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Prihantoko KE
Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University Professor Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Ramadhan P
Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University Professor Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Kurohman F
Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University Professor Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Suherman A
Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University Professor Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Fitriani A
Alumnus Master Programme of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, Diponegoro University, Prof. Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Setiyanto I
Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University Professor Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Corresponding Author:
Prihantoko KE
Department of Capture Fisheries, Faculty of Fisheries and Marine Sciences, Diponegoro University Professor Jacub Rais ST., Tembalang, Semarang 50275, Central Java, Indonesia

Specifications and net construction of tilapia nets in Rawa Pening Lake

Prihantoko KE, Ramadhan P, Kurohman F, Suherman A, Fitriani A and Setiyanto I

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Abstract
Rawa Pening is one of the inland waters located in Central Java Province and is included in FMA 434. Rawa Pening is used by local communities for fishing activities using Tilapia nets. The objectives studies are to analyze the specifications and characteristics of the construction of Tilapia nets in Rawa Pening waters. In situ measurements were carried out on Tilapia nets from 29 fishermen. Technical calculations of Tilapia net size data were carried out to obtain hanging ratio, net area, net height, and shortening values. The research results show that the Tilapia net has mesh size variants of 2.5 inches, 3 inches, and 3.5 inches. The shape of the net is rectangular with a total net length of 50-100 m, the hanging ratio value is in the range 0.22-0.75, the net area is between 33.48-90.13 m^2, the net height is 0.65-0.93 m and the shortening value ranges from 52.28% - 70.40%. The construction of the Tilapia net only consists of the head rope, net body, and weights. During operation, the Tilapia net utilizes water hyacinth as a float for the net and uses bamboo stakes to form the position for installing the net in the water.

Keywords: Freshwater, gillnet, hanging ratio, mesh size

Introduction
Rawa Pening is an inland water that is administratively part of the Semarang Regency area. Rawa Pening is one of the public waters that is a national priority lake rescue program area (Presidential decree No. 60 of 2021). In national fisheries management, Rawa Pening is included in the Republic of Indonesia State Fisheries Management Area (FMA) 434. The coverage area of FMA 434 consists of the north-central part of Java Island, the Karimunjawa Islands, and Bawean Island (MMAF regulation No. 9 of 2020). Rawa Pening fishery production achievements in 2021 are 1,263,752 kg with a production value of IDR 22,144,805,000.-. This achievement is supported by the number of fishing gear operating in Rawa Pening of 2,725 units. The fishing gear used by Rawa Pening fishermen is fixed gill nets (44, 04%) [1]. Fishing gear used by Rawa Pening fishermen includes gill net, branjang (lift net), cast net, traps (icir), spears, and fishing rods [2].

Tilapia net is the term for fishing gear used by local fishermen in Rawa Pening for gill net. The shape form of the gill net is rectangular. Gill net is made from sheet netting is equipped with buoy components and a sinker, and is installed in an upright position or stretched to the depth of the water and stretches along the water [3-5]. In general, gill nets are environmentally friendly fishing tools based on the criteria indicators of the Code of Conduct for Responsible Fisheries (CCRF) [6]. The Gill net fishing method is to block the flow of the fish so that the fish gets entangled or gilled in the operculum or around the operculum [4-5]. Based on the classification of fishing gear, the Gill Nets and Entangling Nets group consists of 6 (six) types [7-8]. The types of gill nets are fixed gill nets (set gillnets/anchored), drift gill nets (drift nets), encircling gill nets, fixed gill nets (on stakes), layered gill nets (trammel nets), and combination gill nets - trammels nets. Fishing gear in Rawa Pening waters has been researched on various topics. Some of these studies include fishing techniques using branjang (lift net) fishing gear [9], fish caught in different nets of mesh size [10], economic analysis of the gill net business [11], the use of bait in kalar fishing (line fishing) [12], catch results and catch rates on bubu (trap) [13], and fish caught by widik fishing gear [14]. Apart from that, there is also

research on the introduction of folding traps and dome traps [15], the use of bait in folding dome traps [16-17], and the use of bait in folding box traps [18]. These research topics indicate that information regarding the technical characteristics of Tilapia nets is still limited. Several parameters that can be used to determine environmentally friendly fishing activities are the method of operating fishing gear, materials and construction of fishing gear, location of fishing areas, and availability of fish resources [19].

