ECONOMIC VIABILITY OF TILAPIA (BFAR IExcel Strain) CULTURED IN HDPE-LINED SMALL FARM RESERVOIR (SFR) UNDER GUIMARAS, PHILIPPINES CONDITION

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ABSTRACT The study was conducted to look into the economic viability of Tilapia in Small Farm Reservoir (SFR) with high-density polyethylene (HDPE) lining as this strategy eliminates other basic steps in pond preparation and input application. A Small Farm Reservoir lined with HDPE and 500 m³ was used as a culture pond for Tilapia. A total of 2,500 good quality Hybrid Tilapia fingerlings (BFAR IExcel) size 15 from BFAR hatchery was stocked in the pond. Water quality monitoring was done at a 7-day interval. A feeding guide was used based on the fish's body weight after sampling. Sampling was done every 15 days to compute the feeding requirements and the development of fish. The ABL of Tilapia during stocking was 8.5cm; ABW 15g; total biomass 37.5kg; and initially fed with 1.88kg per day. Within the 120-day culture period of Tilapia in HDPE-lined SFR, the ABL reached up to 22.35cm; ABW 250.0g; average total weight gained of 245.0g; total biomass 560kg; total feed consumed 941.22 kg or 13.44bags; FCR 1.68; survival rate 89.6%; and a total harvested stocks of 2,240. The pH level of the pond in the entire culture period of Tilapia was slightly acidic, ranging from 6.5-6.8, but had a favorable temperature and DO level. Tilapia cultured under HDPE-lined SFR appeared to have good growth performance. The present study is commensurate to economically viable technology wherein the farmer could gain income while conserving and preserving water sources for other agricultural use.

Keywords: BFAR IExcel, Economic, High-Density Polyethylene, Viability, Small Farm Reservoir, Tilapia

INTRODUCTION

The productive activity with the highest growth in the agricultural sector in recent decades has been aquaculture, presenting an annual growth of 5.8% during the period from 2000 to 2018, which is faster than other animal production segments [Froehlich, Runge, Gentry, Gaines, Halpern, (2018); FAO (2012)]. Among the species of relevance in aquaculture are cichlids (tilapia), representing the largest aquaculture production group in the world (Betanzo-Torres, Pinar-Alvarez, Sierra-Carmona, Santamaria, Loeza-Mejia, Marin-Muniz, & Herazo, 2021).

Tilapias are originally from Africa, particularly Sub-Saharan Africa and the Middle East. The first species of tilapia brought into the Philippines in 1950 was the Mozambique tilapia (Oreochromis mossambicus), and this was introduced by way of a few pieces brought in by the Bureau of Fisheries Aquatic Resources from Java, Indonesia (Romana-Eguia, Eguia, & Pakingking, 2020). From the 2018 statistics, tilapias comprised 12% of the total aquaculture production in the Philippines at 277, 006 metric tons (BFAR). It was noted as the third major species in terms of local aquaculture production, next to seaweeds (1,478,301 MT) and milkfish (303,402 MT).

A small farm reservoir (SFR) is a water-impounding earth structure designed for a single farm. Farm reservoirs have been developed indigenously by Central Luzon [Philippines] farmers and are now being adopted by farmers nationwide. Most of the reservoirs are situated in gently undulating or flat terrain. The stored water is used for supplemental irrigation of rainfed lowland rice in the wet seasaon, dry season rice crop irrigation, and fish production. Farmers without farm reservoirs cannot grow a dry-season crop (Guerra, Watson, & Bhuiyan, 1991).

The high-density polyethylene (HDPE) lining system is the world’s most widely used liner for Aquaculture practices. When used for fish, shrimp ponds, and other systems for aquaculture, its durable and impervious surface gives more control over the crop environment and greater pond utilization. It was proven effective in the country and had promising advantages and benefits compared to traditional aquaculture (Climax Synthetics, 2018).

