



**BUSITEMA
UNIVERSITY**
Pursuing Excellence

FACULTY OF ENGINEERING

AN INVESTIGATION OF THE FACTORS FOR RICE YELLOWING ALONG RIVER NAMADOPE



CHRISTINE AERON WOTALI, BU/UG/2011/209

**A FINAL YEAR PROJECT SUBMITTED TO THE FACULTY OF ENGINEERING, BUSITEMA
UNIVERSITY IN PARTIAL FULLFILMENT OF THE REQUIREMENTS FOR AWARD OF A
BACHELOR OF SCIENCE DEGREE IN WATER RESOURCES ENGINEERING**

SUPERVISORS:

- 1. Mr. Chris KAVUMA**
- 2. Mr. Emmanuel MUYINGO**

ABSTRACT

Rice (*Oryza glaberrima*) is a grain and the most widely consumed staple food for a large part of the world's human population, especially in Asia. It is the agricultural commodity with the third-highest worldwide production, after sugarcane and maize (FAO, 2012). Since a large portion of maize crops are grown for purposes other than human consumption, rice is the most important grain with regard to human nutrition and caloric intake, providing more than one fifth of the calories consumed worldwide by humans (Smith and Bruce, 1998). Genetic evidence has shown that rice originates from a single domestication 8,200–13,500 years ago (Molina *et al.*, 2011) in the Pearl River valley region of China (Huang *et al.*, 2012).

Rice (*Oryza*) was introduced in Uganda by Indian traders as early as 1904 (Bigirwa *et al.*, 2005). Rice production in Uganda started in 1942 mainly to feed the world war two soldiers, schools, prisoners and hospitals. However due to a number of constraints, production remained minimal until 1974 when farmers appealed to the then government for assistance (Bigirwa *et al.*, 2005).

Total production is estimated at 165,000 metric tons with total rice consumption estimated at 225,000 metric tons this makes national rice demand higher than current national production yet according to the Uganda National Bureau of Statistics (UBOS) (2009), the population growth rate is 3.2 % per year thus the demand for rice is expected to rise much higher.

Despite the demand for rice, it has been observed in Luuka District that rice is being affected in Luuka District through yellowing of the leaves and finally drying up.

This report involves a statement of problem(s), justification and objectives of study. It also reviews various literatures on the agronomic aspects of origins of rice, nutrition requirement and growth conditions of rice.

The report also outlines the various data collection methods (approaches) which were used to gather information, survey activity, several soil and water samples' tests was done in recognized laboratories, outcomes, data analysis and benefits of the investigation if implemented.

DEDICATION

I dedicate this report to my mother Mrs. Nattabi Juliet Ssanyu, my uncle Mr. Kyeyune Elmegious and my aunt Nakyeyune Resty who have raised me up, given me financial assistance, parental guidance and counseling plus encouragement in all my academic endeavors.

ACKNOWLEDGEMENT

I do give great gratitude to my supervisors who have worked tirelessly to see that my project becomes successful.

Appreciations also go to my friends who have always given me the words of encouragement.

I would also like to appreciate the residents of the project area for the knowledge got from them and for the amicable hospitality offered to me for the period I spent at the station.

DECLARATION

I do hereby declare that this project report has been compiled by me and has not been presented to any university or other institution of higher learning for any academic award.

Signature: Wotali Christine Aeron

WOTALI CHRISTINE AERON

Date: 22/05/2015



APPROVAL

This project work has been supervised by;

Signature:

MR. KAVUMA CHRIS

Main Supervisor

Date:

Signature:

MR. MUYINGO EMMANUEL

Co-Supervisor

Date:

TABLE OF CONTENTS

ABSTRACT	i
DEDICATION.....	ii
ACKNOWLEDGEMENT.....	iii
DECLARATION.....	iv
APPROVAL.....	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES.....	ix
LIST OF FIGURES.....	x
LIST OF ACRONYMS AND SYMBOLS	xi
CHAPTER ONE.....	1
1.0 INTRODUCTION	1
1.1. Background of the study.....	1
1.2. Problem statement.....	2
1.3. Justification.....	2
1.4. Purpose of study.....	2
1.5. Objectives	2
1.5.1 Main objective.....	2
1.5.2 Specific objectives.....	2
CHAPTER TWO.....	3
2.0 LITERATURE REVIEW.....	3
2.1. Origin of Rice	3
2.2. Nutritional role of Rice.....	3
2.3. World rice production.....	5
2.4. Production conditions (growth conditions) of rice.....	6
2.4.1. The total concentration of soluble salts.....	6
2.4.2. Sodicity.....	11
2.4.3. Water pH.....	12
2.4.4. Bicarbonate.....	13
2.5. SOIL PROPERTIES	15

