



FABRICATION AND TESTING OF A SEMI-MANUALLY OPERATED FISH SCALE REMOVER



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ABSTRACT

Commercial fish scale removers are very expensive. This study was conducted in order to fabricate and test the performance of a low cost, stand-alone semi-manually operated fish scale remover. The randomized complete block design (RCBD) quasi-experiment was used to test the capacity and efficiency of the semi-manually operated fish scale remover. Three (3) different kinds of fish in Northern Samar (Bangus, Sagision and Kirawan) with three (3) different sizes of scales (Large, Medium and Small) were used in the testing of the fabricated fish scale remover at three (3) different speeds of the scaling drum (High, Medium and Low). The results revealed that the higher the speed of the scaling drum, the higher is the scaling capacity of the manually-operated fish scale remover. Likewise, the bigger the scales of fish being descaled, the higher is the scaling capacity of the manually-operated fish scale remover. The average scaling capacity of the fish scale remover is higher than the average scaling capacity of an experienced fish vendors for kirawan and sagision but is lower than that of the experienced fish vendors for bangus. On the other hand, the average scaling efficiencies of the machine for all the fish used in testing the machine were highest at medium speed setting of the scaling drum. The cost and return analysis on the operation of the semi-manually operated fish scale remover revealed that it will have an annual net income of P 48,724.37, a payback period of 50 days, and a rate of return of 3.82. The actual cost of constructing the semi-manually operated fish scale remover is **₱ 12,756.00**.

1. INTRODUCTION

Technological innovation is very advance nowadays. For this reason, man is determined to conduct more beneficial projects and upgrade devices/equipment for special purposes. Our local communities are composed of different groups of people with different needs and concerns. Community folks, like fishermen and fish vendors need improved equipment to sustain post-fishing operations just like fish scaling wherein fish scale is removed from the fish prior to cooking (Byrd, 1951).

Fabrication and Testing of a Semi-Manually Operated Fish Scale Remover

In the Philippines, the common practice of removing fish scales is done by moving the dull side of a knife, spoon, fork, or wood with spike nails against the fish in a direction opposite to the extending scales (Dela Cruz, 1983). This procedure, however, is difficult, time consuming, and very messy since the removed scales is snapping off in a variety of directions. The tool must be repeatedly moved over the same area of the fish in order to ensure that all scales are removed and so there is that tendency to destroy the skin of the fish.

There are already many fish scale removers commercially available in the market and advertised in the internet. Fish scalers are manufactured in the US and China. Particularly, there is a model of fish scaler in the US like (a) the DS-800 which has a power requirement of 1.1 kW/380V and a capacity of 800 kg/hr; (b) the DS-1500 requiring a power of 3 kW/380v and has a capacity of 1,500 kg/hr; (c) the DS-5000 which has a power of 5.5 kW/380v and a capacity of 5,000 kg/hr; (d) the cordless, rechargeable fish scaler; and (e) a hand held, electrically operated fish scaler which has been already patented by William Tietz, Leonard Fisher, Floyd Saizon and the Bay State Fishing Company (Clucas and Sutliff, 1981). However, the stand alone fish scale removers are very expensive, with prices ranging from US\$ 1,000 – 1,200 and are not readily available in the Philippines.

Tripodi et al. (1974) stated that an electric fish scaler comprising of a motor, a pair of oppositely rotating eccentric cams in a driven connection with said motor, a pair of fulcrum mounted arms engaging said cams being actuated in a scissor like manner separately and sequentially there by and having, respectively, a terminal knife edge and shoe member at the free ends provide a fish scaler of relatively economical manufacture which is capable of convenient handling and efficient performance. But this is not available in the Philippine market. In this work, a locally manufactured/developed fish scale remover is deem necessary to address this problem, and, hence, this research study on a semi-manually operated fish scale remover was proposed.

2. MATERIALS AND METHODS

The Randomized Complete Block Design (RCBD) was used to evaluate the capacity and efficiency of the semi-manually operated fish scale remover. Three (3) different kinds of fish (Bangus, Sagision and Kirawan) with different sizes of scales (Large, Medium and Small) were scaled off at varying speed of the scaling drum (High, Medium and Low). Therefore, the treatment combinations are presented in Table 1.