Indicated in the Sustainable Development Goals of the United Nations, it calls for zero hunger and zero poverty as among its 17 goals. Moreover, the National Government, with its Long Term Vision; AmBisyon Natin 2040, indicates that by 2040

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Indicated in the Sustainable Development Goals of the United Nations, it calls for zero hunger and zero poverty as among its 17 goals. Moreover, the National Government, with its Long Term Vision; AmBisyon Natin 2040, indicates that by 2040 the country will "matatag, masagana at panatag na buhay". In addition, the Provincial Government of Guimaras crafted its Provincial Development Agenda (2017-2022), a strategy itemizing the objectives of the province in order to attain its vision states that there is a need to increase the production of potential agri-fishery commodities for food sustainability, sufficiency and the same time increase the income of farmers for a healthy and progressive economy.

Provincial Development Agenda (PDA) of the Province of Guimaras (2017-2022) under the economic sector aims to increase agri-fishery production by providing production support such as inputs, machinery, and small farm reservoir (SFRs) for sufficient water supply. In addition, freshwater production, particularly on Tilapia, also needs to be increased such that fish production in SFRs greatly encourages.

Moreover, during the ninth inaugural session held last July 2, 2019, the Honorable Governor of the Province of Guimaras emphasized focusing on inland fisheries to assure fish production. Likewise, the issue of fish supply in this pandemic is being augmented by local inland/brackish water fish production.

Thus, this study was conducted to look into the economic viability of Tilapia in SFR with high-density polyethylene (HDPE) lining, as this strategy eliminates other basic steps in pond preparation and input application. Specifically, it aimed to develop tilapia culture technology suited for SFR with HDPE lining, identify the effect of HDPE lining in terms of water quality parameters (DO, pH, & temperature), and determine the economic viability in culturing Tilapia in HDPE-lined SFR.

MATERIALS AND METHODS

Research Design

1. **Preparation of Culture Pond**

A Small Farm Reservoir (SFR) lined with HDPE and with a volume of 500 m^3 was used as a culture pond for Tilapia. This is situated in Brgy. Nazaret, Buenavista, Guimaras. Pond preparation was done by draining existing SFR water and eliminating unwanted species and hazardous gasses. Flooding was done right after draining, up to 1.0-meter depth.

Photo: GST Gamo
Fig. 1. SFR with HDPE Lining
at Brgy. Nazaret, Buenavista

2. **Stocking**
A total of 2,500 good quality Hybrid Tilapia fingerlings (BFAR I-Excel) size 15 from BFAR hatchery was stocked in the pond. The fingerlings were delivered early in the morning or late in the afternoon. The stocks were acclimatized for about two (2) hours prior to stocking.

3. **Water Quality Monitoring**
Water quality monitoring was done at 7-day intervals. Parameters such as temperature and dissolved oxygen (DO) were monitored with the use of a thermometer and DO meter. Data were recorded in the monitoring logbook.

4. **Feeding Management**
The following feeding guide was used based on the fish's body weight after sampling.

Feeding Guide for Tilapia

Body Weight (grams)	Feeding Rate (%)	Feeding Frequency	Feed Type
Two days old/ 1 gram	10	6 x	Fry mash
1 – 5	6	5x	Crumble
5 – 50	5	4x	Starter
50-100	5	3-4x	Grower
100 up	5	2-3x	finisher

Feeding Ration:

a. Average Body Weight (ABW)

$$= \frac{Total\ Weight\ of\ the\ Fish\ Radomly\ Sampled}{No.\ of\ Fish\ Samples}$$

b. Daily Feed Ration (DFR)

= ABW x No. of Stocks x Feeding Rate

c. Total feed Ration (TFR)
= DFR x Feeding Duration

d. Feed Conversion Ratio (FCR)

$$= \frac{Amount\ of\ Feeds\ Consumed\ (kgs)}{Wet\ Weight\ Gain\ of\ Fish\ (kg)}$$

5. **Feeding approach**
The stock was fed through hand feeding (broadcasting) so that all fish would have access to the food.

6. **Sampling**
Sampling was done every 15 days to compute the feeding requirements and the development of fish. Using a cast net, 30-50 fish samples were subjected to sampling. This should be done early in the morning. Bodyweight with the use of a weighing scale and body length with the use of a ruler was recorded. The sample should be released immediately after measuring. Data gathered was used in computing the feeding ratio.