2.5.1 Chemical properties.....	15
2.5.2 Physical Properties.....	17
2.5.3 Biological Properties.....	20
2.6 The Interaction between Soil and irrigation Water.....	22
2.6.1 Boron.....	22
2.6.2 Sodium.....	23
2.6.3 Salinity.....	24
2.7. Pests and diseases.....	25
2.7.1. Insects that affect rice.....	25
2.7.2. Diseases that affect rice.....	25
2.7.3. Nematodes.....	25
2.7.4. Other Pests.....	26
2.7.5. Integrated Pest Management.....	26
CHAPTER THREE: METHODOLOGY.....	28
3.1 Preamble.....	28
3.2 Assessing the physio-chemical composition of River Namadope water.....	28
3.2.1 Sample testing.....	28
3.2.2 Materials and equipment used in the study.....	28
Temperature was determined was determined using the thermometer.....	29
3.3 Assessing the properties of the soil along the banks of River Namadope.....	29
3.3.1 Sample testing.....	29
3.3.2 Materials and equipment used in the study.....	30
3.4. Identifying the pests and diseases affecting the rice growth in the area.....	33
3.4.1 Consultations.....	33
3.4.2 Interviews.....	33
CHAPTER FOUR: DATA PRESENTATION AND ANALYSIS.....	34
4.1 Preamble.....	34
4.2 Analysis and discussion of the physio-chemical composition of water results.....	34
4.4 Analysis and Discussion of the Soil Test Result.....	42
4.4.1 Infiltration Tests.....	42
4.3.2 Laboratory Tests.....	45
4.5 Analysis and Discussion of the pests and diseases results.....	51

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS.....	57
5.1 Preamble.....	57
5.2 CONCLUSION.....	57
5.3 RECOMMENDATIONS.....	57
REFERENCES.....	58
APPENDIX A.....	64
APPENDIX B.....	67
APPENDIX C.....	69

LIST OF TABLES

Table2. 1 Showing the nutrition content of rice compared to other food stuffs.....	4
Table2. 2 Showing USDA Salinity Laboratory's classification of saline irrigation water based on salinity level, potential injury to rice, and management necessary for satisfactory utilization.....	8
Table2. 3 Showing the leaching requirements.....	10
Table2. 4 Showing the classification of SAR.....	12
Table2. 5 Showing the classification of pH.....	13
Table2. 6 Showing the potential limitation of irrigation water due to carbonate level.....	13
Table2. 7 Showing the potential for precipitation of calcium and magnesium at the soil surface by high carbonate and bicarbonate in the irrigation water as determined by Residual Sodium Carbonate (RSC) equation.....	14
Table2. 8 showing the diameter soil type of four soil particles.....	17
Table4. 1 Showing average results of sample 1 taken during dry season.....	34
Table4. 2 showing average results of sample 2 taken during wet season.....	35
Table4. 3 showing the conversions mill equivalent per liter.....	36
Table4. 4 showing the discussions of the water results taken during the dry and wet season.....	37
Table4. 5 showing FOA's maximum permissible standards required in a stream.....	38
Table4. 6 showing the average temperature values taken during the dry season.....	41
Table4. 7 showing the average temperature values taken during the wet season.....	41
Table4. 8 showing infiltration test results.....	42
Table4. 9 soil grading results:.....	45
Table4. 10: Showing the soil classification using coefficient of uniformity C_u and degradation C_d	46
Table4. 11: Showing the liquid limit and plastic limit results.....	47
Table4. 12: Showing the soil classifications according to Plasticity Index.....	49
Table4. 13: Showing the Values of I_p and I_c according to consistency of soil.....	49
Table4. 14 showing the soil classification according to activity.....	49
Table4. 15: Showing a summary of chemical laboratory soil test results.....	50

1 LIST OF FIGURES

Figure2. 1 : illustrating the world production rice.....	5
Figure2. 2 : USDA Soil Classification Texture Diagram.....	18
figure4. 1: Graph comparing the results of sample 1 to the permissible water standards.....	39
figure4. 2: Graph comparing the results of sample 2 to the permissible water standards.....	39
figure4. 3: showing the comparison between sample 1 and sample 2.....	40
figure4. 4: Graph showing the infiltration depth against time.....	43
figure4. 5: Graph showing the infiltration rate against time.....	43
Figure4. 6: Graph illustrating the grading.....	46
Figure4. 7: illustrating the liquid limit and plastic limit results.....	48
Figure4. 8: Showing the state type of attack of rice diseases.....	51
Figure4. 9: Showing the state type of attack that mostly affects the farmers.....	51
Figure4. 10: Showing the pests that attack the rice.....	52
Figure4. 11 : Showing how farmers handle the challenge of pests in the area.....	52
Figure4. 12 : Showing how farmers are coping up with the diseases.....	53
Figure4. 13: Showing the farmers proposed solution to pests and diseases.....	53

