



**STUNTED GROWTH IN NILE TILAPIA (*Oreochromis niloticus*) AND ITS
IMPLICATION ON THE PROFITABILITY AND PRODUCTIVITY OF SELECTED
EARTHEN POND FARMS IN KAMULI DISTRICT**

BY:

NAMBI CALORINE

REG NO. BU/UP/2017/1958

**A RESEARCH REPORT SUBMITTED TO THE FACULTY OF
NATURAL RESOURCES AND ENVIRONMENTAL SCIENCES, DEPARTMENT
OF GEO-INFORMATION, EARTH OBSERVATION AND PHYSICAL LAND
RESOURCES IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR
AWARD OF BACHELOR'S DEGREE IN FISHERIES AND WATER
RESOURCES MANAGEMENT OF BUSITEMA UNIVERSITY**

2021

DECLARATION

I NAMBI CALORINE, declare that this research thesis titled “Stunted growth in Nile tilapia (*Oreochromis niloticus*) and its implication on the profitability and productivity of selected earthen pond farms in Kamuli district” has been through my own efforts and never has it been submitted to Busitema University or any other institution of higher learning for the award of a degree or any other qualification.

Signature:




Date:

03 / 05 / 2022

APPROVAL

This is to certify that this research report has been submitted with my approval.

SUPERVISOR'S NAME: RWEZAWULA PHILIP

Date.....

Signature..03./05/.2022.....

DEDICATION

I dedicate this report to my lovely parents; Mr. Kakungulu Nelson and his wife Mrs. Kakungulu Beatrice, my daughter Namuwaya Macklin, my late brother Waibi Jonathan, my sisters and friends for the love, encouragement and support-morally and financially. You are greatly honored. May God bless you abundantly.

ACKNOWLEDGEMENT

I take this opportunity to thank the almighty God for the gift of life and having enabled me finish my research successfully. I also thank so much Busitema University for the knowledge they have given me. I am also grateful to my research supervisor Rwezawula Philip for his valuable technical input in this research. I also acknowledge my parents, my daughter, classmates, brothers and sisters for the love and support. May the almighty God bless you abundantly.

Table of content

DECLARATION	i
APPROVAL	ii
DEDICATION	iii
ACKNOWLEDGEMENT	iv
Table of content	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
ACRONYMS	ix
ABSTRACT.....	x
CHAPTERONE	1
INTRODUCTION.....	1
1.0Introduction	1
1.3.0 Objectives of the study.....	3
1.5. CONCEPTUAL FRAMEWORK	4
1.6 Originality and contribution to new knowledge.....	4
1.7 Significance of the study.....	5
CHAPTERTWO	6
LITERATURE REVIEW	6
2.1. Aquaculture.....	6
2.2. Aquaculture development in Uganda.....	6
2.3. Earthen pond aquaculture and challenges	7
2.4. The Nile tilapia (<i>Oreochromis niloticus</i>)	8
2.5.0. Nile tilapia in aquaculture	9
2.6.0. Environmental biology and nutritional requirements.....	10
2.7. Causes of stunted growth in Nile tilapia and mitigation measures	15
CHAPTERTHREE	17
MATERIALS AND METHOD	17
3.0 Introduction.....	17
3.1 Research design	17
3.2 Study area	17
3.4 Data types and collection methods.....	18

3.5 Data collection tools.....	19
3.7 Data collection method	19
3.8. Analysis and presentations	19
3.9 Ethical consideration.....	19
CHAPTER FOUR: RESULTS	20
4.1 Introduction.....	20
4.2 Sub counties of the study area.....	20
Part 1: Evaluation of the causes of stunted growth in earthen pond Nile tilapia	21
Part 2 mitigating the causes of stunted growth in earthen pond Nile tilapia	38
The duration of the production cycle	38
Size of the fish at harvest	38
Strategies/practices to prevent or reduce stunted growth	39
Control of over breeding in the ponds.....	40
Part 3. Evaluation of the implication of stunted growth on profitability and productivity.....	41
Weight of fish at harvest.....	41
Amount of money spent on feeds, fish seed/ fingerlings and labour, fertilizers and other extra costs.	42
The other challenges faced by farmers.....	44
Solutions to the challenges.....	45
CHAPTER FIVE: DISCUSSIONS.....	46
5.0 Discussion of the study findings	46
CHAPTER SIX.....	50
Conclusions and recommendations.....	50
6.1 Conclusions.....	50
6.2 Recommendations.....	50
6.3 Areas of further research.....	50
REFERENCES	51
APPENDIX 1: FISH FARMER’S QUESTIONNAIRE	53