This research was conducted to analyze the specifications and characteristics of the construction of Tilapia nets operated in Rawa Pening waters. This research will support fishing management policy-making for the sustainability of fish resources in Rawa Pening waters. Technical information regarding fishing gear in public waters can be used as data in determining fishing gear regulations in fishing management.

Materials and Methods

The research was conducted in the Tambakrejo Village area, Ambarawa District, Semarang Regency. This location is one of the fishermen's fishing bases in the Rawa Pening Waters area. The research data consists of specifications for Tilapia nets with mesh sizes of 2.5 inches, 3 inches, and 3.5 inches. Data collection was carried out by in situ measurements using scale measuring instruments. The Tilapia net samples measured came from 29 fishermen at the research location. The data collection process was carried out during November 2022. The data from the Tilapia net measurements were then analyzed to achieve the research objectives. Data analysis carried out in this research includes analysis of component type and material specifications, design and construction, calculation of hanging ratio, calculation of net surface area and net height, as well as calculation of the ratio of mesh size and thread diameter and calculation of the ratio of weight distance to installed net height. Visualization of construction drawings of fishing gear is carried out by referring to the Catalog of Fishing Gears in Indonesia [5]. The following are the calculation formulas carried out in data analysis.

Hanging ratio (E) [4, 20-22]

$$E = \frac{L}{L_0}$$

Where L is the length of the rope on which the net is hung (m) and L_0 is the length of the stretched net that is hung (m)

Surface area of net (*S*) [21-22]

$$S = E \times \sqrt{1 - E^2} \times L \times H \times a^2$$

Where S is the surface area of the net (m^2), E is the hanging ratio (horizontal), L is the number of net meshes (horizontal), H is the number of upright meshes, and a^2 is the square of the stretched mesh size (m^2)

Hight of net (h) [21-22]

$$h = high\ strecth\ mesh \times \sqrt{1 - E^2}$$

Where h is the height of the net (m), E is the hanging ratio (horizontal)

Shortening (S) [23]

$$S = \frac{L - L_a}{L}$$

Where S is shortening, L is the length of the net in the horizontal direction, namely the total number of meshes in the horizontal direction multiplied by the mesh size (m) and L_a is the length of the buoy rope or length of the head rope (m)

Result and Discussion

Characteristics of Fish Caught in Gill nets

Gill nets are a type of passive fishing gear with the target of catching fish that are actively moving in the water [24]. The operation of gill nets is carried out by placing them stretched perpendicularly in the water [20]. This operating pattern is in line with the principles of the Gill Net fishing method, namely blocking fish or blocking the movement of fish in the waters. Fish are caught in gill nets because they get entangled in their gills, their whole body twists, or they get caught in the fish's fins [25-26]. Fish that are entangled in nets will spend their energy trying to escape until they finally become weak and die [27]. The method for catching fish in gill nets consists of [20, 22, 23, 28].

1. **Snagged:** the fish is caught because it is entangled in the head in front of the gills (operculum).
2. **Gilled:** the fish is caught because it is entangled right in the gills (operculum).
3. **Wedged:** the fish is caught because it is entangled in the head behind the gills (operculum) or in the dorsal fin.
4. **Entangled:** the fish is caught because it is entangled in the net.

Successful fishing in gill nets requires design and construction that suits the characteristics of the fish target. Making gill nets requires paying attention to the type of net material, hanging ratio value, shortening value, net height, and mesh size [3]. These parameters are an indication of the strength of the Gill Net in catching fish and minimizing fish escapes. This is necessary so that the Gill Net can carry out the fishing mechanism by entangling fish or spinning fish. The specifications and construction characteristics of gill nets are important knowledge because they are an indication of the gill net's ability to catch fish.

