014), the rest is spread over several islands large and entering the periphery and border areas (Bintoro et al., 2017). Sago starch generated has many derivative products that can be developed in the future.

Utilization of sago starch in Indonesia has been used for household purposes and industry. Sago starch can be used as noodles, sago rice, liquid sugar, bioethanol, biofoam, environmentally friendly plastics and pharmaceuticals (Ramadhan et al., 2015; Karouw et al., 2015; Komarayati et al., 2011; Kamsiati et al., 2017; Pandey et al., 2015). Waste results sago pith dissolution can be used as animal feed, mushroom and crop media organic fertilizer (Bintoro et al., 2010). Sago starch content is healthier than other starch,

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because sago starch has a low glycemic index so good for of prediabetes (Hariyanto et al., 2017).

Sago is one of the plants that thrive on peatlands. Ecosystems wet peat in accordance with sago growing environment. Sago growing on the land peat is largely not done by community maintenance. The habit difficult to change because sago is a perenial plant that takes time a long harvest, which is about 10 years old. No maintenance of sago on peatlands have an impact on low and unsustainable sago growth sago land becomes unproductive plus the economic problems of society namely the debt bondage system. Communities in the peatlands are familiar with the debt bondage system, due to increasing economic needs, while employment not available. Communities in the peatlands, especially the coastal areas have been converted mangrove loggers. It has a negative impact on the coastal environment there is abrasion. The big problems that occur in peatlands are related to the ecosystem peat fire. Fires have already hit the existing peat and non-peatlands in Indonesia by 2015 with an area of 2 million ha (BNPB, 2015). Problems it should be anticipated so as not to reoccur one of them with effort utilization of sago area with cultivation technique appropriate with peat ecosystem.

Sago newly planted area with a spaced distance between sago plants can cultivate horticultural crops, fishing and livestock activities. Efficiency land use in sago plantation can increase economic income community from the sale of non-sago products. Integrated farming system with sago main commodity suitable for development on peatland. Institutional strengthening through farmer groups can support the sustainability of the model. Meranti Island District are one of the sago-producing areas in the peatlands the largest in Riau Province, but the people's economy has not yet been felt maximum. Therefore, the integrated agricultural model of sago, duck, cattle, fish and horticultural crops needs to be done and applied in community sago plantation. The purpose of such activities is to develop integrated agriculture in the community, especially sago-producing areas for the economy of the community increased.

Materials and Methods

The intercropping activities are conducted in Tanjung Peranap Village, Meranti Island District, Riau Province, Indonesia. Activities are held in July-December 2017. The area used is burnt area of 1 ha with coordinate point 00°55'23.3" N, 102°27'11.5" E. Local farmers are included in the activities and given authority in the maintenance of all commodities being piloted.

The main cultivated crop is sago. Sago seedlings planted with a distance of 10 m x 10 m with total seedlings planted as many as 100 plants. The row inside the sago plant intercropping with sweet corn, corn kernel, chili, watermelon, green kale, catfish, cattle and ducks.

Selection criteria good sago seedling i.e. seedling weight 5-7 kg, shape 'L', not attacked by pests and disease. Sago seedling is cutting on the part of the petiole and the leaf midrib. Cutting works to reduce transpiration (water loss) during nursery and stimulate the growth of new shoots. Cutting is also done on the root contained in the rhizome, because the root is no longer functioning in the absorption of nutrients. Pruning the roots will stimulate the growth of new roots that function for water absorption and nutrients during the growth of seedlings in the nursery. The horticultural planted i.e. corn and sweet corn. Spacing applied to sweet corn is 70 cm x 70 cm with the number of seeds as many as three seeds per hole. Spacing applied to corn that is 70 cm x 45 cm with the number of seeds as much as three seeds per hole. Planting distance of cayenne pepper is 40 cm x 25 cm, big red chili 40 cm x 25 cm, green kale 10 cm x 5 cm and watermelon 50 cm x 10 cm. The area of cayenne pepper is 2700 m^2, big red chili 900 m^2, green kale 30 m^2 and watermelon 400 m^2.

