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A study of the growth, feed conversion and mortality rate of Nile Tilapia (Oreochromis niloticus): A case study of Craig Farm in Mashonaland Central Province.

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I have supervised the project of the above-mentioned student and l am convinced that this research project can be submitted.

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Dedication

I dedicate this thesis to my family, for their unwavering love and support throughout my academic journey. Their encouragement and motivation have been the driving force behind my success and this achievement is as much yours as it is mine. Thank you for always being there for me and for believing in me even when the road ahead seemed uncertain. I hope this study makes you proud and inspires you to make a different in this world. I love you all.

Abstract

This research was designed to investigate growth rate and feed conversion ratio as they are important factors in the cultivation of Nile tilapia. A total of 4 earthen fish ponds were selected based on their high yields recorded during the previous harvesting each pond containing 10 000 fingerlings. The study was carried out at Craig Site fish farm in Mashonaland Central province in Zimbabwe. During the experiment, fingerlings were stocked in ponds at a density of 12 fish per square meter and they were fed three times a day at the rate of 10% of their body weight for 6 month. The initial average weight body of Nile tilapia was 7.9grams and the growth rate was measured by monitoring their weight gain after every 2 weeks. The experiment was carried out at an open space where there was no blockage of sunlight. The temperature was maintained at 25 to 26 ^{0}C, pH at 6.8 and oxygen above 5 mg l-1. The experiment was carried out with duration at six months. Feed conversion ratio was determined by calculating the amount of feed required to produce 1 kilogram of fish in each pond. Mortality rate was calculated as the percentage of fish that died during the cultivating period.

The fish obtained the average weight of 313 to 390 grams in 6 months. There is almost 99% survival rate of tilapia fish. Pond 3 and 4 had 100% survival rate as compared to ponds 1, 2 and 3 and the mortality rate was very low. There was no difference in survival rate of the fish as the table 4.2 shows that 3 and 4 had highest survival rate of 100% in the sixth month and pond 1 and 2 had 99. 9%.Total quantity of fish harvested was 99% in the 4 ponds with average production of 15 kilograms per square meter. Feed conversion efficiency mean obtained in the final month was 0.0676. The FCR ranged from 2.9 to 9.9 in all ponds during the first month. These high figures were as a result of the Tilapia not consuming much of the food since they were at juvenile stage. Pond 4 has the highest FCR of 9.943. FCR was in a constant increase in all the ponds from 1 to 4. FCR ranged from 0.279 to 0.924 during the whole year.

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Firstly l express my gratitude to several people who have made this thesis possible. I would like to thank my dissertation advisor (Mr Mhlanga) for his guidance, support, and valuable insights. I am also grateful to the staff and employees of Craig site farming for their cooperation, assistance, and provision of necessary data and resources for the completion of this research. Moreover, I extend my appreciation of this research to my colleagues and friends who have offered their encouragement and motivation throughout the study. Finally, I would like to thank my family and loved ones for their unwavering support and patience during the research and writing process.

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LIST OF ACRONYM

ADG: Average Daily Growth

BWG: Body Weight Gain

DO: Dissolved Oxygen

FAO: Food and Agriculture Organization.

FCE: Feed Conversion Efficiency

FCE: Feed Conversion Efficiency

FM: Fish Meal

GM: Geometric Mean

IBW: Initial Body Weight

MR: Mortality Rate

pH: Hydrogen ion Concentration

SBM: Soya Bean Meal

SGR: Specific Growth Rate

SR: Survival Rate

TL: Total Length

CHAPTER ONE

INTRODUCTION

1.1 Research Background

Almost everywhere in the world, fish is an essential source of food. From 9.0 kg in 1961 to 20.2 kg in 2015, the world's per capita fish consumption has increased (FAO, 2018), the population expansion, the health benefits of eating fish, and developments in aquaculture are only a few of the factors contributing to the rising growth. According to Rosa et al. (2007), both freshwater and marine aquaculture have experienced significant expansion due to the rising demand for fish products. As a means of ensuring food security during the past three decades, aquaculture has expanded incredibly quickly (Bell et al., 2009; Filipski and Belton, 2018). It now feeds and pays the majority of developing nations. Feed was highlighted as the primary limiting issue in aquaculture expansion in Africa (Gabriel et al., 2007). The study by Munguti et al. (2009), fish meal is crucial for fish farming and is responsible for more than 60% of all operating costs. Studies measuring the growth rate, feed conversion ratio, feed conversion efficiency, mortality, and production costs of Nile tilapia in ponds, as well as studies targeted at lowering feed costs, are essential to promoting the aquaculture business and supporting its sustainable expansion. Fish meal, especially fish meal that has been utilised for decades, was viewed as the product with the highest input cost from animal protein sources (Ogello et al., 2014). Fishmeal competition with humans has led to extremely high costs, shortages, and demands in the aqua food sector despite a decline in fishmeal and fish oil availability and an increase in their use in aquaculture (Jonni and Janice, 2014). Finding affordable and accessible substitutes for fishmeal that will produce development outcomes that are comparable to or better than fishmeal is therefore important (Ginindza, 2012). The ingredients for alternative feed need to be easily accessible and have the least amount of fibre and nutrients feasible (Gatlin et al., 2007). Nigeria, a nation that has increased its production of aquaculture, is unable to be supported by the aqua feed sector. Because of this, fish producers' increasing food needs were satisfied by 75% of imported aquatic feeds (Udo and Umanah, 2017). Additionally, since fishmeal has been used as human food due to its high nutritional content, there are less nutritious ingredients available in the food business as a result of the decline in fish harvests (Watanabe, 2002; Ginindza, 2012; and number 41). The two main sources of protein in Zimbabwe are freshwater prawns (Caridina nilotica), which are bycatch in the Omena fishery, and omen (Rastrineobola argentea), which are eaten directly by people (Munguti et al., 2009). Animal sources of protein are typically more difficult to find and more expensive than plant sources. Because of this, further study would be extremely beneficial, particularly when it comes to cultivating significant fish species like Oreochromis niloticus, which is the most popular and desired by people in Zimbabwe.

1.2 Statement of the problem

Nile Tilapia (*Oreochomis Niloticus*) is a popular fish for aquaculture, but the growth rate, feed conversion rate and mortality rate are all important factors that can affect the profitability of Tilapia farming.