The operculum is part of the fish's body that is the target for fish to become gilled/entangled in gill nets [5, 23, 29]. The location of the operculum is behind the gills and before the maximum body girth [30]. The size of the fish operculum has geometric similarities to the mesh, so the size of the fish operculum is a parameter in determining mesh size [31]. Mesh size is an important variable in fishing using gill nets. In general, the mesh size is adjusted to the average size of the fish targeted for fishing [32]. Apart from the operculum size, the mesh size can also be determined based on the maximum body circumference of the target fish [20]. The size of fish caught in gill nets is influenced by the mesh size used [33]. Tilapia nets in Rawa Pening waters consist of 3 (three) mesh sizes, namely 2.5 inches, 3 inches, and 3.5 inches. Furthermore, the construction characteristics and technical size specifications of Tilapia Nets will be described in the next discussion.

Construction Characteristics of Tilapia nets

Gill nets are a type of fishing gear made from net sheets with

a rectangular main shape [3, 4, 34]. Gill nets are formed from components that are assembled, so they can be operated in waters and the fishing mechanism can effectively catch fish. The components that construct a gill net consist of a float, float line, upper and lower head ropes, upper and lower selvedge hanging ropes (upper bolch line and under bolch line), upper and lower selvedge (upper selvedge and under selvedge), net body (main net), sinker line and sinker [20]. The components that make up a gill net consist of a float, head rope, upper selvedge, net body, lower selvedge, sideline, rope, lower selvedge line, sinker and one net pis [23]. In general, the main components of gill nets can be identified as consisting of ropes, floats, net body, and sinker.

Tilapia nets operated in the waters of Rawa Pening are rectangular. This type of fishing gear belongs to the gill net group [8]. The components that construct Tilapia nets are similar to the components that construct gill nets. However, several components are not found in Tilapia nets, namely floats, float lines, upper and lower selvedge, bottom ropes, and sinker line. The results of the identification of the construction of the Tilapia net show that the main components consist of the head rope, net body, and sinker (Fig. 1). Apart from that, there are other components in the Tilapia net which are used when operating in waters. The other components are water hyacinth and bamboo stakes. The differentiating components between Tilapia nets and gill nets in general are:

1. Tilapia nets only use a head rope and do not use the bottom rope.
2. Tilapia nets do not use float lines or sinker lines,
3. Tilapia nets do not use floats,
4. Tilapia nets use water hyacinth components and bamboo stakes to install nets in water.

The two important components of Tilapia net that form a net in the water column are bamboo stakes and water hyacinth. These two components assist in net positioning stretch perpendicularly in the water. These two components are indications that float isn't used in Tilapia net. Float is one of the gill net components which function as buoyancy of net in water [23]. The use of bamboo stakes and water hyacinth makes the float component unnecessary because the buoyancy function has been replaced by these two components. Gill net construction without floats and bottom ropes is also found in the waters of Lake Kerinci [35]. Gill nets without bottom rope can be found in the Jati Gede Reservoir (West Java) [36].

