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International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Biotechnic of Silvoaquaculture in Indramayu Regency

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Abstract

Silvoaquaculture ponds were developed as an alternative to overcome the problem of mangrove conservation, especially due to the conversion of mangrove forest into ponds. Silvoaquaculture pond in Indramayu Regency have three type, there are Empang Parit Pond, Komplangan Pond, and Kao-kao Pond. Silvoaquaculture pond has some adventages for pond and coastal environment. These adventages were such as safe pond from wind, tide, wave, and so treatment of water quality from pollutants. Silvoaquaculture has negative impact for aquaculture too, such as high numbers of predators, difficult to feed treatment, difficult for havest fish, etc. Fish cultivation in the Kao-kao pond has followed the good methods of fish farming, such as pond drying, soil management, fertilization, seed adaptation, stocking time, feeding frequency, and water changes. Komplangan and empang parit ponds have followed good cultivation techniques in the fields of fertilization, stocking time, feeding frequency, and water changes.

Keywords: biotechnic; silvoaquaculture; mangrove; milkfish; conservation.

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1. Introduction

Mangrove is one of the coastal ecosystems that have important ecological and economic functions. Mangrove conservation is an effort to preserve the important functions of mangroves to support the coastal communities welfare for sustainable [1]. The existence of mangrove ecosystems in Indonesia has covering 3,112,989 hectares (22.6% of mangroves in the world)[2] shows the sustainability of Indonesia's mangroves will also provide services for the preservation of world fisheries resources. One threat to the preservation of mangroves is the conversion of mangrove habitats to aquaculture ponds [3]. Mangrove habitat provides a substrate that is rich in nutrients [4], making it ideal for aquaculture ponds. Fish farming business have provides high economic benefits [5], make people continue to convert mangrove ecosystems into aquaculture ponds. The development of aquaculture ponds in mangrove habitats will reduce the extent of mangroves and will threaten the sustainability of resources in coastal areas. Silvoaquaculture ponds are type of ponds that integrate mangrove and ponds for aquaculture [6]. The silvoakuaculture pond model provides space for mangrove conservation, while providing opportunities for the community to obtain economic value from fish farming. This pond model becomes a win-win solution between mangrove conservation and the development of aquaculture in coastal areas[7]. Coastal people communities in Indramayu Regency have developed silvoaquaculture. There are three types of silvoaqualture ponds, namely *Empang Parit*, *Komplangan*, and *Kao-kao*. The aquaculture commodity that it cultivated in silvoaquaculture ponds is milkfish[8]. The existence of silvoaquaculture ponds needs to be maintained, because it will also take care of mangroves which are important to exist in coastal areas. A silvoaquaculture biotechnical study is important to find out the cultivation techniques developed by fish farmers for this pond. Silvoaquaculture biotechnics are traditional and have differences with the proper fish culture techniques[9]. The different characteristics between ordinary ponds and silvoaquaculture farms allows there to be peculiarities in silvoakuaculture farms. The results of the study will be able to know the advantages and disadvantages of fish farming techniques in this pond, so that evaluation and improvement can be done to improve production performance. A good aquaculture biotechnics will produce high fish production from silvoakuaculture ponds so that it can attract the interest of the community to convert fish ponds into silvoaquaculture farms.

2. Methods

2.1. Data Collection Technique

This research was conducted in May until August 2019 in the Karangsong, Brondong, and Pabean Ilir villages. Data collection using questionnaires for 100 respondents. Determination of the respondents was done by purposive sampling with the aim of getting fish farmers in silvoaquaculture ponds. Data collected includes pond preparation (pond draining, soil treatment, fertilization, liming, and water filling); seed management (seed density, seed adaptation, and seed stocking); feed management (feeding and feeding rate); and water quality management (water change and second fertilization).

2.2. Data Processing Techniques

Data is processed using data tabulation techniques. All observational data are grouped according to the type of silvoaquaculture ponds, namely empang parit ponds, komplangan ponds, and kao-kao ponds. The existence of

biotechnical components in silvoaquaculture will be processed based on the percentage of its implementation by fish farmers.