Table 1: The treatment combinations employed in this study.

Kind of Fish	Scaling speed	Treatment Combination
Bangus	Low speed	BLS
	Medium Speed	BMS
	High speed	BHS
Sagision	Low speed	SLS
	Medium speed	SMS
	High speed	SHS
Kirawan	Low speed	KLS
	Medium speed	KMS
	High speed	KHS

This study observed the following scientific procedure in achieving its objectives:

2.1. DESIGN AND FABRICATION OF THE SCALE REMOVER

Based on the previous designs of fish scale removers seen in the internet, the researchers created a design applicable to the local conditions and the data gathered. The components were carefully selected to satisfy the necessities of a reliable semi-manually operated fish scale remover.

The semi-manually operated fish scale remover has the following parts, to wit:

- 1) Support frame. This was fabricated using 1½" x ½" x 20 cm angle bars. With a height of about 85 cm from the ground, the support frame is 65 cm wide. It is in the form of pyramid frustum.
- 2) Scaling board. This is a rectangular shaped platform made from gauge # 18 GI sheet. It has a thickness of 10 cm, a length of 68 cm and a width of 40 cm. A rectangular slit was cut from the scaling board

wherein the fish scale remover is mounted. It has a 33 cm long opening at the right side of the scaling board for cleaning/removing the fish scales after each test.

- 3) Another part of the machine responsible in the scaling of the fish is the scaling drum. It is a pyramid frustum shaped good lumber with a diameter and a length of 12 cm and 30 cm, respectively.
- 4) A 0.395-kiloWatt motor with a variable speed button at the left side underneath the scale hopper is connected to the shafting of the scaling drum and served as the prime mover. The rotational power is transmitted from the motor to the scaling drum through a V-belt and pulley system.
- 5) The hopper of the scale remover was constructed to gather the detached scales and is made from a 33 cm x 60 cm gauge #18 GI sheet.

2.2. SELECTION, SPECIFICATION AND POSITIONING OF MATERIALS

Having finished the fabrication of the different parts of the fish scale remover, the same are assembled into the manually operated fish scale remover shown below.



2.3. COST ESTIMATION

In this particular activity, the researchers estimated the total cost of the machine considering the prevailing prices of the materials and labor needed in the construction of the machine.

2.4. TESTING PROCEDURE

After the fabrication of the machine has been completed, a series of tests were conducted to determine its performance.

Three (3) different kinds of fish (bangus, sagision and kirawan) with three (3) different size of scales (large, medium and large) were used in the testing of the semi-manually operated fish scale remover at three (3) varying speeds of scaling drum (high, medium and low).

The following are the step by step procedure during the testing of the semi-manually operated fish scale remover:

- 1) The semi-manually operated fish scale remover was ran at low speed and, when the drum rotation is already stable, the sample fish (bangus) is immediately placed on top of the scaling drum one at a time until all the 1 kg bangus samples were scaled off.
- 2) When the samples were completely scaled, the machine was immediately shut off and the operating time was recorded.
- 3) The removed and unremoved scales (to be removed manually) were then noted and placed on the drying tray.

Fabrication and Testing of a Semi-Manually Operated Fish Scale Remover

- 4) The testing at medium and high drum speed were conducted following the testing at low speed drum rotation.
- 5) Steps 1 to 4 were repeated three (3) times, thus making a total of three replications for bangus.
- 6) After drying the removed and unremoved scales, they were weighed for the determination of the scaling efficiency.



Kirawan



Bangus



Sagision

- 7) The above steps for the testing of the fish scale remover using bangus fish were repeated for sagision and kirawan as samples.
- 8) After testing, the following were computed based on the data gathered:

- Scaling Capacity
$$\text{Scaling Capacity} = \frac{\text{Weight of Fish (kg)}}{\text{Operating Time (hr)}}$$
- Scaling Efficiency
$$\text{Scaling Efficiency} = \frac{\text{Weight of Removed Scales (g)}}{\text{Total Weight (g)}} \times 100$$

Where:

$$\text{Total Weight of Scales} = \text{Removed Scales} + \text{Unremoved Scales}$$

2.5. COST AND RETURN ANALYSIS

Using the given information and assumptions in the table below, a cost and return analysis was conducted to determine the desirability of the machine.