7. **Recording**
All activities in the pond were properly recorded. Data gathered was used to evaluate the production performance of the culture area.

8. **Harvesting**
After 120 days of the culture period, total harvesting was done using the seine net. Harvest was weighed and recorded to determine the total production, and soon after was placed in a thermos chest and sold in local markets.

Statistical tools

Frequency, Percentage, and Mean were used.

RESULTS AND DISCUSSIONS

Table 1 below presents the growth performance of Tilapia cultured in HDPE-lined Small Farm Reservoir (SFR) technology in 120 days. The 500m3 pond was used in this study with a stocking density of 5 pcs per cubic meter with a total stock of 2,500 pieces of Tilapia. The Average Body Length (ABL) of Tilapia during stocking was 8.5cm, Average Body Weight (ABW) was 15.0g, total biomass 37.5kg, and initially fed with 1.88kg per day. Within the 120-day culture period of Tilapia in HDPE-lined SFR, the ABL reached up to 22.35cm; ABW 250.0 g; average total weight gained of 245.0 g; total biomass 560 kg; total feed consumed 941.22 kg or 13.44 bags; Feed Conversion Ratio (FCR) 1.68; survival
Table 1. The Growth Performance of Tilapia Cultured in HDPE-lined SFR rate 89.6%; and a total harvested stocks of 2,240.
According to the United State Department of Agriculture (USDA), as cited in Makori, Abuom, Kapiyo, Anyona, & Dida (2017), the optimal levels of physical and biological properties are frequently impacted by water quality changes in ponds. High temperatures and high dissolved oxygen levels tend to stimulate fish growth in ponds. The physicochemical characteristics like temperature, Dissolved Oxygen (DO), and pH favor the optimal growth of Tilapia species cultured in HDPE-lined SFR technology in 120 days. According to Makori et al. (2017), the DO, temperature, and ammonia bore positive signs, indicating a commensurate increase in fish weight for every unit that these parameters increased.

DOC	Sampling Days Interval	ABL (cm)	ABW (g)	Average weight gained (g)	Total weight gained (kg)	Total Biomass (kg)	Daily Feeding Ration (kg)	Total Feed	FCR (%)
Stocking	0	8.50	15.00	-	-	37.50	1.88	-	-
1-20	20	10.79	27.27	12.27	27.48	61.08	3.05	37.5	32.57
21-40	20	11.01	35.81	8.54	19.13	80.21	4.01	58.0	32.96
41-49	9	12.18	40.50	4.70	10.53	90.72	4.54	32.1	32.83
50-71	22	15.23	78.75	38.25	85.68	176.40	8.82	95.3	90.06
72-87	16	17.89	139.52	63.77	142.84	312.52	15.62	132.3	58.08
88-104	17	20.36	200.00	60.48	135.47	448.00	22.40	250.0	54.21
105-120	16	22.35	250.00	50.00	112.00	560.00	-	336	31.25

Note: AREA: 500sqm; STOCKING RATE: 5pcs/sqm; STOCKING DENSITY: 2,500pcs; SURVIVAL RATE: 89.6%; TOTAL STOCKS: 2,240; TOTAL BIOMASS: 560kg; Total Feed Consumed: 941.22 kg or 13.44bags; FCR 1.68

Concerns about pond water quality are directly related to its production, so it is important to take these parameters into account in fish culture. Physico-chemical parameters such as temperature, dissolved oxygen (DO), and pH determine water quality and make up the successful management of fish ponds (Bryan et al., 2011).

In this study, the water quality was monitored at a 7-day interval from the start of the culture period. The temperature during cloudy days ranges 18-200C, with a corresponding DO of 7-8.5 mg/l, with an average pH of 6.8. Then obviously, during sunny days of water quality monitoring, the temperature increased ranging 20-280C, DO of 6.5-9.0 mg/l and pH level of 6.5-6.8. Meanwhile, during the flooding schedule, the mean range of the Physico-chemical parameters was temperature 24-250C; DO 8.0-9.0 mg/l; and pH 6.8. The highest temperature level of 27-280C was observed during sunny days of monitoring for 91 – 120 days of Tilapia culture, wherein the DO also increases 7.0-9.0 mg/l. Generally, the pH level of the pond in the entire culture period of Tilapia was slightly acidic, ranging from 6.5-6.8. This was because of the soil characteristics of the Guimaras province, and the technology does not use Agricultural lime to lessen the acidity of the pond.