2.3. Data Analysis Techniques

The research data were analyzed using a qualitative data analysis approach. Each component of biotechnics in silvoaquaculture ponds was analyzed based on the criteria for milkfish farming biotechnics referring to some literature on good milkfish biotechnics..

3. Results and Discussion

3.1. General Condition of Silvoaquaculture Pond in Indramayu Regency

Silvoaquaculture ponds in Indramayu Regency have three type, there are Empang Parit Pond, Komplangan Pond, and Kao-kao Pond (Table 1). Empang parit ponds has found in Karangsong Village. Komplangan pond located in Brondong and Pabean Ilir Villages. Kao-kao pond has spread in Karangsong, Brondong, and Pabean Ilir Villages. Empang parit ponds are silvoaquaculture ponds where the mangrove forest is in the middle of the pond (Figure 1a). Komplangan ponds have mangroves forest on one side of the pond (Figure 1b). Finally, mangrove trees in the kao-kao pond have spread outside the pond (Figure 1c). Empang parit ponds and komplangan ponds have mangrove areas higher than kao-kao ponds.

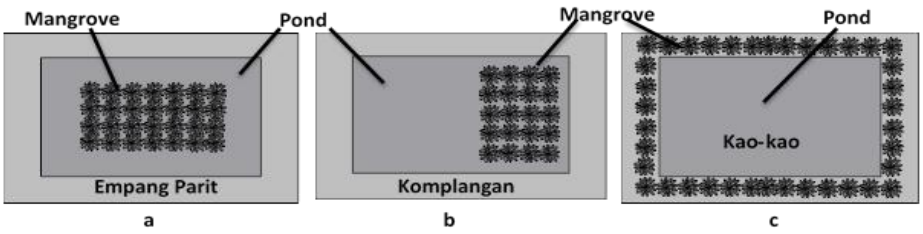

Figure 1: Types of Silvoaquaculture Ponds

Total areas of each type of silvoaquaculture ponds has different. Kao-kao ponds (average 2,36 Ha) have higher area than other type pond of silvoaquaculture (empang parit pond (average 1,38 Ha) and komplangan pond (average 1,47 Ha)). Pond area is a variable that determines the value of production [10], but highest of total area has some problem of silvoaquaculture management, especially for feeding treatment. Silvoaquaculture pond has some advantages for ponds and coastal environment. These advantages were such as safe pond from the wind, tide, wave (mangroves protect the beach from erosion [11]), and so treatment of water quality from pollutants (mangrove plants are able to become water pollution biofilter [12]). Silvoaquaculture has negative impact for aquaculture too, such as poison from the tree and substrate mangrove [13], many fish predators live in mangrove[14], difficult to feed treatment, difficult for harvest fish, etc.

3.2. Biotechnic Characteristics of Silvoakuakultur Pond

The preparation activities for milkfish cultivation to complete pond management includes soil management, liming, fertilizing, and water filling [15][16]. The farmers of kao-kao ponds have carried out all preparations for

milkfish culture (57.89% -84.21%), but in the most of empang parit ponds and komplangan ponds (60-86%) they did not do this activity (Table 2). The characteristics of the site of empang parit ponds and komplangan ponds close to the beach and relatively inundated, making it difficult to drain, soil treatment, and liming. While, farmers of all types of silvoaquaculture ponds have carried out fertilizing and replenishing water activities.

Table 1: Type, location, and area of silvoaquaculture pond in Indramayu Regency

Type of Pond	Location	Area of silvoaquaculture pond (Ha)		
		Average	Min	Max
Empang Parit	Karangsong	1,38	1,00	2,50
Komplangan	Brondong and Pabean Ilir	1,47	1,00	2,00
Kao-kao	Karangsong, Brondong, and Pabean Ilir	2,36	1,00	4,50

Table 2: Pond draining, soil treatment, fertilizing, and water filling activities

Tipe Tambak	Pond Draining (%)		Soil Treatment (%)		Fertilization (%)		Water Filling (%)	
	Yes	No	Yes	No	Yes	No	Pump	Tide
Empang Parit	38,46	61,54	23,08	76,92	15,38	84,62	23,08	76,92
Komplangan	13,33	86,67	40,00	60,00	26,67	73,33	40,00	60,00
Kao-kao	73,68	26,32	84,21	15,79	57,89	42,11	78,95	21,05