LIST OF TABLES

Table 1:Limits and optima for water quality parameters for Nile tilapia	11
Table 2:Protein requirements (dry basis) of Nile tilapia at various sizes, Source; FAO, 2017	12
Table 3:Amino acid requirements (dry basis) for O. niloticus	13
Table 4:Vitamin requirements (dry basis) for Nile tilapia	14
Table 5:Mineral requirements -dry basis (Halver, 2011)	15
Table 6:The sources of water used for production at the fish farms	23
Table 7:Management of the quality of water in the fish ponds	25
Table 8:Frequency of fertilization used by farmers	27
Table 9:Source of fish fingerlings, stocking density, weight/size of fingerlings stocked in the pond, sex cultured and population management in ponds	28
Table 10:The number of times fish were fed in a day and quantities used on each feeding	32
Table 11:Source of advice to farmers on fish farming	37
Table 12:Ratio of big fish to small fish harvested by the farmers at the end of the production cycle	38
Table 13:Expenditure on fish seed, labour, fertilizers and extra inputs	43

LIST OF FIGURES

Figure 1: conceptual framework	4
Figure2: The Sub counties where the study was conducted.....	20
Figure3.The number of fish ponds owned by each farmer.....	21
Figure4: The size of fish ponds (in square meters) used in production by farmers.....	22
Figure5.The depth of fish ponds used in production by farmers.....	23
Figure 6: Seasonality of the water sources used for production.....	24
Figure7. Farmers' back-up plans for temporary water sources.....	25
Figure 8. How often farmers changed water in their ponds during production.....	26
Figure9. The practice of fertilization of the fish ponds by the farmers	26
Figure10. The type/form of fertilizers used for fertilization of thefish ponds by farmers.....	27
Figure11: Responses from farmers about the practice of feeding fish	30
Figure12: Sizes of pellet used for each age group of fish by farmers	31
Figure13: Feeding frequency/intervals used in feeding of fish by farmers	33
Figure14: The practice of fish sampling and grading by farmers	34
Figure15: Types of fish predators at the fish farms	35
Figure16: The control measures employed by farmers against the fish predators at their farms	36
Figure17: The number of months (period) fish were reared by farmers until harvest	38
Figure18: Strategies used by the farmers to prevent or reduce stunted growth in ponds	39
Figure19: Responses on control of over breeding in ponds by farmers	40
Figure20: Number of kilograms of fish harvested at the end of the production cycle by farmers	41
Figure21: Expenditure on fish feeds/feeding by the farmers	42
Figure22: Other challenges farmers faced by the farmers apart from stunting of fish.....	44
Figure23: solutions to the challenges recommended by farmers	45

ACRONYMS

FAO:	Food and Agriculture Organization
NaFIRRI:	National Fisheries Resources Research Institute
MAAIF	Ministry of Agriculture Animal Industry and Fisheries
GDP:	Gross Domestic Product
DO:	Dissolved Oxygen
BOD:	Biological Oxygen Demand.
SPSS:	Statistical Package for Social Sciences.
FAO:	Food and Agriculture Organization.
NEPAD:	New Partnership for Africa's Development.
SPADA:	Special Program for Aquaculture Development in Africa.
KDAPS:	Kamuli District Aquaculture Production Statistics.
CAGR:	Compound Annual Growth Rate.
SMEs:	Small and Medium scale Enterprises.
B C:	Before Christ
DiFR:	Directorate of Fisheries Resources
GIFT:	Genetic Improvement in Farmed Tilapia
PH:	Hydrogen potential
CP:	Crude protein