1.3 Specific Objectives

1. To determine the Specific growth rate (SGR).
2. To determine the Survival Rate of Nile Tilapia(SR)
3. To determine the Feed Conversion Ratio of Nile Tilapia (FCR)
4. To determine the Feed Conversion Efficiency of Nile Tilapia (FCE)
5. To determine the quantity of fish harvested in each pond

1.4 Justification of the study

The purpose of this study was to determine the growth rate, feed conversion rate, and mortality rate of Nile Tilapia at Craig farm as this information had not been documented before.

1.5 Research questions

1. What is the specific growth rate of Oreochromis niloticus in each pond?
2. What is the growth rate of Oreochromis niloticus in ponds?
3. What is the feed conversion ratio of Nile tilapia in pond?
4. What is the mortality rate of Oreochromis niloticus?
5. What is quantity of Nile tilapia harvested in each pond?

CHAPTER 2

LITERATURE REVIEW

2.1**Growth Rate of Nile tilapia**.

In a study carried out by Hussain et al. (2000) the Genetically Improved Farmed Tilapia (GIFT) strain has a growth performance better than the Non-Improved strain (NS) Nile tilapia. In the same experimental study, Mather and Nandlal (2000) submitted that Genetically Improved Farmed Tilapia (GIFT) strain obtained a mean weight of about 21.7 g after 56 days compared to Non-Improved strain (NS) Nile tilapia that weigh14.6 g after 56 days. In addition to that Hussain et al. (2000) submitted that Genetically Improved Farmed Tilapia (GIFT) strain has a daily growth rate of 0.37 g compared to Non-Improved strain (NS) Nile tilapia 0, 24 g per day. The results obtained by Dey et al. (2000) in study of Aquaculture and Fishery revealed the Non-Improved breed of Genetically Improved Farmed Tilapia will reach the size of 20 g ten to fourteen days quicker than the GIFT strain, shortening the GIFT strain's production cycle. In the same study the quality of water was monitored after every two to three weeks to check for dissolved oxygen, pH, total ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen (Dey et al., 2000). Using immersion heaters, the water's temperature was kept constant at 29, 0 ^{0}C 2, 0 ^{0}C during the duration of the study. According to Al-Ahmed (2004), male Nile tilapia performs better in terms of growth rate in Kuwaiti farms than females do. Consequently, it is more advantageous to produce an all-male population than one that is mixed-sex.

The growth rate of Nile tilapia differs based on genetics. Those that have their genes modified or improved have a better growth performance compared to those whose genes are not tempered with. In the same manner, the production cycle is shortened when the Nile tilapia’s genes are improved compared to those whose genes are not improved. The weight of the Nile tilapia is improved when the quality of water is being monitored and when the temperatures are being maintained. Thus, the growth rate is improved under these conditions. This therefore will motivate the researcher in this study to monitor the daily growth rate, the weight, quality of water, the temperature, to consider the genes of the Nile tilapia in order to improve and/or determine the growth rate of Nile Tilapia at Craig Farm-case study. At the same time, the researcher noted that growing male Nile tilapia is more profitable than females since the males' growth performance is better than that of the female ones.

2.2 Survival Rate of Nile Tilapia.

Madalla, Jauncey and Richards (2008) noted that survival of Nile tilapia depends on the feeds given to the Oreochromis niloticus. On the same matter Tacon and Foster (2000) submitted that the experimental fish were fed three times a day with feeding ratio of 10% of their body weight. The type of feed and the amount of feed determine the survival of Nile tilapia. In this manner the researcher is motivated to make sure that in carrying out this study, the survival of the Oreochromis niloticus lies in the type of feed given and the amount per day. In as much as Tacon and Foster (2000) emphasize on the feeds given for survival, FAO (2012) emphasize on the quality of water supplied to the Nile tilapia for survival. The water should be checked for dissolved oxygen, pH, total ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen (Dey et al., 2000). If these conditions are maintained Nile tilapia fish will survive till the harvesting stage.

2.3 Feed Conversion Ratio of Nile Tilapia.

The rate at which the Nile tilapia is fed depends on the nutritional target by the farmer. The feed conversion ratio depends on the size of the Nile tilapia and the expected production. To support this, a study by Noor, Deen and Mona (2010) proved that the experimental fish were fed three times a day with feeding ratio of 10% of their body weight. The amount of the feed was adjusted once in two weeks intervals based on the body weight of the fish.

2.4 Feed Conversion Efficiency of Nile Tilapia

In determining the efficiency of the feed conversion one needs to understand that variation in growth rate and feed usage effectiveness is due to variations in the nutritional mix and quality of supplemented meals (Ulloa and Verreth, 2002). A research by Tacon (1990) revealed that O. niloticus accepted diets from agro-industrial by-products such wheat bran, coffee husks/pulp, beer trash, potato scrap, and jatropha seed cake meal are readily available. At the same time, the quality of supplement diets will affect efficiency of feed conversion and the processing of these diets. According to Tacon (1990) O. niloticus will eat local market-bought grains like maize, sorghum, wheat, rice, soybean, bone meal, and peanut.

CHAPTER3

RESEARCH METHODOLOGY

3.1Experimental site and pond preparation

The present study was conducted at Craig farm fish ponds in Mashonaland central province, to study the growth performance of Nile tilapia. The ponds at Craig Farm were utilised for the purpose of investigation. Four ponds were used each with varying conditions. They measured 20m width and 30m length and 1.5m height. The ponds received their water from rain and were completely exposed to sunlight. The pond borders were densely vegetated and well-defended. Before the trial began, aquatic plants were physically cleansed. Rotenone was applied at a rate of 40 kg ha-1 to completely remove all undesirable fish. On the first day, 300 kg of lime ($CaCO_3$) per hectare was applied.

3.2 Stocking and pond management

Tilapia fingerlings were transported in plastic bags filled with hatchery pond water and filled with air and transported to experimental sites. Aeration was also done by the help of Blower 30 Hp (20.5amps) (3500rpm) (vertical pump diffuser). The aeration line from the blower was fixed across the pond. Sand filter and bio filter also proved beneficial to increase the oxygen contents in the water and release the other gases hence we got rid of suffocation. Water was exchanged every month from July to December. Application of inorganic fertilizer was carried-out weekly with urea and ammonium phosphate at a rate of 55 kg of N/ha/wks, and 15 kg of P/ha/wk. Pond fertilization was done by dissolving 5 kg of urea and 2.6 kg of ammonium phosphate in water for each 20m by 30m pond with depth of 1.5m and broadcast on the pond surface to enhance the growth of natural food. 40 000 fingerlings were randomly distributed in each pond to make 10 000 in each pond.