Pond draining, soil treatment and fertilization activities will support the success of milkfish farming. Basic soil preparation (drying and reversal of soil) aims to oxidize organic matter and sulfuric acid, liming aims to increase the acidity of the soil, and fertilization aims to increase the availability of nutrients to grow natural food [16]. The absence of this activity in most of the management of empang ponds and komplangan pond will have an impact on the lack of production of these two types of ponds.. Liming activity in silvoaquaculture ponds are important to support fish production. Agricultural limestone may be applied to aquaculture ponds to increase total alkalinity[17]. Treatment pond with the highest liming amount presented the highest concentrations total phosphorous and tended to decrease ammonia levels [18,19]., CO2, and nitrite [19]. Common uses of sodium bicarbonate: 1) removing carbon dioxide, 2) decreasing high pH, and 3) removing off flavors [20]. Other important benefits of liming: 1) Liming may enhance the effect of fertilization. 2) Liming helps prevent wide swings in pH. 3) Liming also adds calcium and magnesium, which are important in animal physiology[21]. Water filling for silvoaquaculture ponds has used a pump machine or tidal mechanism. Fish farmers of empang parit and komplangan ponds have used tidal mechanism to fill water in to pond. The site conditions of empang parit and komplangan ponds have relatively inundated so that the fills water by tidal mechanism is most effective. Kao-kao ponds have located far from the beach, so they needs a pumping machine to fill water into the pond.

Table 3: The existence of milkfish seed management in silvoakuaculture ponds

Pond Tipe	Fish Fry Adaptation (%)		Stocking time (%)		Density stocking (idv/Ha)		
	Ada	Tidak ada	Pagi	Sore	Rataan	Min	Maks
Empang Parit	15,38 %	84,62 %	30,77 %	69,23 %	5533	4000	8000
Komplangan	46,67 %	53,33 %	26,67 %	73,33 %	5467	2000	10000
Kao-kao	73,68 %	26,32 %	47,37 %	52,63 %	4407	1111	10000

Steps of activities that important in the operational stages of milkfish cultivation include fish fry management (adaptation, stocking time, and stocking density); feeding (frequency and percentage of feed), water change, and re-fertilization[15,16]. Time stocking of milkfish fry on the all silvoquaculture ponds is morning or afternoon. Morning is the most appropriate time to stock fish fry, because in morning time water temperature is low so it reduces fish stress and so can reduce the mortality rate [22]. Fish fry may be stocked in the afternoon when the water temperature has dropped. Few fish farmers of empang parit and komplangan ponds (15.38% to 46,67%) adapted fish fry before cultured them (Table 2). It's different from most kao-kao farmers have adapted fish fry (73,68%). The adaptation principle is to adapt fish fry to new environmental conditions (temperature, salinity, pH, etc. [22]) slowly so that they are able to survive in the silvoaquaculture pond. Fish fry adaptation techniques in silvoaquaculture ponds include floating plastic bags that contain fish fry on the surface of the pond water, then opening it to put pond water little by little in a plastic bag, so that water mix perfectly. In addition to stocking time and seed adaptation, fish farmers must pay attention to stocking density. Stocking density is an important factor of fish farming, it has a direct effect on growth and survival, which affects aquaculture production[23]. In principle, stocking density must adjust to the carrying capacity of the pond. High density stock increases the risk of death and slow growth, this is impact of competition in food, home range, and dissolved oxygen. A good milkfish density is 5 fish / m2[22]. All silvoaquaculture ponds in this study have low stocking density (Table 3), so that the carrying capacity of the pond environment will be able to support the sustainability and growth of milkfish.