LIST OF ACRONYMS AND SYMBOLS

Mt	Million tonnes
TDS	Total dissolved salts
SAR	Sodium absorption ratio
FAO	Food agricultural organization
RSC	Residual sodium carbonate
UNRDS	Uganda National Rice Development Strategy
DRS	Doho Rice Scheme
UBOS	Uganda National Bureau of Statistics
USDA	United States Department of Agriculture
ECw	Electrical conductivity
dS/m	DeciSiemens per meter
S/m	Siemens per meter
μS/cm	micro Siemens per centimeter
mmhos/cm	milliohms per centimeter
μmhos/cm	micromhos per centimeter
mg/lm	milligram/liter
ppm	part per million
CEC	Cation exchange capacity

LP	Leaching Percentage
mm	millimeters
IRRI	International Rice Research Institute
LR	Leaching Requirement

CHAPTER ONE

1.0 INTRODUCTION

This chapter explains the background of the study that leads to the problem statement. It also contains the main and specific objectives of the project in line with the significance of the research.

1.1. Background of the study

Rice (*Oryza glaberrima*) is a grain and the most widely consumed staple food for a large part of the world's human population, especially in Asia. It is the agricultural commodity with the third-highest worldwide production, after sugarcane and maize (FAO, 2012).

According to Bigirwa *et al.*, 2005, Rice (*Oryza*) was introduced in Uganda by Indian traders as early as 1904. Rice production in Uganda started in 1942 by the Uganda Government, mainly to feed the world war two soldiers, prisoners, schools and hospitals however due to a number of constraints, production remained minimal until 1974 when farmers appealed to government for assistance (Bigirwa *et al.*, 2005). In response, government introduced Doho Rice Scheme (DRS) with assistance from the Chinese experts as stated by the Uganda National Rice Development Strategy (UNRDS) (2009). In Uganda the total area under formal irrigation is 14,418 ha out of an estimated 560,000 ha with irrigation potential (FAO, 2004).

Today UNRDS (2009) says rice is grown mainly by small scale farmers almost throughout the country plus also some large scale farmers in few places. Total production is estimated at 165,000 metric tonnes with total rice consumption estimated at 225,000 metric tons this makes national rice demand higher than current national production yet according to the Uganda National Bureau of Statistics (UBOS) (2009), the population growth rate is 3.2 % per year thus the demand for rice is expected to rise much higher.

According to UBOS (2009) about 80% of rice farmers in Uganda are small scale farmers with an area of less than 2 hectares using simple technologies including use of rudimentary tools, little or no fertilizer use, poor qualified seeds, with little or no irrigation and poor water management practices among others. Recent developments have seen rice cultivation expand in the traditional crop growing districts of Bugiri, Iganga, Tororo and Pallisa (UNRDS, 2009).

REFERENCES

- "IRRI Rice insect pest factsheet: Stem borer". Rice Knowledge Bank. Archived from the original on November 22, 2014.
- "Possible connection between imidacloprid-induced changes in rice gene transcription profiles and susceptibility to the brown plant hopper *Nilaparvata lugens* Stål (Hemiptera: Delphacidae)". *Pesticide Biochemistry and Physiology* 102 (3): 213–219.
- 29, rev. 1, Food and Agriculture Organization of the United Nations, Rome.
- A National Irrigation Master Plan for Uganda (2010 - 2035)
- Akbar M. and Ponnampereuma F.N., 1980. Saline soil of South and Southeast Asia as potential rice lands. In 'Rice Research Strategies for the Future, IRRI, Manila, Philippines', pp. 265–281
- Ayers and D. W. Westcott. 1989. Water Quality for Agriculture. Irrigation and Drainage Paper
- Bauder TA, Cardon GE, Waskam RM and Davis JG (2004) Irrigation water quality. Colorado
- Chen H.J., Chen J.Y. and Wang S.J., 2008. Molecular regulation of starch accumulation in rice
- Cheng, Yao; Shi, Zhao-Peng; Jiang, Li-Ben; Ge, Lin-Quan; Wu, Jin-Cai; Jahn, Gary C. (2012).
- Cohen, J. E., Schoenly, K., Heong, K. L., Justo, H., Arida, G., Barrion, A. T., & Litsinger, J. A.; Schoenly; Heong; Justo; Arida; Barrion; Litsinger (1994). "A Food-Web Approach to Evaluating the Effect of Insecticide Spraying on Insect Pest Population-Dynamics in a Philippine Irrigated Rice Ecosystem".
- Cuena, R.H. 1989. Irrigation System Design. Prentice Hall, Englewood Cliffs, NJ, USA. pp. 552.
- Djanaguiraman M., Senthil A. and Ramadass R., 2003. Assessment of rice genotypes for salinity tolerance at germination and seedling stage. Madras Agriculture Journal 90(7-9): 506-510.
- Döll, P. and S. Siebert. (2002) Global modeling of irrigation water requirements, Water
- Douangboupha, B, K Khamphoukeo, S Inthavong, J Schiller, and GC Jahn, 2006. Pests and diseases of the rice production systems of Laos. Chapter 17, pp. 265–281. In JM Schiller, MB Chanphengxay, B Linquist, and S Appa Rao, editors. Rice in Laos. Los Baños (Philippines): IRRI. ISBN 978-971-22-0211-7.
- Elisa AA, Shamsuddin J, Fauziah CI (2011) Root elongation, root surface area and organic acid exudation by rice seedling under Al³⁺ and/or H⁺ stress. Amer J Agric Bio Sci. 6: 324-331.
- Farnham et al, 1984 Wastewater Reuse for Golf Course Irrigation. adapted from Westcott and Ayers,
- Ferrer, B. (2012), Do rice and salt go together?