Table 2: Basic information and assumptions used in the cost and return analysis of the semi-manually operated fish scale remover

ITEM	ASSUMPTION
Initial cost of the Semi-Manually Operated Fish Scale Remover	₱ 12,751.00
Salvage Value of the Semi-Manually Operated Fish Scale Remover	20% of IC
Repair and Maintenance	5% of IC
Capacity of the Machine	g/day
Useful Life of the Machine	ears
Operating Days Per Year	ys/year
Labor Cost	₱ 150/day
Price of Fresh Fish	₱ 180.00/kg
Price of Descaled Fresh Fish	₱ 195.00/kg

The following formulas were used in the cost and benefit analysis, as follows:

1) Fixed Cost per Year

The fixed cost per year was computed using the depreciation (straight line method)

$$D = \frac{IC - SV}{n}$$

Where:

D = Depreciation

IC = Initial cost of the machine

SV = Salvage Value of the machine

N = Life Span of the machine (yr)

2) Variable Cost per Year

Labor Cost = Annual hours of utilization x hiring rate

3) Total Operating Cost (TOC)

$$TOC = FC + VC$$

4) Output Capacity (OC)

OC = Mass of Sample Fish / Time to Finish Scaling

5) Payback Period

$$\text{Payback period (years)} = \frac{\text{Investment} - \text{Salvage Value}}{\text{Net Annual Cash Flow}}$$

6) Rate of Return

$$r = \frac{\text{Net Annual Profit}}{\text{Capital Invested}}$$

3. RESULTS

The researchers developed and constructed a semi-manually operated fish scale remover consisting of the following parts:

- 1) Machine Support Frame
- 2) Scaling Drum
- 3) Scaling Board / Platform
- 4) Scale Collecting Hopper
- 5) Motor

The component parts and the materials used in the fabrication of the above manually operated fish scale remover are the following:

Table 3: The component parts and materials used in the fabrication of the manually operated fish scale remover.

Quantity	Unit	Description
1	pc	Second-hand Aircon Motor with variable speed
2	pcs	Pillow Block Bearing
1	pc	Lauan wood (12cm x 30cm)
1	kg	Concrete nails (1")
1	pc	G.I Pipe (3/4"x 50cm), sched.20
1	pc	Angle Bar (1 1/2" x 1/8" x 20cm)
1	pc	Stainless Solid Shafting (1" Ø x 24")
1	sheet	Steel Plate (gauge #18)
1	pc	Single-grooved V-Pulley (3/4" Ø)
1	pc	V-Belt(A-37)
4	set	Bolt with nut (1/2 X 2")
12	set	Bolt with nut (1/2 x 1")
6	set	Bolt with nut (1 1/2" X 1")
12	set	Bolt with nut (1/4" x 1")

The actual cost of fabrication of the semi-manually operated fish scale remover was estimated using the prevailing prices of materials in the market as presented below.

Table 4: Cost of fabricating the semi-manually operated fish scaler.

Quantity	Materials	Price per Unit	Amount
1 pc	Second-hand Aircon Motor with Variable Speed	₱ 1,800.00	₱1,800.00
2 pcs	Pillow Block Bearing	200.00	400.00
1 pc	Lawaan lumber (12cm x 30cm)	680.00	680.00
1/2 kg	Concrete nails (1")	180.00	90.00
1 pc	G.I. Pipe (3/4"x 50cm), sched. 20	350.00	350.00
1 pc	Angle Bar (1 1/2" x 1/8" x 20 cm)	410.00	410.00
1 pc	Stainless Solid Shafting (1" Ø x 24")	700.00	700.00
1 sht	Steel Plate (gauge #18)	1,100.00	550.00
1 pc	Single-grooved V-Pulley (3/4" Ø)	300.00	300.00
1 pc	Single-Grooved V-Pulley (1" Ø)	450.00	450.00
1 pc	V-Belt (A-37)	160.00	160.00
4 sets	Bolt with nut (1/2 X 2")	30.00	120.00