The land is first cleaned from the bush manual (cleared), after which it is planted without land preparation. Planting corn hole made using a cane, after which the seeds are inserted and applied for insecticides preventing pests in corn seeds. Maintenance of corn includes embroidery, weed and fertilizer control. Embroidering is done at 2 MST (weeks after planting). Weed control is done manually, by weeding and weeds out on the ground. Dominant weeds that grow on maize fields are weed ferns (ex: *Nephrolepis biserrata*). Fertilization consists of giving lime 5.49 farming ton ha^{-1} and NPK 300 kg ha^{-1} fertilizer with two applications. Provision of fertilizer with the system groove, ie fertilizer is applied in a groove made 7 cm from the row of planting, after that the grooves are closed again to prevent fertilizer evaporation.

Results and Discussion

Intercropping Sago, Fish, Livestock and Crops/Horticulture

The planted horticultural crops such as chilies (cayenne pepper and big red chili), green kale and watermelon. Chili production is well and suitable to developed on the peatland (Figure 1). Chili can be harvested at the three months after planting so that the people can get the income every three months from the sale of chili. The harvest time of green kale relatively faster than the others, that is three weeks after planting (Figure 2). If making sustainable cropping system arrangements, the people can sell their crops every day. Watermelon can start to harvest at the three months after planting, so they can sell every three months by arranging the sustainable cropping system. The advantages of watermelon post-harvest are easier because watermelon can last for more than a month (Figure 3).

At the eight weeks after planting (MST), vegetative observations were made on 10 random sample of sweet corn (Table 1). The average of plant height and leaf number respectively 76.90 cm and 6.10 sheet. If compared sweet corn growth on the peatland with on the mineral soil (optimum condition), the peatland is lower than mineral soil. Peat soil is a nutrient-poor soil, besides that many other limiting factors, affect plant growth and development, such as soil pH, water table, low soil porosity, and low saturation of the soil base.

The low soil pH in peatland needs maximum calcium oxide to increase soil pH level into neutral.

Figure 1. Chilies ready to harvest

Figure 2. Green kale

Figure 3. Watermelon

Table 1. Sweet corn growth at 8 MST

Sample	Height	Leaf number (sheet)
1	64	5
2	79	7
3	73	6
4	99	8
5	71	6
6	85	7
7	60	4
8	92	8
9	77	5
10	69	5
Mean	76.90	6.10
Standard deviation	12.25	1.37
Coefficient variability	15.93	22.46

Economic Revenue Result of Intercropping

a. Sweet corn

Land area = 800 m^2
Population = 1632 plants
1 kg = 4 cobs
Total cob production (kg) = (1632 x 2): 4 = 652.8 kg
Cob production is = 85%
Cob yield = 554.8 kg
Sweet corn price per kg = Rp 5000
Total revenue = Rp 2774400 (USD 201.73)

b. Corn

The maize cultivation system consists of 3 seeds per planting hole, with the aim to produce corn feed, baby corn and animal feed. Live fodder can be used for woof at the age of 8 MST, so the rupiah value is not calculated.

1. Baby corn

Harvest age of 70 days after planting
Land area = 3700 m^2
Population = 11746
1 kg = 16 cobs
Total cob production (kg) = 11746:16 = 734.12 kg
Cob production is = 85%
Cob yield = 624 kg
Baby corn price per kg = Rp 7000
Total revenue = Rp 4368000 (USD 317.60)

2. Corn kernel

Harvested at 85 days after planting
Land area = 3700 m^2
Population = 11746
Per cob = 80 g corn kernel
Cob production is = 85%
Total corn kernel (kg) = 9984.1 kg
Corn kernel price per kg = Rp 3000
Total revenue = 2995230 (USD 217.79)

c. Chili

Results from chili:
The total land area of 3600 m^2 of chili, comprising 2700 m^2 of cayenne chili and 900 m^2 of big red chili.