ABSTRACT

Stunted growth has been reported by many Nile tilapia earthen pond farmers as a major problem that's hindering their success. Generally, as a result of rampant stunted growth, very low yields from production of very small low-value fish of different generations, which result into very little revenue obtained from such farms has been reported to demoralize farmers. The aim of the study was to identify and evaluate the causes of stunted growth in earthen pond farmed Nile tilapia (*Oreochromis niloticus*) and its implication on the profitability and productivity of selected farms. The study established that stunted growth in earthen pond Nile tilapia (*Oreochromis niloticus*) in the selected fish farms in Kamuli district was mainly caused by poor feeding (inadequate feeding), over stocking, poor water quality management, poor quality seed/fingerlings, inadequate technical knowledge and poor pond fertilization techniques. Farms that were more affected by stunted growth had poor yields and generated less income as compared to their counterparts that had some knowledge on how to counteract it. Training on feeding, and other good pond husbandry practices such as predator control, water quality management, sampling and grading, were recommended to create awareness and preparation of farmers to mitigate stunted growth and its effects. The government should also establish fish hatcheries in the district to provide good quality fingerlings to farmers, a feed producing plant to avail good quality feeds, and also employ enough fisheries extension workers, to equip farmers with relevant knowledge on good fish farm management practices.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

1.1 Background to the study

Aquaculture involves the cultivation of both animals and plants in aquatic environments (marine, fresh or brackish) under controlled environmental conditions in production systems such as ponds, tanks, cages, and raceways (Pillay, 1990). Commercial fish farming started in China in the 12th Century B.C, and it has extended throughout the world (FAO, 2009). With a contribution of about 16% of the total animal protein supplies, aquaculture is presently the most productive industry in the agriculture economy (Wang, 2009). According to FAO, (2020), global fish production was estimated to have reached about 179 million in 2018 with an estimated value of USD 401 billion. It accounted for 82 million, approximately 46% of the total production, valued at USD 250 billion, and contributing 52% of the produce for human consumption (FAO, 2020). As opposed to the declining aquaculture production in Europe and Oceania, production in the continents of Africa and Americas has increased although it is still below the dominant Asian production that accounts for over 89% of the global production (Halwart, 2020). The African contribution to world aquaculture production is still insignificant (~2.7%) (Halwart, 2020) albeit significantly increasing with large-scale investments in Egypt, Nigeria, Uganda and Ghana (Cai, et al., 2017; FAO 2018). According to Halwart, (2020), the region produces around 1.74 million of aquaculture produce, with Egypt (1.1 million), Nigeria (313,000) and Uganda (111,000) as the top three producing countries in Africa. The African production is dominated by Nile tilapia (43.6%), African catfish (11.9%) and common carp (10.15%) (Sserwambala, 2018). The region recorded a 20-fold production increase from 110,200 to 2,196,000 from 1995 to 2018 with a compound annual growth rate (CAGR) of 15.55% (FAO 2016; Halwart, 2020). The growth of aquaculture production in the area was due to the advent and intensification of private sector controlled small and medium scale enterprises (SMEs) (Satia, 2011). Furthermore, the development of big commercial enterprises mostly stimulated by the combination of burgeoning public support, expertise, foreign direct investment, interest in aquaculture, the global awareness raised through the New Partnership for Africa's Development (NEPAD), Fish for All Summit of 2005, and the

implementation of the FAO Special Program for Aquaculture Development in Africa (SPADA) contributed to aquaculture growth (FAO 2020b).