Table 4: Feeding on silvoaquaculture ponds

Pond types	Feeding Frequency		Feeding Rate		
	Twice/day	Once/day	Average	Min	Max
Empang Parit	92,31 %	7,69 %	2,86 %	1,97 %	4,93 %
Komplangan	93,33 %	6,67 %	3,55 %	1,97 %	7,8 %
Kao-kao	78,95 %	21,05 %	3,40 %	1,97 %	7,8 %

The aspects related to feed in milkfish culture are feeding frequency and feeding rate. Feeding frequency is relatively the same in all types of silvoaquaculture ponds, which it is twice a day. Empang parit ponds have smallest percentage of feeding rate (1.97% to 4.93% and average 2.86%), while in komplangan ponds and kao-kao ponds are higher (1.97% to 7.88% and average of 3.55 and 3.40%) (Table 4). Malik (2010) uses feeding twice a day and feeding rate 3-5% for milkfish culture. The existence of natural food in silvoakuaculture ponds is sufficiently available, so that by feeding 1.97% it can support production. Statistical analysis showed that

there was no correlation between feeding and growth of milkfish biomass that was maintained in empang parit ponds and kao-kao ponds, while in Komplangan ponds there was a positive relationship between feeding and biomass growth. Manufactured feeds allow much greater production than possible with fertilizers, and feeding has become more common than pond fertilization. However, fertilization remains an important practice for smallholder farmers in developing countries[24]. Feeding activity may be attention to feed quality, and a good fish feed must be contains enough protein energy because it will affect the level of consumption, growth, and feed efficiency[25].

Table 5: Water quality management in silvoaquaculture ponds

Pond types	Water exchange (%)		Fertilization (%)	
	Yes	No	Yes	No
Empang Parit	92,31 %	7,69 %	69,23 %	30,77 %
Komplangan	100,00 %	0,00 %	93,33 %	6,67 %
Kao-kao	100,00 %	0,00 %	36,84 %	63,16 %

Water quality greatly determines the production of milkfish culture, so water quality management becomes important in silvoaquaculture. Water exchange and fertilization are two activities of water quality treatment to stay good water quality in the pond. New water intake with good quality replace the old water with poor quality. Advantage of water exchange for pond aquaculture was being able to control the water quality parameters has best for fish health [26]. The farmers of all type silvoaquaculture ponds had water exchange (93,31%-100%) (Table 5). Fertilization is useful for maintaining the availability of sufficient nutrients in the pond. Nutrients in pond waters play a role in the growth of natural food. Fertilizers has applied to aquaculture ponds to increase fish production. Pond fertilization increases concentrations nutrient in water (nitrogen, phosphorus and other nutrients) to stimulate phytoplankton and algal photosynthesis as a food web base in fish culture [24]. Most the farmers of empang parit ponds (63.23%) and komplangan ponds (93.33%) did the second fertilization, while in the Kao-kao pond only 36.84% of the fish farmers did the second fertilization (Table 5). Statistical analysis for fertilization and production of milkfish has no relation fertilization and production. Mangrove environment has rich of nutrients[27], o pond water enough nutrient without fertilization. Mangroves have a role as producers of organic nutrients [28], mainly in the form of leaf litter, the main source of organic matter in the ecosystem [29]. The highest average value based on partial group showed that R. mucronata had the highest nitrogen accumulation at 0.56 ± 0.07 %; for phosphorus, the mixed species pond (62.02 ± 7.84 mg/kg); and for organic matter, R. mucronata (2.41 ± 0.39 %)[30]. Too much Fertilization has high risk to milkfish culture, because nutrient enrichment of the coastal zone places intense pressure on marine communities[31].

4. Conclusions

Silvoaquaculture in Indramayu Regency has 3 types, namely empang parit ponds, komplangan ponds, and kao-kao ponds. The process of draining ponds, soil treatments, and basic fertilization cannot be carried out in most empang parit ponds and komplangan ponds because most of these ponds are relatively always inundated. Fish fry adaptation is not carried out in most ponds in empang parit ponds and komplangan ponds. Milkfish stocking

densities in most silvoaquaculture ponds are relatively low. Silvoaquaculture pond biotechnics that meets the criteria for good fish culture are replenishing water, stocking time, and feeding frequency. Feeding rate is mostly low, but the support of mangrove nutrients provides enough natural feed.

Acknowledgements

Authors would like to thank KEMENRISTEKDIKTI for funding this research (PTUPT Research Programme), to LPPM and Department of Fisheries Universitas Djuanda Bogor for support project..

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