1. Cayenne chili

Land area = 2700 m^2
Plant spacing = 40 cm x 25 cm
Plant population = 27000
1st (50 kg), 2nd (70 kg), 3rd (80 kg) and 4th (40 kg) harvest
Total harvest = 240 kg
Cayenne chili price per kg = Rp 30000
Total revenue = Rp 7200000 (USD 523.52)

2. Big red chili

Land area = 900 m^2
Plant spacing = 40 cm x 25 cm
Plant population = 27.000
1st (10 kg), 2nd (30 kg), 3rd (20 kg) and 4th (15 kg) harvest
Total harvest = 75 kg
Big red chilli price per kg = Rp 35000
Total revenue = Rp 2625000 (USD 190.87)

d. Green Kale

Green kale harvested 25 days after planting and harvesting can be done 2 time period.
Land area = 30 m^2
Plant spacing = 5 cm x 10 cm
Plant population = 600
Production success is = 90%
Total 1 bunch of green kale = 4 stems
Production of green kale = 135 bunch
Green kale price per bunch = Rp 2000
Total income = Rp 2700000
Total revenue 2 period = Rp 5400000 (USD 392.64)

e. Watermelon

Land area = 400 m^2
Plant spacing = 50 cm x 10 cm
Population = 8000 plants
Total harvest = 70 kg
Watermelon price per kg = Rp 7000
Total revenue = Rp 4900000 (USD 356.29)

Livestock and Sago Waste

Livestock husbandry with integration model between cattle and agricultural crops are popular program nowadays. Cattle integration with sago plant is a new thing. Sago plant produces starch as food raw materials and pulp as waste. Sago waste that not been used will throw away and contaminate the adjacent environment, especially water environment and will kill water biota.

Sago waste still consists of starch and can be used as energy resources for cattle. Cattle can consume sago waste and reduce environmental pollution. Sago waste lack is low protein levels, low crude fiber, and low-fat level. Protein levels are a key factor for cattle's growth and progress beside energy levels. Feed ingredients for cattle can be made from local resources raw material. Source of local feed is:

1. Sago waste can be used as an energy source because of high-level starch. The result of proximate analyze from sago waste shows that level of carbohydrate is 90%, consist of 2% of crude fiber and 88% starch level. The protein level of sago waste is 2% and fat level 4%.
2. Trash fish have very high protein level, about 60% and can be used as protein, mineral, calcium, and phosphor source.
3. Rice bran as energy, fiber, and vitamin B source.
4. Vegetables, especially kale and leaf taro as a source of fiber, vitamin C, vitamin A, and vitamin B.
5. Ashes from sago bulk burning as a source of calcium, magnesium, and micro mineral.

Weakness from duck and cattle cultivation are water quality. Water at Tanjung Peranap Village is peatlands water. These water have acidity level 4.0 – 5.0 acid water make feed can't be digested, kill microbes in a cow stomach, and make micro mineral tied and unused. The micro-mineral can increase reproduction process. Lacks micro mineral disturb reproduction process.

A society that hasn't raised duck intensively doesn't have experience. The other weaknesses are low educational background. To handle those problems, supervising is held to increase their knowledge. Several strategies that can be done for village society to increase their income are:

1. Available land can be used for cattle and sago integration farming. Sago waste can use as cattle feed sources combining with trash fish. These activities will make land more productive.
2. Rainwater must be collected and used as a source of cattle drinking water. The other solution is reducing acidity level through water treatment process.
3. Trash fish and rice bran that abundant at some season must be preserved and stored for famine season.
4. Supervising for village society is needed because cattle husbandry in the cage is a new thing for them.

Duck feed that given is a mixture from sago waste (35%), trash fish (50%), rice bran (10%), vegetable (5%), and ashes (0.1%). Every duck fed as much 250 g day^{-1} for 2 times. Mixtures feed consists of 30 % protein. These levels are high and enough to fulfill nutrition. Trash fish are protein, calcium, and phosphor sources. Female duck needs high calcium to formed egg skin. Concentrate feed from the factory can be used as a substitute if there is no trash fish available. Sago waste will be used as energy source, and there is no problem with its availability.

The cattle will be given fermented sago waste (Figure 4). This is substitute feed for the cattle. Drinking water for a cow is peatlands water. Peatlands water has acidity level at 4.0 to 5.0. This is not a problem to the cattle. The cattel have rumen that has a function as feed fermentation place before chewed back (ruminate). Rumen fluid is acid, so acid water as drinking water is allowed as long as the water not contaminated by feces and urine.

Figure 4. Feed from sago waste

Sago waste utilization as cattle feed will decrease environmental pollution. Sago waste fermentation process do with simple technology that can be applied in village society. Sago waste fermented process not added probiotic and other carbohydrate sources as like molasses and drops of sugarcane. Sago waste just added with urea as a nitrogen source and ashes as mineral sources. Addition of each urea and ashes are about 1% of sago waste mass. Feed consist of sago waste given as much as 50 % of its natural feed.