3.3Monitoring of Physico-chemical parameters.

Parameters of water quality such as Dissolved Oxygen (DO) and temperature during the experiment were recorded on daily basis at 10:00 AM, 4:00 PM and 8:00 PM. The temperature was recorded on the spot by a mercury thermometer. DO was measured daily by digital oxygen meter and also confirmed by titration method (Winkler's method). The parameters such as pH, TDS and salinity were all recorded using a conductivity meter, whilst the ammonia (NH3) was analysed through using an ammonium kit on monthly basis for each of the 4 ponds.

3.4 Feed formulation

Only one nutritionally balanced feed was prepared for all the four experiments. The feed was prepared from fish meal, soybean meal, sunflower meal, pea protein concentrate, corn gluten and wheat were mixed with appropriate amount soy oil, vitamin and mineral premix, mono calcium phosphate, yttrium oxide, lysine and methionine.

Table 1 Components of the feed

Content	**Value**
Dry matter (DM), g kg-1	4
Ingredients composition	8
Fish meal	23%
Soybean meal	12 %
Sunflower meal	45%
Pea protein concentrated	100
Wheat	300.0
Corn gluten	80.0

3.5 Feed Analysis

Chemical compositions of the diet are given in Table 3. Dry matter content of diet was determined as weight loss after drying the samples at 103°C until constant weight (ISO, 2008). Crude proteins (Kjeldahl N×6.25) were determined Kjeltec auto 1035/1038 system (Tecator, Sweden). Solvent Extraction (ASE) method was used to determine crude fat of diet. Ash contents were determined by heating at 500°C in muffle furnace. Starch was analyzed as glucose after starch hydrolysis with a heat tolerant amylo-glucosidase in accordance with the procedure of (McCleary et al, 2017). The sample was burned at 500°C in muffle furnace and dissolved in 1M HCl, lastly it was analyzed by spectrophotometer (Bourke and Yanagawa, 2016) to determine total phosphorus. Bomb calorimeter was used to calculate energy contents of diet.

Table 2: Chemical composition of experimental diet.

Chemical composition	**Experimental Diet**
Dry matter, g (kg)-1	908.7
Crude protein, g (kg DM)-1	341.63
Crude fat, g (kg DM)-1	66.55
Ash, g (kg DM)-1	47.00
Starch, g (kg DM)-1	25.10
Total Phosphorous g (kg DM)-1	4.98
Energy MJ Kg-1 DM	18.77

3.6 Diet preparation

Macro ingredients of formulated diet were weighed using a large weighing scale mean whilst micro ingredients were weighed using Sartorious analytical balance. To produce slow sinking tilapia feed, all macro ingredients were transported in a Münch Hammer mill (HM 21.115, Wuppertal, Germany) and grinded to particle size of 0.5 mm using 1 mm screen. The milled ingredients and micro ingredients were mixed homogenously in a small Dinnisen twin shaft mixer (Pegasus Menger 400 1, Sevenum, Holland) for 2 minutes. Then it was transferred to a mini feeder of extruded barrel (Twin screw Bühler BCTB 62 extruder) to produce slow sinking diet. Into the barrel, the compounded mixer of raw ingredients precooked with addition of hot water, shearing, pressure and finally heat generated before exit through the die.

3.7 Feeding and sampling method

The feed was supplied three times a day in the feeding trays (2ft2 in size) in the morning (9:00 AM), at noon (11:00 noon) and in the evening (at 13:00 PM) and 1500hrs at rate of 10% of the body weight for initial three months and then feeding rate was reduced to 7% for the rest of the period. The feed was supplied in feeding trays on each side near the wall of the ponds. A sampling of experimental fish was carried out monthly. Sampled fish were weighed on an electronic balance (model DECKLA-15, China) with a plastic 20litre bucket. The feeding varied from the one pond to another. The fish were fed a pelleted diet (Table 1) at a rate of varying from 5% to 10% fish biomass. Four diets were formulated as F1, F2, F3, and F4.

Table 3 feed content

Ingredients		**Composition**				
Name	%	Protein	Fat	Carbohydrates	Fibre	Gross energy (Kcal 00g)
Dry matter (DM), g kg-1	17	45.0	13.8	30.8	5.5	98.67
Ingredients composition	18	15.7	8.6	64.4	2.8	79.60
Fish meal	37	7.9	4.6	1.3	2.3	45.53
Soybean meal	8	69.0	2.2	0.3	1.3	27.67
Sunflower meal	6	3.6	0.1	0.9	2.09	11.45
Pea protein concentrated	9	77.0	10.0	0.003	0.7	17.18
Wheat	4	15.0	0.001	88	39	144.23
Corn gluten	8	-	8.78	0.006	33	34

3.8 Weighing and sampling

During inception of the experiment, after weighing, some of the fish were placed into the freezer, at -25ºC. And at the end of the experiments, same numbers of fishes were placed at -25ºC after weighing. Body weight of fishes was taken at 25 days interval. Before weighing, all fishes were anaesthetized by MS222 (0.2g l^{-l}). The faeces were collected from distal part of intestine after opening of abdomen and also frozen for digestibility study.

3.9 Sample preparation

The meat grinder was used to grind the big fish whilst a small grinder (A11 Basic Analytical mill, IKA, Wilmington, USA) was used for the small fish. Grinded fishes and fecal content were subjected to freeze drier. To make the sample homogenous, it was treated with dry ice and then grinding was done. The feed samples were prepared by grinding the pellet into mash by A11 basic Analytical mill. All the dry samples were kept at 2 ºC until all analyses finished.

3.10 Analyses

The experiments were held between the periods July 2023 to December 2023. A total number of 10 000 Nile tilapia were in each pond at the start of the experiment.

3.10.1 Temperature

The fish were all kept at in 4 ponds at ambient temperature was measured.

Table 4 temperature in all ponds

Pond label	**Ambient temperature**
Pond 1	13ºC
Pond 2	11 ºC
Pond 3	11ºC
Pond 4	14ºC

3.10.2 Quantity

The quantity of fish was determined every fortnight for four months then every month for the last two months.

3.10.3 Mortality

The mortality was checked by using a fish quantity scale which detect the number of fish died during the production period. In order to determine the mortality rate of Nile tilapia, number of fish stocked subtract from number of fish died to get the quantity of fish harvested. We could also use the scale to weigh the sample weight of fish in each pond.