12 sets	Bolt with nut (1/2 x 1")	8.00	96.00
6 sets	Bolt with nut (1½" X 1")	13.00	78.00
12 sets	Bolt with nut (¼" x 1")	6.00	72.00
Total Material Cost			₱ 6,256.00
Add: Miscellaneous Expenses			₱ 1,500.00
Add: Labor Cost			₱ 5,000.00
GRAND TOTAL			₱ 12,756.00

The performance testing of the semi-manually operated fish scale remover was conducted to determine the machine’s scaling capacity and scaling efficiency.

Table 5 presents the scaling capacity of the machine using the three (3) different kinds of fish with different size of scales (large, medium, and small scales) when the scaling drum was run at varying speeds of the scaling drum (high, medium and low).

Table 5: The scaling capacity of the semi-manually operated fish scale remover.

Kind of Fish	Drum Speed	Scaling Capacity (kg/hr)			Total	Mean
		R1	R2	R3		
Bangus	L	27.00	52.20	32.76	111.96	37.32
	M	46.44	60.84	90.00	197.28	65.76
	H	55.08	77.04	158.76	290.88	96.96
Sagision	L	87.84	32.76	34.56	155.16	51.72
	M	78.48	52.92	68.40	199.80	66.60
	H	118.44	83.16	102.96	304.56	101.52
Kirawan	L	52.20	60.12	69.12	181.44	60.48
	M	78.12	78.84	83.52	240.48	80.16
	H	100.08	135.00	141.84	376.92	125.64

The results revealed that the highest scaling capacities of the machine were obtained for the descaling of Kirawan with 125.64, 80.16, and 60.48 kg/hr when the scaling drum was set at high, medium, and low speeds, respectively. On the other hand, the lowest scaling capacities of the machine were recorded for the descaling of Bangus with 96.96, 65.76, and 37.32 kg/hr when the scaling drum was set at high, medium, and low speeds, respectively. Generally, the results revealed that the highest and lowest speeds of the scaling drum resulted to the machine’s highest and lowest scaling capacities, respectively, for the three (3) kinds of fish used in the testing.

Table 6 presents the scaling efficiency of the semi-manually operated fish scale remover. It shows that the highest and lowest average scaling efficiency of the machine were 82.21 and 73.25 % when the scaling drum was set at medium and high speed, respectively, for bangus. For sagision, the highest and lowest average scaling efficiency of the machine were 74.52 and 69.71 % when the scaling drum was set at low and high speed, respectively. Finally, the machine had highest and lowest average scaling efficiencies of 83.35 and 72.56 % for kirawan when the scaling drum were set at medium and low speed, respectively.

Table 6: The scaling efficiency of the semi-manually operated fish scale remover.

Kind of Fish	Drum Speed	Scaling Efficiency (%)			Total	Mean
		R1	R2	R3		
Bangus	L	76.00	75.30	68.45	219.75	73.25
	M	78.57	84.62	92.44	255.63	82.21
	H	72.73	77.78	90.00	240.51	80.17
Sagision	L	69.44	65.22	88.89	223.55	74.52
	M	81.82	67.86	62.50	212.18	70.73
	H	72.73	73.91	62.50	209.14	69.71
Kirawan	L	64.44	71.43	81.82	217.69	72.56
	M	71.64	90.90	87.50	250.04	83.35
	H	71.43	92.85	85.71	249.99	83.33

Comparing the average scaling efficiencies across the different fish used in the test reveals that at low speed setting the scale removal of sagision and kirawan had the highest and lowest average scaling efficiencies of 74.52 and 72.56 %, respectively; at medium speed setting the scale removal of kirawan and sagision had the highest and lowest average scaling efficiencies of 83.35 and 70.73 %, respectively; and at high speed setting the scale removal of kirawan and sagision had the highest and lowest average scaling efficiencies of 83.33 and 69.71 %, respectively.