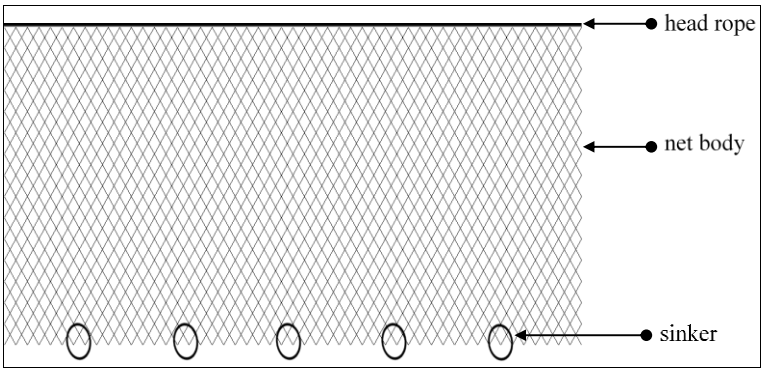

Fig 1: Illustration of Tilapia net construction

Technical Size Specifications of Tilapia nets

In Table 1, the sizes of the various components that construct the Tilapia net are presented for each type of mesh size. Tilapia Net measurement in the field shows that the three mesh sizes are known to have a relatively uniform net length, namely 50-100 m. The type of yarn material used as the head rope is Polyamide (PA) monofilament with a diameter ranging from 0.20-0.27 mm. This type of PA monofilament yarn material for use as a head rope is also found in gill nets operated in Lake Singkarak [37]. However, in general, the type of head rope material used in gill nets is Polyethylene (PE) [38, 39, 40]. The type of PE material has the physical advantages of floating in water, not absorbing water, good friction resistance, and flexibility [22]. The type of PA material has the physical advantages of sinking in water, good breaking strength and friction resistance, good elongation, and flexibility [23]. The use of PE material is generally influenced by the size of the net and the location where the net is operated. When operating gill nets in marine waters, it is known that there are higher current and wave conditions compared to inland waters (freshwater). Apart from that, the density of seawater and freshwater is also different. Swamp or lake waters tend to have low current and wave patterns, so the use of PE ropes is not necessary.

The type of net body material used in Tilapia nets is PA monofilament. The diameter of the yarn used ranges from 0.02-0.16 mm. The number of horizontal mesh in Tilapia nets is around 1,150-3,800 mesh. Among the three mesh sizes, the number of horizontal mesh in the 3.5-inch Tilapia net is known to be the lowest among the others, namely 1,150-3,000 mesh. The number of vertical mesh for the three Tilapia nets is in the range of 10-12 mesh with the installed net height being 65-93 cm.

Table 1: Technical Size Specifications of Tilapia nets in Rawa Pening Waters

No.	Fishing Gear Components		Units	Tilapia net 2.5 inch			Tilapia net 3 inch			Tilapia net 3.5 inch		
				Range	Average	Std.	Range	Average	Std.	Range	Average	Std.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Head rope	Length	m	50,00 - 100,00	61,11	17,64	50,00 - 100,00	67,50	20,94	50,00 - 100,00	78,75	24,75
2		Diameter	mm	0,20 - 0,25	0,22	0,02	0,20 - 0,26	0,22	0,02	0,21 - 0,27	0,24	0,02
3		Material		PA *monofilament*			PA *monofilament*			PA *monofilament*		
4	Net body	Mesh size	inch	2,50			3,00			3,50		
5		Diameter of yarn	mm	0,02 - 0,16	0,05	0,04	0,02 - 0,06	0,04	0,02	0,02 - 0,12	0,05	0,03

6		Horizontal mesh	mesh	1.650,00 - 3.800,00	2.813,33	615,00	1.500,00 - 3.400,00	2.454,17	585,31	1.150,00 - 3.000,00	2.053,75	746,97
7		Vertical mesh	mesh	12,00	12,00		10,00 - 12,00	11,58	0,67	10,00 - 12,00	10,75	0,71
8		High of net	m	0,67 - 0,74	0,71	0,02	0,70 - 0,89	0,82	0,05	0,65 - 0,93	0,84	0,09
9		Material		PA *monofilament*			PA *monofilament*			PA *monofilament*		
10	Sinker	Shape/form		ring			ring			ring		
11		Material		*Cuprum* (Cu)			*Cuprum* (Cu)			*Cuprum* (Cu)		
12		Number of sinker	pieces	12,00 - 125,00	79,22	32,01	42,00 - 120,00	86,92	19,39	34,00 - 102,00	75,25	19,36
13		Diameter	mm	61,25 - 83,75	70,86	7,16	66,25 - 86,75	78,92	5,39	81,25-104,00	86,72	7,28
14		Length	mm	236,00 - 261,00	243,94	7,62	241,00 - 261,50	251,46	5,66	252,50 - 274,25	260,84	6,17
15		Thickness	mm	2,25 - 5,75	3,67	1,40	2,25 - 4,75	3,40	1,07	2,25 - 5,50	4,19	1,17
16		Distance between sinker	mm	360,00 - 1160,00	821,67	248,80	640,00 - 1410,00	888,33	259,99	770,00 - 1800,00	1.076,25	347,11
17		Number of mesh between sinker	mesh	7,00 - 103,00	31,78	27,58	17,00 - 35,00	6,08	5,47	10,00 - 35,00	22,25	8,55
18		Number of mesh in the sinker	mesh	3,00 - 8,00	5,44	1,51	1,00 - 22,00	6,08	5,47	3,00 - 6,00	5,00	1,07
19		Weight	gram/pieces	3,00 - 4,00	3,33	0,50	2,00 - 5,00	3,92	0,79	5,00	5,00	
20		Total weight of sinker	gram	36,00 - 375,00	262,67	99,92	168,00 - 500,00	338,67	100,84	170,00 - 510,00	376,25	96,80
21	Others component	Water hyacinth	pieces	4,00 - 25,00	8,00	6,71	4,00 - 20,00	7,83	4,71	4,00 - 13,00	6,75	3,65
22		High bamboo stake	cm	249,25 - 418,00	341,43	70,64	80,50 - 418,00	246,39	103,82	80,50 - 249,25	173,38	68,75
23		Number of bamboo stakes	pieces	2,00 - 5,00			2,00 - 5,00			2,00 - 5,00		
24		Distance of bamboo stake installation	m	12,50 - 25,00	15,28	4,41	12,50-25,00	16,88	5,24	12,50 - 25,00	19,69	6,19