Sago waste can be used as an energy source because still have high starch levels. The sago waste proximate analysis result shows that carbohydrate levels are 90%, consists of 2% crude fiber and 88% of starch. Protein level analysis result shows that protein and fat level are very low, 2% and 4%. This level of protein is too low to be used as feed. Sago waste that has been fermented can increase its protein level and increase productivity, especially weight gain.

Development of Catfish (Clarias sp.) in Peatlands

Rural development on peatland in this activity is applied one of them through the cultivation of fisheries. The abundance of water in peatlands is a potential for aquaculture activities. The acidic water of peat (reaching pH 4.0) becomes one of the obstacles to fish farming, not all fish survive and grow in the environment. Therefore, the adjustment of catfish in peat water and the provision of feed made from local as a substitution of plant feed become the main thing to consider the solution.

Initially, the pond for fish cultivation using a ground pond measuring 7 x 10 m long and with a depth of 1.5 m. The pond is made in the middle of peatland and around it is made a ditch as a waterway to enter. But problems arise because the farmers are still not able to understand the instructions well from technical experts related to the provision of water quality formula, feed and sorting caused by the size of the pond. Solutions to overcome these problems is to create a tarpaulin pond size 3 m x 4 m or smaller pool size. This is so that farmers are easy to apply with appropriate dosage.

Implementation of activities during July-December 2017 has shown a change better. This is seen in cultivated fish managed to experience weight gain and length. Movement of catfish agile forward and down. Fish treated with mastery succeeds so as to allow fish to adapt to the appropriate pH to grow. Parameters used as a measure of growth and development of catfish culture are water quality, growth (weight and length), sorting, fish health, reservoir and pond construction (water discharge hole).

One of the efforts to increase the oxygen demand in the waters, namely by the addition of water plants based on peat air. The next treatment for water quality in accordance with life is to start the provision of animal waste (ducks and cattle). The given dose is 10kg $(10m^2)^{-1}$. The dirt used does not affect the toxicity of the fish and is then fermented. Furthermore, the salt administration is intended to kill harmful pathogenic bacteria for fish.

Water quality that is not in accordance with the standard of cultivation (acid) becomes the main limiting factor in fish farming in peatlands. It needs a solution to eliminate or minimize the influence of the main limiting factors in peatlands. Efforts are made by making a reservoir or treatment pond or treatment to adjust the water conditions into water ready for cultivation.

The concept of this raw water is the catchment of rain in the hope that the water is not acidic and uses water from peatland which is pH sour. The pond is made up of two mutually similar sizes of length, width and height: 2 m, 1 m, and 1 m. The pool material used is a tarpaulin A 20 which is thicker and has a durability of more than 4 years.

The treatment provided in the reservoir pool includes the application of agricultural lime and the addition is gradually increased every 5 days until the water quality changes for the better according to fish farming standards. In addition, salt administration of 3 kg once a week until the pool water is ready for use. The formula is given in a homogenized way first into the next bucket inserted into the standard water pond gradually. Giving is done alternately from one pool to another pool.

In the fish farming activities, the main factor that has the most influence on the growth, health and quality of fish is the environment which in this case is water as a medium of cultivation. Therefore, water becomes the most important thing to be prepared. Including in this case water that in fact is sourced from peatlands. Peatlands are a source of acidity in water used in tarpaulin catfish farming ponds. Originally pH water cultivation reached 4 so that when imposed for the maintenance of fish it affects the death, the minimum damage to organs. While in the pH range 5 impact on damage to fish organs, minimum growth disturbance occurs somatic and gonads. At pH 6 the impact of growth disturbance of fish, the minimum lust eating downhill.

The challenge in this Tanjung Peranap Village is the absence of electricity so that the need for oxygen for fish becomes a limiting factor other than water for cultivation sources. Dissolved oxygen has a vital role to water aquaculture activities namely improving the quality of water and appetite, as well as chemical reactions in the waters. Automatic peat water management cannot rely on the supply of aerators, so a formula that includes physics, chemistry and biology is required in order for water to be suitable for cultivation. The water quality treatment formula that was administered was considered successful, as evidenced by the pH value at the beginning of fish stock 4.5 and after treatment on day 8 of water pH to 7.0 or normal.