3.10.4 The feeding

Feeding time was administered differently for each pond and they were fed 3 times. In pond 1 the feeding time was 0900am, 1300pm and 1500pm. In pond 2 the feeding time was 1000am, 1200pm and 1500pm, in pond 3 and 4 the feeding was 1000am, 1400pm and 1500pm.

3.11 Calculation:

3.11.1 Specific Growth Rate

Specific Growth Rate (SGR) was calculated. SGR refers to percentage increase in body dimensions per time and the results are given in percentage increase per day (Tekla, 2012). It is calculated mathematically using the following formula:

$$sgr(\%0 = \frac{log(w_t) - \log(w_i)}{t} * 100$$

Where w_i is initial weight/length, w_t Wt is final weight/length, t is time in days Hopkins (1992).

3.11.2 Geometric mean (GM) weight

Hopkins (1992), suggested that:

Geometric mean (GM) weight were calculated using

$$GM = \sqrt{W_1 * W_2}$$

Where W1 and W2 are mean wet weights for fish in grams.

3.11.3 Total feed consumption

Total feed consumption (CT) was calculated as:

$$C_T = F_s - F_c$$

Where F_s total feed is supplied in grams (g) and F_c is total collected excess feed Hopkins (1992).

Daily feeding rate (F %) was calculated as

$$F\% = 100[\frac{C}{\frac{B_1 + B_2}{2}} * (t_2 - t_1)^{-1}$$

Where C is total feed consumption per each pond in the period, and B1 and B2 are fish biomass (g)

3.11.4 Feed conversion Efficiency

Feed conversion rate (FCE) was calculated as:

$$FCE = \frac{B_1 + B_2}{C}$$

Where C is total feed consumption in the pond for the period, and B1 and B2 are fish biomass.

Feed Conversion Ratio

Feed conversion rate (FCR) was calculated as suggested by Hopkins in 1992 as:

$$\mathbf{FCR} = \frac{\mathbf{feed\ intake\ (\ kg)}}{\mathbf{weight\ gain}}$$

Mortality rate

The mortality rate is measured as:

$$MR = \frac{TOTAL\ FISH\ DIED}{TOTAL\ FISH\ STOKCED} * 100$$

Data analysis

Data collected on growth and water quality was recorded in MS Excel. Descriptive statistics was used to outline the basic features of the data in the study by giving simple summaries like the mean and standard deviation of weight and length of fish and other physico-chemical properties.

CHAPTER FOUR

RESULTS

4.1 Specific growth rate (SGR).

Table 4.1 Specific Growth Rate of the Nile Tilapia in the 4 ponds from first month to the final month.

SGR Means and standard deviation								
Pond number	**July**	**August**	**September**	**October**	**November**	**December**	**Mean**	**Std**
1	13.75	16.16	18.97	23.17	17.71	23.74	18.91	0.57
2	16.45	12.27	14.78	12.94	18.21	15.54	14.62	0.34
3	12.73	19.36	19.02	15.97	16.48	16.62	16.23	0.063
4	12.16	13.13	12.15	14.73	18.16	17.51	14.42	0.074

Table 4.1 shows the average specific growth rate of tilapia fish as observed from month 1 to 6 in four different ponds.

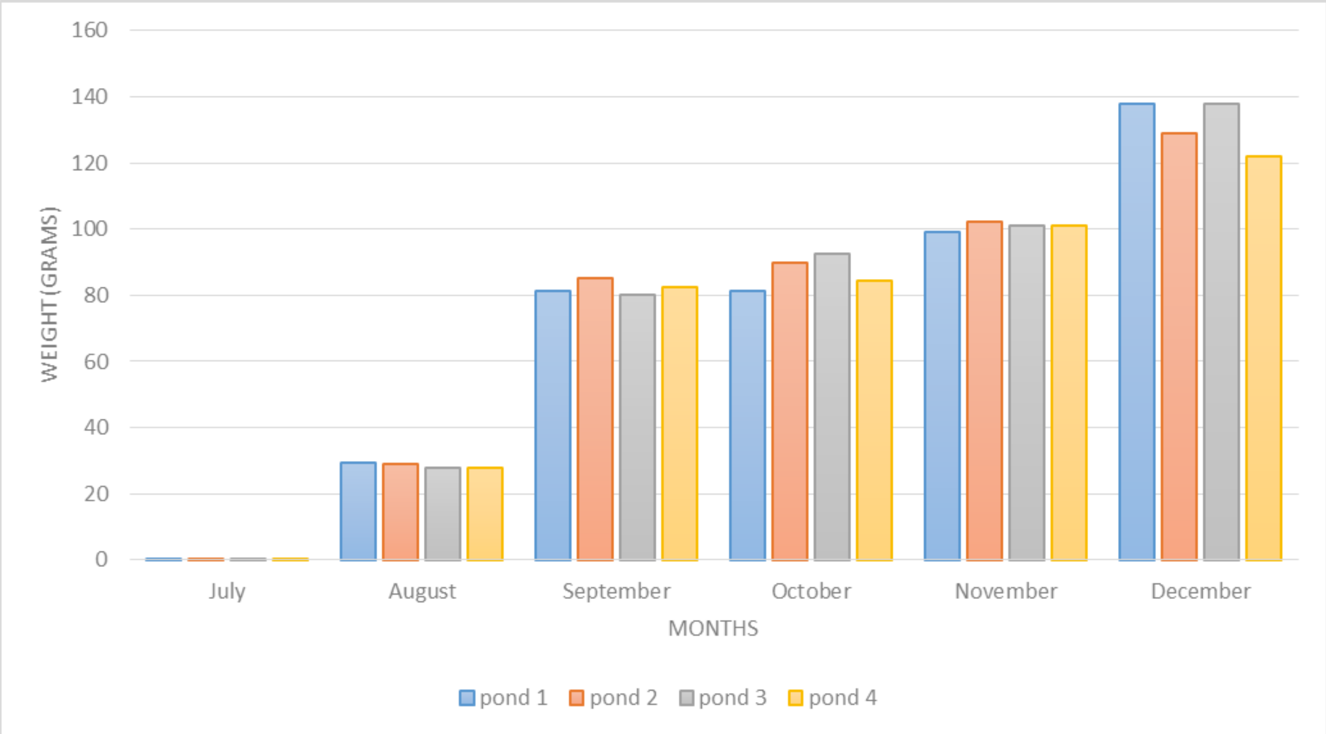

Figure 1 mean weight of fish in grams for pond 1 to 4

Mean weight of fish in grams in 4 ponds with different feed treatment, thus growth performance. There is gradual increase in weight of fish, therefore different feed treatments has effect on growth of tilapia fish in different ponds. A gradual increase in growth of fish in pond 2 for 6 months and slightly slow increase in month 3 and 4. A constant sharp increase in growth of fish from months 3 to months 5. There was an increase in growth from month 2 to 3 and slow increase in growth in month 3 and 4. A sharp increase in growth from month2 to month 3 and slow growth different in month 5 and 6.