In Uganda, aquaculture started in 1941 with the introduction of carp into the country by the colonial authorities (MAAIF,2012). Production grew from 15,000 to 118,000 from 2005 to 2015 due to interventions of government and developmental partners such as FAO (FAO, 2020). African catfish (*Clariasgariepinus*) and Nile tilapia (*Oreochromis niloticus*) are the two predominantly cultured fish species in Uganda, with production mainly made up of catfish (60%) and Nile tilapia (40%) (FAO,2020). Nile tilapia is widely cultured among the Ugandan fish farmers due to its prolificacy and tasty appeal (Cai et al.,2017). African Catfish production has been growing and notably common among farmers in the Eastern region as a result of perfection in the breeding technology among hatchery operators (Mwanja,2007).

Although Kamuli district produces mainly Nile tilapia (*Oreochromis niloticus*), there are also other species being farmed (KDAPS, 2020). Earthen ponds dominate the aquaculture production and these total to about 200 in number in the whole district (KDAPS,2020).Theproduction in the district is estimated at 6,516 kilograms per year, valued at 33,770,000 shillings (KDAPS,2021). Fish farmers producing Nile tilapia in earthen ponds in Kamuli experience a number of challenges which include; lack of quality fish seeds, lack of quality fish feeds, inadequate technical staff, lackof organized markets predators, floods, drought, insecurity/theft of fish and stunted growth(Ssebisubi, 2011 &Sserwambala, 2018). This study assessed and analyzed the causes of stunted growth and its implication on Nile tilapia earthen pond farm profitability and productivity. Information generated from this study will help in guiding farmers on how to minimize stunted growth and associated low yields and overall poor farm profitability.

1.2 Statement of the problem and justification of the study

Stunted growth is a major bottle to the rearing of earthen pond Nile tilapia (*Oreochromis niloticus*) in Kamuli district (Lovshin et al., 1990). At harvest, 28% to 70% of the total biomass consists of small stunted low-value fish (Bardach et al., 1972; Ruwet et al., 1976). This has resulted in the desertion of the fish farms by discouraged farmers because of the low output from the harvests, and poor productivity of the farms (Huisman, 1986). Therefore, this study identified and evaluated the causes of stunted growth in earthen pond Nile tilapia andassessed its implication on the profitability and productivity of the farms. This will help to guide farmers on how to counteract

the causes of stunted growth to optimize their Nile tilapia earthen pond production system productivity and profitability.

1.3.0 Objectives of the study

1.3.1 Main objective

To identify and evaluate the causes of stunted growth in earthen pond farmed Nile tilapia (*Oreochromis niloticus*) and its implication on profitability and productivity of selected Nile tilapia earthen pond farms in Kamuli district.

1.3.2 Specific objectives

1. To identify and analyze the causes of stunted growth of Nile tilapia from selected earthen pond farms.
2. To evaluate the implication of stunted growth on the profitability and productivity of Nile tilapia earthen pond farms.
3. To identify ways of mitigating the causes of stunted growth to optimize the growth performance of Nile tilapia in earthen fish ponds.

1.4 Research questions

1. What are the local causes of stunted growth in Nile tilapia raised under earthen pond culture system?
2. What is the implication of stunted growth on profitability and productivity of the fish farms?
3. How can stunted growth in earthen pond farmed Nile tilapia be mitigated?