Catfish is inserted in the condition of water protected from the sun, with use a barrier above the pool. The barrier used is a sago leaf placed over a pond. The fish fries are 3-4 cm in size with a density of 6.000 catfish fry $(12\ m^2)^{-1}$. Catfish are fish that tend to be active at night or called nocturnally. Feeding is not appropriate time active fish, it will have an impact on the lack of appetite. If outside the active period of catfish, then most likely fish to eat but not optimally absorbed by the fish's hull or eaten food will be spewed when the fish at the bottom of the pond. In these activities to fit Standard Operating Procedure (SOP) and growth can be better, then feeding time adjusted to catfish metabolic clock, from the best time of absorption to the lowest that is at: at 05.00, 21.00, 01.00 and 18.00 WIB (Western Indonesian Time). Fourth of those timing founded by research from various variables, which is an interval of stomach emptying, feed absorb enzyme optimization and speed to take food on the water surface.

Catfish sampling activity held every week. These activities are done in order to know progress and growth generally, finds out if there are troubles or incompatibility indication between water; feed, and fish qualities, and finds out exactness fish treatment; does fish feed already fulfill the requirement of fish seed growth.

Sampling performed the amount of fish at one-kilogram mass. Decreases in fish number mean fish have good growth, the same amount of increase in fish number mean some problem in the cultivation process.

Fish health determines life sustainability, if fish does not health then will susceptible to disease. A fish disease that occurs in peatlands caused by highly acidic water. These water will make fish skin scratch. Acidic water influence fish health quality. At the beginning of the activity, partially catfish skin somewhat peeling and the other parts are died with swollen gill.

Catfish sorted to decrease the probability of inequality growth. Catfish tend to cannibal and have different fast growth between the seed up to 30% of the population. This condition will make bigger catfish eat the smaller catfish and spend the feed faster than it should. Development of catfish seeds depends on catfish raising management (including fish sorted and water replacement).

Tarpaulin pool at peat lands doesn't have water resources as like inland. Peatlands do not have electric current so for water circulation depend on human strength. Water replacement performed with pipe usage around the pool and using the basket for discharge water. Discharge water from tarpaulin pool streamed to soil/land pool. Water replacement streamed from reservoir pool near from tarpaulin pool.

Addition of aquatic plants needed to assist reduction process of ammonia level at tarpaulin pool and land pool. Addition of aquatic plants amounted to 50% of water surface area to accelerate the ammoniac decomposition process. Aquatic plants can be functioned as natural feed for catfish at night. Type of aquatic plants that added to the pool is *Eichhornia crassipes*. These plants have proper morphology to absorb water.

Sago Farmer Institutional

Institutional in agriculture environment formed with the purpose to optimize farmer work in the structured organizational framework. The organizational framework needs to be equipped with work distribution that can be measured and evaluated. Organizational reinforcement at the research project is important to be implemented so introduction program can run simultaneously, effective, and optimal.

In order to reinforcement farmer organizational framework at Tanjung Peranap Village, reserch team assisted by four field agricultural instructor from Meranti islands. These activity beginning with formed farmer workgroup. These workgroups consist of thirty people, but as time goes by a decrease to sixteen people with gender ratio 1:1.

Approach to understanding rationalization that research activity will give economic benefit and good impact on the natural environment is needed. Society at Tanjung Peranap Village is the first party that affected if peatland is broken. The society expected to be independent through these research activities, as like independent to fulfill needs and from persuasion to the damaging environment.

Reinforcement of farmer organizational framework become important to maintain farmer trust and commitment, so the farmer will consistent with farming, became sustainability farmer and totally stop for damaging forest or mangrove.

Conclusion

The intercropping can be found people mindset for conducting integrated farming system and a long time can be increased economic people. It has been changed people mindset in a framework that mangrove destroys become an integrated farming system, until can be decreased environmental damage. The people economic income from selling cayenne chili, big red chili, sweet corn, baby corn, corn kernel, green kale and watermelon is Rp 7200000 (USD 523.52), Rp 2625000 (USD 190.87), Rp 2774400 (USD 201.73), Rp 4368000 (USD 317.60), Rp 2995230 (USD 217.79), Rp 5400000 (USD 217.79) and Rp 4900000 (USD 356.29) respectively. The founding organization farmer system based on sago palm in

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