Table 4.2 Survival rate (%) of Tilapia fish from 1st month to 6th month.

Pond	**July**	**August**	**September**	**October**	**November**	**December**	**Mean**	**Standard deviation**
1	99.52	99.70	99.91	99.93	99.96	99.99	99.84	0.23
2	99.62	99.80	99.81	99.97	99.99	99.99	99.87	0.225
3	99.66	99.75	99.93	99.93	99.97	100	99.95	0.243

4	99.72	99.78	99.95	99.97	99.98	100	99.97	0.24

Table4.2 shows a mean of mortality where there is almost 99% survival rate of tilapia fish. Pond 3 and 4 had 100% survival rate as compared to ponds 1, 2 and 3.

Table 4.3. Monthly feed conversion ratio in the 4 ponds.

FCR month means and standard deviation								
Pond number	**July**	**August**	**September**	**October**	**November**	**December**	**Mean**	**Std**
1	2.890	5.4428	6.762	5.5312	9.237	9.635	6.533	0.056
2	6.728	8.1869	9.0784	6.3945	6.522	9.0374	6.77	0.043
3	8.733	9.1495	4.6881	8.0145	8.046	5.4302	7.65	0.065
4	9.943	7.8814	3.7117	6.6253	7.869	7.179	7.77	0.076

Table4.3 shows a summary of growth of fish for 6 months. There is sharp gradual increase in growth for feed conversion ratio as shown by the gradual increase in means and standard deviation of the growth rate of fish therefore there is slow rate in feed conversion thus slow growth in months 1 and 2.

Table 4.4 Monthly food conversion efficiency in the 4 ponds.

FCE Monthly mean and standard deviation								
Pond Number	**July**	**August**	**September**	**October**	**November**	**December**	**Mean**	**Std**
1	0.0279	0.0525	0.0692	0.0844	0.0549	0.0718	0.0656	0.0054
2	0.0526	0.0713	0.0.744	0.0567	0.0453	0.0617	0.0733	0.0045
3	0.0655	0.0846	0.0723	0.0.854	0.0654	0.0688	0.0788	0.0067

4	0.0753	0.0924	0.0432	0.0531	0.0749	0.0676	0.0667	0.0078

Table 4.4 shows a fairly increase in feed conversion efficiency as the values from month 2 to 5 shows a small difference as the number months increases.

Table 4.5Average length of fish for 6 months

	Mont hs	**average**	**Length**	**(cm)**		
Pond number	**July**	**August**	**September**	**October**	**November**	**December**
1	**9.8**	**11.9**	**15.6**	**19.2**	**19.6**	**18.6**
2	**10.1**	**12.3**	**17.7**	**19.8**	**18.7**	**19.7**
3	**10.7**	**15.5**	**18.4**	**19.2**	**19.4**	**18.4**
4	**10**	**15.8**	**19.2**	**19.5**	**19.9**	**19.7**

Table 4.5 shows the average length of fish across 6 month time frame of study. The length of fish increases as number of months increases.

Table 4.6 Quantity of fish harvested.

Pond	**Number**	**Weight (kg)**
1	**9988**	**1 486**
2	**9990**	**1 562**
3	**9995**	**1 646**

4	**9998**	**1 709**

Table 4.6 shows the number of tilapia fish that were harvested after 6 months from each pond and the total weight of fish in 6 months.

CHAPTER FIVE

DISCUSSION

5.1 Specific growth rate (SGR).

The SGR of Nile Tilapia in ponds 1-4 was monitored from the first to the sixth month of harvest. The table 4.1 shows a fluctuation of in the SGR of fish in four ponds. In pond 1, the SGR was 13.75 in the first month and steadily increased to 23.17 in the fourth month. It then slightly decreased to 17.71 in the fifth month and steadily increased to 23.74 in the final month. In pond 2, shows a high 16.45 in the first month, followed by a slight decrease in the second, fourth and final month and the fifth month recorded the highest SGR of 18.21. Pond 3 showed a highest SGR in the second month 19.36 and a slight decrease in the fourth month 15.95 and the final month recorded steady increase 16.62 in the harvest month. Pond 4 showed a similar pattern, highest SGR was recorded in the fifth month 18.16 then decreased to 17.51 in the final month.

The findings obtained from this study are not similar with studies on growth of Nile Tilapia for example Hopkins et al (1992) obtain the SGR ranged from 4.5% to 6.7% Past studies have reported on the SGR of the Genetically Improved Farm Tilapia and Non-Improved strain Nile Tilapia. For instance, Hussain et al. (2000) reported that the Genetically Improved Farmed Tilapia (GIFT) strain has a growth performance better than the non-Improved strain (NS) Nile tilapia. In the study carried by Mather and Nandlal (2000) submitted that Genetically Improved Farmed Tilapia (GIFT) strain obtained a mean weight of about 21.7 g after 56 days compared to non-Improved strain (NS) Nile tilapia that weigh 14.6 g after 56 days. These studies highlight the importance monitoring the growth rate of both genetically improved and non-improved Nile Tilapia for reduced production cycle and better yield.

5.2 Survival Rate of Nile Tilapia

Table 4.2 presents the survival rate of Nile Tilapia fish from January to June in ponds 1 to 4. The results showed that pond 4 had the highest survival rate on 99.97 on average, while pond 3 and pond 2 had an average of 99.95 and 99.87 respectively. Pond 1 had the least survival rate of 99.84 on average. It is important to note that the SD values for all ponds were relatively low indicating that the mortality of Nile Tilapia fish was consistent throughout the production cycle.

The survival rate of Nile Tilapia fish is a crucial parameter as it affects the profitability of fish farming operations. Various studies have reported the survival rate of Nile Tilapia fish in different factors. The mean survival rate of Nile Tilapia in this study was higher than 67% and 50% reported by Al-Ahmed et al. (1985) and by Ridha and Lone (1990), Madalla, Jauncey and Richards (2008) reported that survival of 68% to 70% for Nile tilapia depends on the feeds given to the fish. Dambo (2000) conducted a study on the growth and survival of Nile tilapia fish in Zimbabwe and reported a survival of 76% in final month and this rate is lower than the rate reported in table 4.2.