Tilapia nets in Rawa Pening waters consist of 3 (three) mesh sizes, namely 2.5 inches, 3 inches, and 3.5 inches. The size of the mesh in gill nets used in lakes and rivers varies depending on the type of fish being caught. Using nets that match the size characteristics of the target fish will ensure that fishing is carried out responsibly and sustainably. Table 2 presents various mesh sizes of gill nets operated in fresh waters. The mesh size of the Tilapia nets operated in Rawa Pening is a normal mesh size which is often found in other freshwater locations as presented in Table 2. The effective mesh size for Tilapia is 2.5 inches [41]. In gill nets, the size of the mesh affects the number and size of fish caught [42, 43]. The size of the net mesh is designed based on the type of fish species that is the target of catching a certain size [44]. Mesh size has a significant effect on the composition of fish caught and fishing efficiency [45]. The types of fish that are targeted for catching in public waters include Tilapia fish [2, 9], Nilem fish [2], Mujahir fish [14, 46], Betutu fish [13, 15, 17], snakehead fish [11, 12, 46], Wader fish [11].

Table 2: Various mesh sizes of gill nets operated in inland waters (freshwater)

Location	Mesh size (Inchi)
Rawa Pening Lake [2]	2", 3,25"
Rawa Pening Lake [11]	¾", 3"
Cacaban Reservoir [41]	2,5", 3"
Sermo Reservoir [47]	2"
Sermo Reservoir [67]	3", 4"
Musi River [68]	2", 3"
Cacaban Reservoir [69]	2", 3"
Jatiluhur Reservoir [70]	1", 1,5", 2", 2,5", 3", 3,5", 4"
Batur Lake [71]	0,5", 1,0", 1,5", 2,0", 2,5", 3,0"
Cirata Reservoir [72]	1", 1,5", 2", 2,5", 3", 3,5"

The size of fish caught in gill nets is influenced by the size of the net mesh. The larger the size of the mesh opening, the larger the size of the fish caught [47]. The size of Tilapia fish caught in gill nets with a 3-inch mesh size is larger than that of a 2-inch mesh size [41]. Tilapia dominate the catch at a mesh size of 3 inches [48-50]. According to local fishermen Rawa Pening, the name Tilapia net is influenced by the dominance of Tilapia fish which are often caught in these nets. Based on the indicators of mesh size and the dominant type of fish caught, the Tilapia net is appropriate with the terms of gill net. The mesh size needs to be adjusted to the body shape of the fish which is the main target for fishing, intending to minimize bycatch so that it is more selective [51].

The sinker component of the gill net has the function of providing a sinking load when installed in water. Apart from that, the sinker also helps form the net in the water so that it remains in an upright position when installed. Cu (Cuprum) is a type of sinker material commonly used in gill nets [20, 23]. The sinker of the Tilapia nets that operate in the Rawa Pening have a particular shape that is different from the types of sinker generally used in gill nets. Tilapia net uses Cu material in a ring shape as a sinker (Fig. 3). The sinker weight used is 2-5 grams/piece with the number of sinkers per net unit between 12-125 pieces. So the total weight of the sinker used per net unit ranges from 36-510 grams. The diameter of the ring used is 61.25-104.00 mm. It is known that the larger the mesh size, the diameter of the sinker ring will increase.