1.5. CONCEPTUAL FRAMEWORK

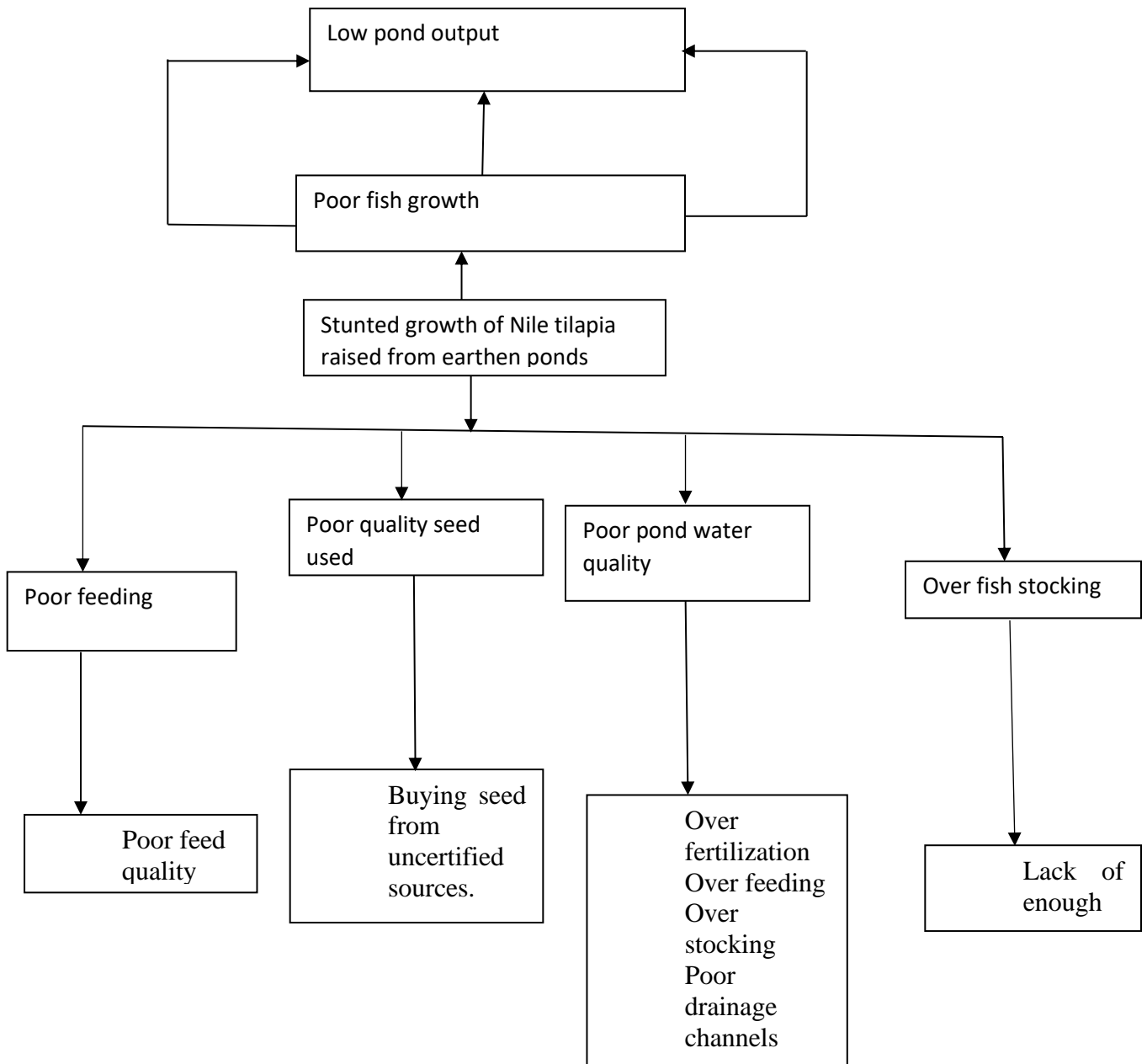


Figure 1: conceptual framework

1.6 Originality and contribution to new knowledge

The proposed study is original in terms of the content and geographical scope. Many studies conducted have focused majorly on the causes of stunted growth of Nile tilapia raised under pond culture system in other parts of the country, but not specifically in Kamuli district, yet it is a very serious problem facing fish farmers raising Nile tilapia in earthen ponds. More specifically, this

study is novel in sense that it seeks to identify and evaluate the causes of stunted growth Nile tilapia raised in earthen ponds, and the implication it has on profitability and productivity. To the best of my knowledge, no study has addressed this in the context of Kamuli, Eastern Uganda.