5.3 Feed Conversion Ratio

Table 4.3 shows the variation of FCR of all 4 ponds as the production cycle progresses. Pond 1 had the lowest FCR in the first month on 2.890 and then recorded highest FCR of 9.635 in the final month. In pond 2, the FCR steadily increased from 6.728 in the first month to 8.1869 and 9.0784 in the second and third month respectively. Meanwhile, pond 4 reported a sharp decrease from 9.943 to 3.7117 in third month which was the lowest FCR across all ponds in the third month. The results in pond 3 showed a lowest FCR of 5.4302 in the final month and pond 4 had the second lowest FCR of 7.179.

These results are in full agreement with the findings of De Croux et al. (2004) and Saber et al. (2004). FCR values obtained in this study were higher than the reported by Ellis and Watanabe (1993) who found a feeding conversion of 1.14 .Also according to Deen and Mona (2000), reported a mean FCR of 1.86 of Nile Tilapia which is comparable to the findings of this study. Francis et aI (2002), obtain mean FCR of 1.6 of Nile tilapia fish in India which is lower than the results indicated in this study.

5.4 Feed Conversion Efficiency of Nile Tilapia

Feed conversion efficiency was also monitored through the production cycle. The table 4.4 shows the differences in FCE across four ponds. In the final month, pond 1 recorded the FCE of 0.0718 which was highest. Whilst in pond 2, 3 and 4 had FCE of 0.0617, 0.0688 and 0.0676 respectively. Pond 1, 2, 3 and 4 had mean of 0.0656, 0.0733, 0.0788 and 0.0667 respectively.

The research findings of study are different with the previous studies reporting FCR values of 0.60 to 0.70 Gong et al (2019). Various studies reported that the changes in growth rate and feed utilization efficiency is as a result of the differences in the quality of supplemental diets in terms of nutrient composition (Ulloa and Verreth, 2002). In another study by Workagegn et al (2014) submissions indicated that selection of the feedstuffs was based on the availability of the ingredients. According to Tacon (1990) cereals such as maize, sorghum, wheat, rice, soybean, bone-meal and groundnut purchased from local markets are accepted by O. Niloticus. Cereals such as maize, sorghum, wheat, rice, soybean, bone meal and groundnut hence improved the FCE Tacon (1990). This is in agreement with this study which used cereals. The variation in FCE in all ponds could imply the differences in pH levels as reported by the study of Saber et al (2004).

5.5 Quantity of Fish harvested in each pond

The results indicate the variation in the mass and the number of Nile Tilapia fish per pond as shown in Table 4.6. The highest number of Nile Tilapia fish harvested of 9 998 and mass of 1 709kg was record in pond 4. Meanwhile in pond 2 had the second highest number harvest of 9 990 and mass of 1562 kg. Pond 1 recorded the lowest number of fish harvested of 9 988 d mass of 1486 kg. To add more, pond 3 had a number of 9 995 mass of 1646 kg. The production per square meter of the all 4 ponds was 15kg per square meter.

The research which was conducted by Dey et al. (2000) shows that genetically improved Nile tilapia yield more than the non-improved. According to FAO (2017), they obtain the production of 14.41 which was little lower as ones obtained is this study.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The mean survival rate of Nile Tilapia was high in this study. Feed management and water quality contributed to the survival rate of the Nile Tilapia. Mortality on the other hand was very low. Cereals such as maize, sorghum, wheat, rice, soya bean, groundnuts hence improved the FCE of the Tilapia. Furthermore, improving digestibility and nutrient use can lead to better FCR in Nile Tilapia.

6.2 Recommendations

Future studies should compare fish performance in each pond with the water quality in each

REFERENCES

A.M. Bell et al. The repeatability of behaviour: a meta-analysis/ Animal Behaviour 77 (2009) 771–783

Abdelghany A.E., Ahmad M.H., 2002. Effects of feeding rates on growth and production of Nile tilapia, common carp and silver carp poly cultured in fertilized ponds. Aquaculture Research 33:415-423.

Abdel-Tawwab M., Ahmad M.H., Khattab Y.A.E., Shalaby A.M.E., 2010. Effect of dietary protein level, initial body weight, and their interaction on the growth, feed utilization, and physiological alterations of Nile tilapia, Oreochromis niloticus (L.). Aquaculture 298:267-274.

Ahmed I., 2010. Response to the ration levels on growth, body composition, energy, and protein maintenance requirement of the Indian catfish (Heteropneustes fossils;—Bloch 1974). Fish Physiology and Biochemistry 36:1133-1143.

Ali A., Al-Ogaily S.M., Al-Asgah N.A., Goddard J.S., Ahmed S.I., 2018. Effect of feeding different protein to energy (P/E) ratios on the growth performance and body composition of Oreochromis niloticus fingerlings. Journal of Applied Ichthyology 24:31-37.

Asche F., Roll K.H., Tveterås S., 2018. Future Trends in Aquaculture: Productivity Growth and Increased Production, in: Holmer, M., Black K., Duarte, C. M., Marbà, N., Karakassis, I., Aquaculture in the Ecosystem, Springer Netherlands. pp. 271-292.

Bergheim A., 2017. Water quality criteria in recirculation systems for Tilapia. International Research Institute of Stavanger, 4068 Stavanger, Norway

Bostock J., McAndrew B., Richards R., Jauncey K., Telfer T., Lorenzen K., Little D., Ross L., Handisyde N., Gatward I., Corner R., 2017. Aquaculture: global status and trends. Philosophical Transactions of the Royal Society B-Biological Sciences 365:2897-2912. 68

Bourke E., Yanagawa N. (1993) Assessment of hyperphosphatemia and hypophosphatemia. Clinics in Laboratory Medicine 13(1):183-207.

Bourke E., Yanagawa N. (2017) Assessment of hyperphosphatemia and hypophosphatemia. Clinics in Laboratory Medicine 13(1):183-207.

Bureau D.P., Hua K., Cho C.Y., 2006. Effect of feeding level on growth and nutrient deposition in rainbow trout (Oncorhynchus mykiss Walbaum) growing from 150 to 600 g.

Chapman F.A., 1992. Culture of Hybrid Tilapia: A Reference Profile. Fisheries and Aquatic Sciences Department, University of Florida, Circular 1051 Charo-Karisa

Curcas Kernel Meal on Growth Performance, Feed Utilization Efficiency and Survival Rate of Juvenile Nile Tilapia. Journal of Aquaculture. Res Development. Development in the New Millennium. International Aqua-Feed Directory and Buyers Guide 2001, Trust RAL, Uxbridge, Middlesex, UK.