Other components used in the construction of Tilapia nets are water hyacinth and bamboo. These two components are used to shape the position of the net so that it remains upright when operated in water. The amount of water hyacinth used varies. This is because the use of water hyacinth is only according to the needs and conditions of the waters where the nets are installed. The size of the bamboo stakes used in installing the net is 80.50-418.00 cm long. The size of the bamboo poles used varies depending on the depth of the water where the net is operated. The distance for installing bamboo stakes is 12.50-25.00 m depending on the conditions of the water environment. The need for bamboo poles ranges from 2-5 depending on the length of the net being operated.

Characteristics Form of Tilapia net

The general shape of the gill net is rectangular. To determine the character of the shape of the gill net, a technical calculation analysis of the components that construct the net is required. In general, it is known that several main components construct gill nets, namely rope, floats, net bodies, and sinkers. Each component has certain dimensions and a certain installation distance on the net. In the Tilapia net in Rawa Pening, the main components that construct the net consist of rope, net body, sinkers, and other components. The size specifications for each component can be seen in Table 1. To determine the shape characteristics of the Tilapia net, the results of calculating the shape characteristics have been presented as presented in Table 3. The shape characteristics of the Tilapia net can be known from the hanging ratio (E) value parameters, surface area net (S), net height (h), the ratio of yarn diameter and mesh size, as well as the ratio between the

distance between sinkers and the height of the installed net.

The results of the calculation of the hanging ratio value show that the E value of Tilapia net in Rawa Pening has a range between 0.22 and 0.75. The higher the mesh size, the hanging ratio pattern of the Tilapia net shows a pattern of increasing hanging ratio values. The hanging ratio is the percentage of the length of the net attached to the rise rope divided by the length of the net in a perfectly stretched condition. The hanging ratio value ranges from 0 - 1 [22]. If the hanging ratio value is <0.5, there is a tendency for fish to be caught in an entangled condition and the type of fish caught is multispecies. If the hanging ratio value is >0.5, the fish will be caught gilled and more selective [4, 20]. A comparison of thread diameter with a stretched mesh of the Tilapia Net shows an increasing pattern along with increasing mesh size. A similar condition was also found in the ratio between the distance between the sinker and the height of the installed net. The ratio of the distance between the sinkers to the height of the net installed in the Tilapia net ranges from 0.49 to 2.18.

Table 3: Characteristics of the shape of Tilapia nets in Rawa Pening

No.	Code	Units	Tilapia net 2,5 inch		Tilapia net 3 inch		Tilapia net 3,5 inch	
			Min	Max	Min	Max	Min	Max
1	2	3	4	5	6	7	8	9
1	$E_{1\mu}$	-	0,24	0,48	0,22	0,52	0,37	0,75
2	dt/mo	-	0,000315	0,00252	0,000262	0,000787	0,000225	0,00135
3	Ss/h	-	0,49	1,60	0,76	1,64	0,85	2,18
4	S	m^2	33,48	69,35	40,44	82,23	41,21	90,13
5	h	m	0,67	0,74	0,70	0,89	0,65	0,93
6	Shortening	%	52,28	58,56	60,23	65,46	65,91	70,40

Annotation:
$E_1\mu$: Hanging ratio on top.
dt/mo: Comparison of thread diameter to stretched mesh.
Ss/h: Comparison of the distance between the sinker and he height of the installed net.
S: Net surface area.
h: Net height.

The surface area of the installed net can be an indication of the size of the catchable area. The 2.5-inch Tilapia net has a net area of 33.48-69.35 m^2 and for the 3-inch Tilapia net, it is 40.44-82.23 m^2, while for the 3.5-inch Tilapia net is 41.21-90.13 m^2. Overall, the Tilapia nets in Rawa Pening have a catchable area of 33.48-90.13 m^2. The results of calculating the surface area of the installed net show that the higher the mesh size of the net, the surface area of the net also increases. This shows that the catchable fishing area for 3.5-inch Tilapia nets is wider when compared to other mesh sizes for Tilapia nets.