Therefore, the water source and its quality are some of the main factors to consider when evaluating and choosing sites for earthen fish pond siting. Other critical factors include ensuring the water source has a high concentration of dissolved oxygen and optimal temperatures, which should be maintained at the right levels throughout the culture period (Ngugi et al., 2007). Fish generally grow much faster in ponds with optimum levels of DO, temperature, and other factors (Bartholomew, 2010).

Tilapia (Oreochromis niloticus) is ideal for culture due to its rapid growth rates, capacity to adapt to a wide range of environmental conditions, ability to grow and reproduce in captivity, and ability to feed at low trophic levels (Abdel-Fattah, 2006). The most preferred temperature range for optimal growth of Tilapia is 25 to 27 °C, while the ideal pH ranges between 6 to 9 (DeWalle et al., 2011).

Table 2. The Water Quality Monitoring of Culturing Tilapia in HDPE-lined SFR

DOC	Temperature (0C)	Dissolved Oxygen(DO) (ppm)	pH	Remarks (Rainy/cloudy/ sunny/etc.)
0	18	7.5	6.8	cloudy
7	20	7.0	6.8	cloudy
14	20	8.0	6.8	sunny
21	18	8.5	6.8	cloudy
28	22	7.0	6.5	sunny
35	20	8.0	6.5	sunny
42	22	8.0	6.5	sunny
49	24	9.0	6.8	Watering
56	24	7.0	6.8	sunny
63	25	6.5	6.8	sunny
70	25	6.5	6.8	sunny
77	26	7.0	6.5	sunny
84	25	8.0	6.8	watering
91	27	7.0	6.8	sunny
98	27	9.0	6.5	sunny
105	28	7.5	6.5	sunny
120	28	7.7	6.5	sunny

Table 3 below shows the Financial Analysis of Culturing Tilapia in HDPE-lined SFR, which concurs with the economic viability of the developed technology. The HDPE-lined SFR has an area of 500 m2, with 1-meter water deep. The Tilapia was stocked at a rate of 5-pieces per cubic meter and a total of 2,500 pieces of Tilapia for a 500 cubic meter pond. Within a 120-day culture period, the total production cost was Php31, 221.50, excluding the polyethylene material. The total yield was 560kg out of the total harvested stock of 2,240 pieces of Tilapia. The average farm-gate price was Php130.00 per kilogram and gained a gross income of Php72, 800, which earned a net income of Php41, 578.50, which corresponds to a promising ROI of 133.2%. These values support the economic viability of tilapia culture on a small-scale farm basis and are an important economic supplement to the family economic base. Among the possible profitable scenarios, this study points to some options best suited to the conditions of micro and small producers in the province of Guimaras. The present study is commensurate to economically viable technology wherein the farmer could gain income while conserving and preserving water sources for other agricultural use.

Table 3. Financial Analysis of Culturing Tilapia in HDPE-lined SFR

Area (m2):	500
Stocking Rate (per m3):	5
Total stocks:	2,500
Survival Rate:	89.60%
Culture Period (days):	120.00
Weight at harvest (g):	250.00
Total yield (kg):	560.00
Farm Gate Price (Php):	130.00
Gross income (Php):	72,800.00
Total Production Cost (Php):	31,221.50
Net Income (Php):	41,578.50
Return of Investment (ROI):	133.2%

CONCLUSIONS

In conclusion, dissolved oxygen, temperature, and pH level in the HDPE-lined SFR were within the optimum range for the growth of Tilapia. The water used for the culture of Tilapia was slightly acidic but registered the favorable growth of Tilapia. Technology was economically viable, wherein the farmer could have gained income while conserving and preserving water sources for other agricultural use. It is therefore recommended that the use of HDPE-lined SFR for tilapia culture must be expanded and introduced to the small-scale farmers through the help of the local government of the province of Guimaras.

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