El-Saidy.A.-F.M., Deyab M.S.D., Gaber, Magdy M.A., 2017. Effect of dietary protein levels and feeding rates on growth performance, production traits and body composition of Nile tilapia, Oreochromis niloticus (L.) cultured in concrete tanks. Aquaculture Research 36:163-171. El-

El-Sayed A.-F.M., Kawanna M., 2017. Effects of photoperiod on the performance of farmed Nile tilapia Oreochromis niloticus: I. Growth, feed utilization efficiency and survival of fry and fingerlings. Aquaculture 231:393-402.

El-Sayed A.-F.M., Tacon A.G.J., 2017. Fishmeal replacers for tilapia: A review. Ciheam-Iamz, Zaragoza (Spain) 22:205-224.

El-Sheriff M.S, El-Feky A.M.I (2009). Performance of Nile Tilapia (O. niloticus) Fingerlings:

Filipski, Mateusz & Belton, Ben, 2018. “Give a Man a Fishpond: Modeling the Impacts of Aquaculture in the Rural Economy,” World Development, Elsevier, vol.

Gabriel, U. U., Akinrotimi, O. A., Bekibele, D. O., Onunkwo, D. N., & Anyanwu, P. E. (2007). Locally produced fish feed: potentials for aquaculture development in sub-Saharan Africa. African Journal of Agricultural Research, 2(7), 287-295

Gao Y., 2018. Improved nutritional value of fish feed with plant protein ingredients by means of organic acid salts and solid state fermentation. PhD thesis 2011:23, Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences. : 121-150.

Garduño-Lugo M., Granados-Alvarez I., Olvera-Novoa M.A., Muñoz-Córdova G., 2017 Comparison of growth, fillet yield and proximate composition between Stirling Nile tilapia (wild type) (Oreochromis niloticus, Linnaeus) and red hybrid tilapia (Florida red tilapia×Stirling red O. niloticus) males. Aquaculture Research 34:1023-1028

Genomar. (2019) Fish farmer- Sep/Oct. http://www.genomar.com/arch/_img/9081395.pdf. Gjøen H.M., Zimmermann S., Unpublished. Feed planner: A guideline for Genetically Superior Tilapia (GST), Genomar, Norway.

Goda A.M.A.S., Wafa M.E., El-Haroun E.R., Kabir Chowdhury M.A., 2017. Growth performance and feed utilization of Nile tilapia Oreochromis niloticus (Linnaeus, 1758) and tilapia galilae Sarotherodon galilaeus (Linnaeus, 1758) fingerlings fed plant protein-based diets. Aquaculture Research 38:827-837.

Han C.Y., Wen X.B., Zheng Q.M., Li H.B., 2019. Effects of dietary lipid levels on lipid deposition and activities of lipid metabolic enzymes in hybrid tilapia (Oreochromis niloticus × O. auras). Journal of Animal Physiology and Animal Nutrition. Article first published online: 26 NOV 2010.

Hanley F., 1991. Effects of feeding supplementary diets containing varying levels of lipid on growth, food conversion, and body composition of Nile tilapia, Oreochromis niloticus (L.). Aquaculture 93:323-334. ISO, 6496. 1983: International Organization for Standardization.

II. Influence of Different Water Temperatures. International Journal of Agricultural Biology.

Liang G.-Y., 2006. The influence of feeding rate on growth, feed efficiency and body composition of juvenile grass carp (Ctenopharyngodon idella). Aquaculture International 14:247-257.

Lim C., Oksoy M., Klesius P., 2018. Lipid and fatty acid requirements of tilapia. North American Journal of Aquaculture. 73(2): 188-193.

Madalla N, Jauncey K, Richards R (2008). *Novel Feed Ingredients for Nile Tilapia*

Munguti, J. M.; Waidbacher, H.; Liti, D. M.; Straif, M; Zollitsch, W. J., 2009. Effects of substitution of freshwater shrimp meal (Caridina nilotica Roux) with hydrolyzed feather meal on growth performance and apparent digestibility in Nile tilapia (Oreochromis niloticus L.) under different culture conditions. Livest. Res. Rural Dev., 21 (8): 129

Ogello, E. O., Safina, M., Aura, C. M., Abwao, J. O., Munguti, J. M. (2014): A critical appraisal of feasibility of tilapia production in earthen ponds using biofloc technology, a review. International Journal of Aquatic Sciences, 5 (1): 21 – 39.

Ogello, E. O., Safina, M., Aura, C. M., Abwao, J. O., Munguti, J. M. (2014): A critical appraisal of feasibility of tilapia production in earthen ponds using biofloc technology, a review. International Journal of Aquatic Sciences, 5 (1): 21 – 39.

Ponzoni R.W., Bovenhuis H., (2000). Genetic and environmental factors affecting growth of Nile tilapia (Oreochromis niloticus) juveniles: Modelling spatial correlations between hapas.

Saidy.A.-F.M., Deyab M.S.D., Saad A.S., 2018. Effects of partial and complete replacement of soybean meal with cottonseed meal on growth, 70 feed utilization and haematological indexes for mono-sex male Nile tilapia, Oreochromis niloticus (L.) fingerlings. Aquaculture Research 42:351-359. FAO. 2010. The state of world fisheries and aquaculture. FAO, Fisheries and Aquaculture Department, Rome, Italy.

T. La Rosa (2007). Impact on the water column biogeochemistry of a Mediterranean mussel and fish farm Water Res.

Tacon AGJ, Foster IP (2000). *Global Trends and Challenges to Aquaculture and Aqua-Feed*

Ulloa R.J.B, Verreth J.A.J (2002). Growth, Feed Utilization and Nutrient Digestibility in Tilapia

Utilization of Sustainable Plant Products in Aqua-Feeds*:* A Review. Aquaculture Research.

Watanabe WO, Kuo CM, Huang MC (2002). The ontogeny of Salinity tolerance in the tilapias Oreochromis aureus, O. Niloticus, and an O. mossambicus 9 O. niloticus hybrid, Spawned and reared in freshwater. Aquaculture, 47(4), 353–367.

Watanabe, T. (2002): Strategies for further development of aquatic feeds. Fisheries Science 68: 242 – 252.

Wicklund R.I., Olla B.L., 1990. Effect of Feeding Rate on Growth and Feed Conversion of Florida Red Tilapia Reared in Floating Marine Cages. Journal of the World Aquaculture Society 21:16-24.