1.7 Significance of the study

The study focused on identification and analysis of the causes of stunted growth in the earthen pond farmed Nile tilapia (*Oreochromis niloticus*), as well as assessing the implication stunted growth has on the profitability and productivity on selected fish farms in Kamuli district. The study will help fish farmers in Kamuli district to increase Nile tilapia production from pond culture systems. Farmers' livelihoods will also be boosted, fish consumption and associated health benefits enhanced, thus, reducing malnutrition incidences especially among vulnerable groups.

References

1. Anders, P. (2001). Predator behavior and prey density: evaluating density-dependent intraspecific interactions on predator functional responses. *Journal of Animal Ecology* **70**,14–19.
2. Bukenya, J.O., Hyuha, T.S., Molnar, J. & Twinamasiko, J. (2013). Efficiency of resource use among pond fish farmers in central Uganda: a stochastic frontier production function approach.
3. Calow, P. (1979). Adaptive aspects of energy allocation. In *Fish Energetics: New Perspectives* (Tyler, P. & Calow, P., eds), pp. 13–32. Baltimore, MD: Johns Hopkins University Press.
4. Chivers, D., Zhao, X., Brown, G., Merchant, T. & Ferrari, M. (2008). Predator-induced changes
5. in morphology of a prey fish: the effects of food level and temporal frequency of
6. Predation risk. *Evolutionary Ecology* **22**, 561–574.
7. Chizinski, C. J. (2007). Life-history and morphological variation in stunted and non-stunted
8. fish. PhD Thesis, Texas Tech University, Lubbock, TX, USA. Cooke, S. J., Philipp, D. P.
9. Elfitasari, T., & Albert, A. (2017). Challenges of Small Scale Fish Farmers for Fish Product Sustainability. *13*(2), 128–136.
10. El-naggar, G. O., & Nasr-allah, A. M. (2017). Factors Influencing Fish Farm (A Case Study Of Behera Province). September 2006.
11. FAO, F. (2012) The state of World Fisheries and Aquaculture 2012.sofia
12. FAO. (2020a). Consumption of fish and fishery products. In: FAO [online]. 20 March 2020. www.fao.org/fishery/statistics/globalconsumption/en
13. FAO. (2020b). The State of World Fisheries and Aquaculture. In *Inform* (Vol. 32, Issue 6). <https://doi.org/10.4060/ca9229en>
14. Halwart, M. (2005). The role of aquaculture in rural development. 41–44.
15. Hyuha T, Bukenya J., Twinamasiko J., J. j. M. (2011). Profitability analysis of small scale aquaculture
16. Keizire, B. (2006). Sustainability impact assessment of proposed WTO negotiations: the fisheries sector. Country case study: Uganda.

17. Kiirya, D. (2011). Land use change and health. A case study of fish farming impacts on malaria prevalence in Kabale District, Uganda. Lund University, Sweden. (MA thesis).
18. MAAIF. (2012). Department of Fisheries Resource Annual Report 2010/2011. Ministry of Agriculture Animal Industry and Fisheries.
19. Makori AJ, Abuom PO, Kapiyo R, Anyona DN, D. G. (2017). Effects of water physicochemical parameters
20. Mulonde, N. (2013). Nikumu fish farming project. Document for NFFP and IECEDAA. (also available at www.globalgiving.org/pfil/14495/projdoc.pdf)
21. Roff, D. A. (1983). An allocation model of growth and reproduction in fish. *Canadian Journal*
22. *of Fisheries and Aquatic Sciences* **40**, 1395–1404.
23. Ssebisubi, M. (2011). Analysis of small-scale fisheries value chains in Uganda. (also available at www.fao.org/...fisheries/...Background_report_Uganda_April_2011.doc)
24. Sserwambala, S. (2018). Viability of aquaculture in Uganda. United Nations University Fisheries Training
25. Theodora, H., Ekere, W., Egna, H., & Molnar, J. J. (2017). Social and economic performance of tilapia farming in Uganda. January.
26. Ugandan fisheries: a contribution to the strategic criteria for rural investments in productivity. (SCRIP) Program of the USAID Uganda Mission. The International Food Policy Research Institute, Washington, D.C.