4. DISCUSSION

The Analysis of Variance showed that the mean scaling capacity significantly varied with respect to the scaling drum speed only. This means that the scaling capacity is affected only by the scaling drum speed such that “at high scaling drum speed, the scaling capacity is also high.” The DMRT at 5% level of significance revealed that, at high drum speed, the mean scaling capacity of machine for Sagision and Kirawan were significantly higher than that for Bangus. On the other hand, the mean scaling capacities of the machine at medium and low drum speeds were not significantly different for all of the three kinds of fish (Table 5). Practically, this means that, for the descaling of fish at a commercial scale, a high drum speed should be used.

Table 7: The mean scaling capacities of the machine at the different testing combinations.

Fish	Drum Speed	Mean Scaling Capacity (kg/hr)
Kirawan	High	125.64 ^a
Sagision	High	101.52 ^a
Bangus	High	96.96 ^{ab}
Kirawan	Medium	80.16 ^{bc}
Sagision	Medium	66.60 ^{bcd}
Bangus	Medium	65.76 ^{bcd}
Kirawan	Low	60.48 ^{bcd}
Sagision	Low	51.72 ^{cd}
Bangus	Low	37.32 ^d

Table 8 presents the mean scaling capacity using the semi-manually operated fish scale remover and the mean scaling capacity of an experienced fish vendor. The table shows that using the machine, 66.68 kg/hr of bangus, 73.03 kg/hr of sagision, and 88.80 kg/hr were descaled. On the other hand, by manual scaling done by an experienced fish vendor, 83.10 kg/hr of bangus, 64.62 kg/hr of sagision, and 33.44 kg/hr of kirawan were descaled. The data shows that the machine can descale fish with large scales faster than it can descale fish with small scales whereas the experienced fish vendor can descale fish with small scales faster than those with large scales.

Table 8: The comparison between the mean scaling capacity using the semi-manually operated fish scale remover and the mean scaling capacity of three experienced fish vendors.

Fish	Mean Scaling Capacity	
	Fish Scale Remover	Fish Vendor
Bangus	66.68	83.10
Sagision	73.03	64.62
Kirawan	88.80	33.44

The analysis of variance revealed no significant differences in the average scaling efficiencies of the machine at the different drum scaling speeds and for the different fish.

Table 9 presents the result of the cost and return analysis for the fish scaler as follows:

Table 9: Cost and return analysis of the fish scale remover.

Details	Computed Value
Initial Cost of Fish Scale Remover	P 12,756.00
Depreciation Cost / year	P 1,020.00

Repairs and Maintenance Cost / year	P 637.55
Labor Cost / year	P 3,600
Fish / year	P 648,000.00
Total Operating Cost per year	P 653,275.53
Annual Gross Income	P 702,000.00
Annual Net Income	P 48,724.37
Payback Period	50 days
Rate of Return	3.82

The researchers concluded that the semi-manually operated fish scale remover should, at least, consist of a machine support frame, scaling drum, scaling board / platform, scale collecting hopper, and a motor as prime mover with an actual cost of onstruction of **₱ 12,756.00**. The study has proven that the higher the speed of the scaling drum, the higher is the scaling capacity of the manually-operated fish scale remover and that the bigger the scales of fish being descaled, the higher is the scaling capacity of the manually-operated fish scale remover.

On the scaling capacity of the fish scale remover, this has higher average scaling capacity than the average scaling capacity of experienced fish vendors for kirawan and sagision but is lower than that of the experienced fish vendors for bangus.

On the scaling efficiency, the fish remover's efficiency for all the fish used in testing the it were highest at medium speed setting of the scaling drum.

Finally, the cost and return analysis on the operation of the semi-manually operated fish scale remover revealed that it will have an annual net income of P 48,724.37, a payback period of 50 days, and a rate of return of 3.82.

The researchers would like to recommend that in the conduct of testing for the manually-operated fish scale remover, the bigger sized fish (about 3- 5 kilograms) should be included; two or three differently designed scaling drums may be tested; and that the optimum scaling drum speed that will result to the highest scaling efficiency without destroying the fish skin be determined.

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CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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