Net height calculation Tilapia nets are known to be in the range of 0.65-0.93 m. Tilapia nets with a mesh size of 2.5 inches have a net height of 0.67-0.74 m and for 3 inch Tilapia Nets it is 0.70-0.89 m, while for 3.5 inch Tilapia nets it is 0.65- 0.93m. Overall, the height of the installed Tilapia net does not differ much between the three different mesh sizes. The height of the installed net is greatly influenced by the water depth parameters where the net will be operated and the position of the net in the water column. Based on the parameters of depth and the condition of the water in Rawa Pening which is not too deep as well as the use of water hyacinth as a floating component of the net, Tilapia nets in Rawa Pening tend to be located at the surface of the water to the mid-depth column of the water. This indicates that the installation of Tilapia nets does not access the bottom of the waters.

Shortening is the difference in body length of the net after the net is attached to the ris rope [3]. In general, local fishermen determine the value of shortening based on experience. Incompatibility of shortening can affect the number of fish caught [52]. In gill net construction, the shortening value required for entangled fish is 30%-40%, while the shortening value of 35%-60% is required for catching fish by spinning [21]. Accurate use of shortening value in gill net construction will be able to increase the number of fish caught [52, 53]. The results of calculating the shortening value of Tilapia nets, the shortening value obtained for mesh size 2.5 inches is 52.28%-58.56%, mesh size 3 inches is 60.23%-65.46%, and mesh size 3.5 inches is 65.91%-70.40%. Based on the shortening value of each Tilapia net with different mesh sizes, it shows that the Tilapia net corresponds to the characteristics of catching fish in gill nets, namely by entangling or twisting. The use of different shortening values in gill nets affects the number of fish caught and a shortening value of 50% produces a higher number of fish caught than shortening values of 45% and 55% [54]. Based on the method of catching the fish, fish are caught by snagging at 20% shortening and by entangling at 30% shortening value [55].

Fishing Operation Tilapia net

Tilapia fish have good adaptability to the surrounding environment, so their numbers are known to tend to be dominant in several public inland waters [56]. Tilapia can live at temperatures of 14-38 ºC with an optimal temperature of 25-30 ºC [57, 58]. Tilapia is a group of omnivorous fish [58, 59]. Tilapia fish eat aquatic plants in the waters where they live [60]. The natural food of Tilapia fish is plankton, periphyton, and soft plants such as hydrilla, silk algae, and klekap [61]. The water temperature of Rawa Pening ranges between 25-31.5 ºC. As the depth increases, the water temperature also decreases [62]. The temperature in the waters of Rawa Pening ranges between 26-27 ºC [63]. Water temperatures of 26 ºC - 20 ºC encourage high activity of microorganisms in the breakdown of organic matter [64]. The temperature conditions of the waters and the abundance of aquatic plants make the Rawa Pening waters a suitable habitat for Tilapia fish to grow and reproduce. Water locations where there is fish habitat, then that location is a potential fishing area for fishermen and fishermen can operate fishing equipment at that location.