Appendix A

FISH INTRODUCED AND NUMBER OF FISH DIED FROM FISRT MONTH TO THE SIXTH MONTH

Total number of fish introduced =10 000		
Pond 1		Deaths
7-6-2022		6
08-12-2022		5
09-17-2022		6
10-18-2022		5
11-23-2022		1
12-28-2022		0
pond 2		
07-06-2022		8
08-12-2022		7
09-17-2022		7
10-18-2023		3
11-23-2022		4
12-28-2022		1
Pond 3		
07-06-2022		10
08-12-2022		7

09-17-2022		5
10-18-2022		5
11-23-2022		2
12-28-2022		1
pond 4		
07-06-2022		5
208-12-2022		4
09-17-2022		3
10-18-2022		2
11-23-2022		1
12-28-2022		0

APPENDIX B

FISH WEIGHTS FOR THE SIX MONTHS

Sampling	Pond	length	weight	
date	Number	cm	grams	
6-01-2022	1	5.5	9	
6/01/2022	1	5.5	9	
6/01/2022	1	5.5	9	
6/01/2022	1	5.5	9	
6/01/2022	1	5.5	9	
6/01/2022	2	5.5	9	
6/01/2022	2	5.5	9	
6/01/2022	2	5.5	9	
6/01/2022	2	5.5	9	
6/01/2022	2	5.5	9	
6/01/2022	3	5.5	9	
6/01/2022	3	5.5	9	
6/01/2022	3	5.5	9	
6/01/2022	3	5.5	9	

6/01/2022	3	5.5	9	
6/01/2022	4	5.5	9	
6/01/2022	4	5.5	9	
6/01/2022	4	5.5	9	
6/01/2022	4	5.5	9	
6/01/2022	4	5.5	9	
First Month of collecting data				
7/06/2022	1		8	23.5
7/06/2022	1		9	25.5
7/06/2022	1		10.5	30.5
7/06/2022	1		10.5	30.5
7/06/2022	1		11	29.5
7/06/2022	2		9.5	29.5
7/06/2022	2		10	30.5
7/06.2022	2		10	30
7/06/2022	2		10.5	27
7/06/2022	2		10.5	28
7/06/2022	3		10	30.5
7/06/2022	3		11	30.5
7/06/2022	3		10.5	40
7/06/2022	3		10.5	29
7/06/2022	3		11.5	40
7/06/2022	4		10	30
7/06/2022	4		9.5	30
7/06/22	4		10	29.5

7/06/2022	4	10.5	30
7/06/2022	4	10	40.5
		Second Month of data collected	
8/12/2022	1	12	50.5
8/12/2022	1	13.5	55
8/12/2022	1	12.5	60.5
8/12/2022	1	10	60
8/12/2022	1	11.5	70
8/12/2022	2	12	70
8/12/2022	2	12	70.5
8/12/2022	2	12	80
8/12/2022	2	12.5	80.5
8/12/2022	2	13	90
8/12/2022	3	15	90.5
8/12/2022	3	14	90.5
8/12/2022	3	15	97
8/12/2022	3	15.5	97
8/12/.2022	3	14	99
8/12/2022	4	14	98
8/12/2022	4	15	100
8/12/2022	4	15.5	99.5
8/12/2022	4	15	100
8/12/2022	4	15	100

	3rd Month		
9/17/2022	1	15	111
9/17/2022	1	15.5	100.5
9/17/2022	1	16	100.5
9/17/2022	1	16	112
9/17/2022	1	16	112.5
9/17/2022	2	16.5	116
9/17/2022	2	17	108
9/17/2022	2	16	115
9/17/2022	2	17.5	115
9/17/2022	2	17	114.5
9/17/2022	3	17	117
9/17/2022	3	17.5	100.7
9/17/2022	3	18	118
9/17/2022	3	18.5	119
9/17/2022	3	18	119.5
9/17/2022	4	19	110
9/17/2022	4	19	110.5
9/17/2022	4	17	112
9/17/2022	4	16.5	114.5
9/17/2022	4	16	114.6

	Fourth month			
10/18/2022	1	16.5	140.5	
10/18/2022	1	17	160	
10/18/2022	1	19.5	160	
10/18/2022	1	18	165.5	
10/18/2022	1	19.5	175.5	
10/18/2022	2	20	190	
10/18/2022	2	19.5	185.5	
10/18/2022	2	20	170	
10/18/2022	2	20	200	
10/18/2022	2	19.5	70	
10/18/2022	3	17.6	190.5	
10/18/2022	3	18.5	190.5	
10/18/2022	3	19	200.5	
10/18/2022	3	20.5	200	
10/18/2022	3	19.5	190	
10/18/2022	4	19.5	190	

10/18/2022	4	20	195.5	
10/18/2022	4	19	200.5	
10/18/2022	4	17.5	190	
10/18/2022	4	18.5	200.5	
		fifth month		
11/23/2022	1	19	210.5	
11/23/2022	1	19	225	
11/23/2022	1	19	220.5	
11/23/2022	1	19.5	200	
11/23/2023	1	20	260	
11/23/2022	2	20.5	265	
11/23/2022	2	18.5	280	
11/23/2022	2	18.5	280.5	
11/23/2022	2	19	255.5	
11/23/2022	2	19.5	260	
11/23/2022	3	20.5	285	
11/23/2022	3	20.5	285.5	
11/23/2022	3	18	250.5	
11/23/2022	3	17	270	
11/23/2022	3	18.5	285.5	
11/23/2022	4	19	287	
11/23/2022	4	21.5	287.5	
11/23/2022	4	21	270.3	
11/23/2022	4	21	280	
11/23/2022	4	21.5	285.5	
	sixth month			
12/28/2022				
12/28/2022	1	17.5	285.5	
12/28/2022	1	18.5	290.5	
12/28/2022	1	17.5	300	
12/28/2022	1	19	300	
12/28/2022	1	19	310	
12/28/2022	2	19	312	
12/28/2022	2	20.5	294.5	

12/28/2022	2	20	305.5
12/28/2022	2	17.5	320
12/28/2022	2	19.5	330
12/28/2022	3	17	335.5
12/28/2022	3	19.5	290.5
12/28/2022	3	21.5	340
12/28/2022	3	22	335.3
12/28/2022	3	21	345
12/28/2022	4	21.5	345
12/28/2022	4	20.5	339.5
12/28/2022	4	20.5	325.5
12/28/2022	4	19	348.5
12/28/2022	4	17.5	350