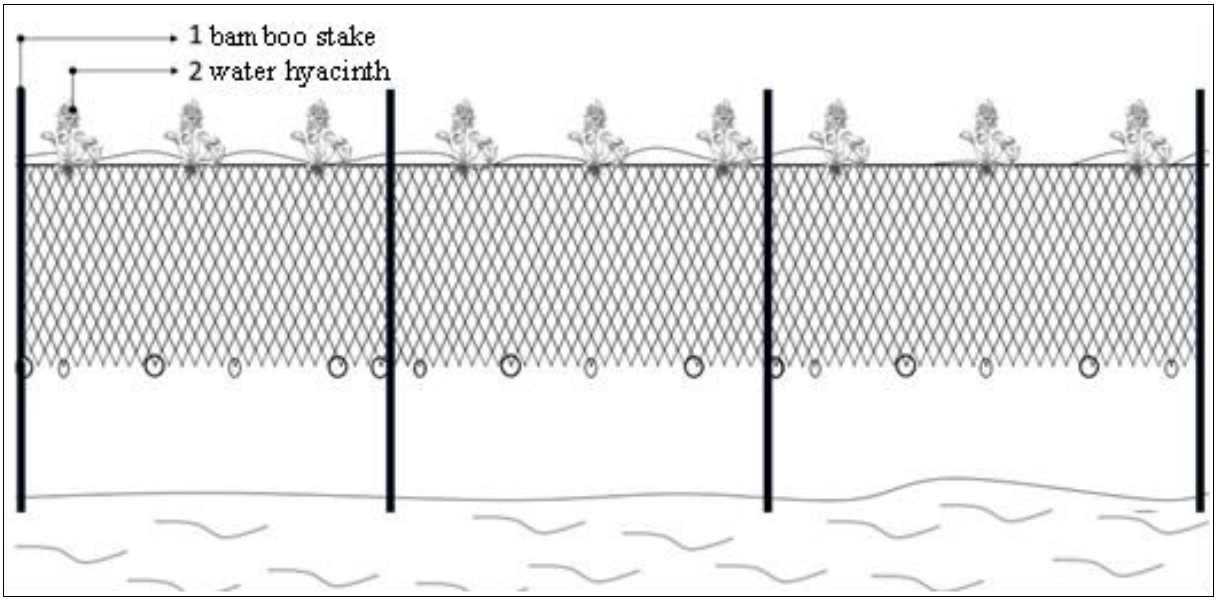

Fig 2: Illustration Tilapia nets Fishing Operation in Water

Fig 3: (A) Bamboo stakes, (B) Water hyacinth in Rawa Pening Waters, and (D) Ring Tilapia nets

An illustration of the operation of a Tilapia net in water can be seen in Figure 2. The Tilapia net is operated at the location of the fishing area starting with tying one end of the net to a stake. The stakes used are made from bamboo pieces. The length of the piles used is adjusted to the depth of the water at the fishing ground location. The average depth distribution of Rawa Pening waters ranges from 5-8 meters [65] with a maximum depth of 18.4 meters [66]. The bamboo stakes used in installing the Tilapia net are 0.8-4.18 m with a net height of 0.65-0.93 m. Thus, based on the average water depth, installing Tilapia nets will fill the waters by 16.00% - 52.25%. After installing the marker stakes, the net is lowered into the water following the pattern of the water hyacinth plants that grow in the water. At a certain distance, stakes are installed again to maintain the position of the net so that it remains perpendicular to the water. Among the bamboo stakes, water hyacinth is used as a net floating medium with the same purpose as installing bamboo stakes. The distribution of water hyacinth in Rawa Pening waters reaches 47.6% of the lake area [65]. The abundance of water hyacinth in the waters of Rawa Pening provides efficiency in making tilapia net materials and minimizes the cost of making nets.

Installing Tilapia nets in water is different from the general installation pattern of gill nets. Tilapia nets are installed in the waters by following the position pattern of water plants or water hyacinths that grow in the waters. Figure 3 shows the condition of the water hyacinth in the waters of Rawa Pening. Installation of Tilapia nets can be winding to follow the pattern of growing aquatic plants. Fishermen in lake waters use water hyacinth as a net float by hanging the upper net mesh on the water hyacinth at unequal installation distances [48].

Conclusion

The tilapia nets operated in Rawa Pening waters are rectangular form with varying mesh sizes of 2.5 inches, 3 inches, and 3.5 inches. The length of the Tilapia net ranges from 50-100 m with the installed net height being 0.65-0.93 m. The hanging ratio value is different for each mesh size. The range of Tilapia net hanging ratio is 0.22-0.75. The main components of a Tilapia net are head rope, net body, and sinker. The sinker form of Tilapia net is a ring. The sinker rings are made from Cu material with the installation position hanging from the net body. Tilapia nets do not have floats, float lines, bottom ropes, and sinker ropes. Tilapia nets use bamboo stakes and water hyacinth as components to form the position of the net when operated in water. The shortening value of Tilapia nets ranges from 52.28% - 70.40%. Further research is recommended to determine the level of selectivity of Tilapia nets based on different mesh sizes and hanging ratio values. Apart from that, it is necessary to conduct studies regarding the composition and size structure of fish caught at each mesh size and hanging ratio.

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