- Flowers T.J and Yeo A.R., 1981. Variability in the resistance of Sodium chloride salinity within rice (*Oryza sativa* L.) varieties. *The New Phytologist* 88:363-373.
- Fredenburg, P. (2007), "Less salt, please" Retrieved September 30, 2013
- Gardiner, D. T. and R.W. Miller. 2004. *Soils in our environment*, 10th Edition. Pearson Education, Inc. Upper Saddle River, New Jersey. 641 p.
- Görham J., 1993. Genetics and physiology of enhanced K/Na discrimination. In 'Genetic Aspects of Plant Mineral Nutrition' (Eds. Randall P.J., Delhaize E., Richards R.A. and Munns R.), Kluwer Academic Publishers, The Netherlands'. pp. 151-159.
- Hand book of Agriculture, 2006. Indian Council of Agricultural Research, New Delhi.
- Hasegawa P.M., Bressan R.A., Zhu J.K. and Bohner H.J., 2000. Plant cellular and molecular responses to high salinity. *Annual Review of Plant Physiology* 51: 463-499.
- Henry Sackville Hamilton (January 18, 2008). "The pesticide paradox". Archived from the original on January 19, 2012.
- hydrochemistry of Kushtia District, Bangladesh. *J. Asiatic Soc. Bangladesh Sci.* 25 (1): 1- 1
- International Rice Research Institute (IRRI) (2013). Retrieved September 30, 2013. "Wild parent spawns super salt tolerant rice"
- International Rice Research Institute (IRRI). Retrieved September 29, 2013 "Drought, submergence and salinity management.
- Islam, M. S., M. Q. Hassan and S.Z.K.M Shamsad. 1999. Ground water quality and
- Jahn, G.C. (1992). "Rice pest control and effects on predators in Thailand". *Insecticide & Acaricide Tests* 17: 252-3.
- Jahn, Gary C.; Almazan, Liberty P.; Pacia, Jocelyn B. (2005). "Effect of Nitrogen Fertilizer on the Intrinsic Rate of Increase of *Hysteroneura setariae* (Thomas) (Homoptera: Aphididae) on Rice (*Oryza sativa* L.)". *Environmental Entomology* 34 (4): 938. doi:10.1603/0046-225X-34.4.938.
- Jahn, Gary C.; JA Litsinger, Y Chen and A Barrion (2007). "Integrated Pest Management of Rice: Ecological Concepts". In O Koul and GW Cuperus. *Ecologically Based Integrated Pest Management*. CAB International. pp. 315-366. ISBN 978-1-84593-064-6.
- Jahn, GC, B. Khiev, C Pol, N Chhorn, S Pheng, and V Preap. 2001. Developing sustainable pest management for rice in Cambodia. pp. 243-258.

- Jahn, GC, S Pheng, B Khiev, and C Pol. 1996. Farmers' pest management and rice production practices in Cambodian lowland rice. Cambodia-IRRI-Australia Project (CIAP), Baseline Survey Report No. 6. CIAP Phnom Penh, Cambodia.
- James B. Beard, 1982 *Turf Management for Golf Courses*; MacMillan Publishing, 642 p
- Juliano, Bienvenido O. (1993). "Rice in human nutrition". Food and Agricultural Organization of the United Nations.
- Lafitte, H.R., A. Ismail, J. Bennett. 2004. Abiotic stress tolerance in rice: Fore asia progress and the future. International Rice Research Institute, DAPO 7777, Metro Manila, Philippines. .
- Linghe Z., Shannon M.C. and Zeng L.H., 2000. Salinity effects on seedling growth and yield components of rice. *Crop Science* 40(4): 996-1003.
- Marschner H., 1986. *Mineral Nutrition of Higher Plants*. Academic Press, London. p. 674.
- Miller, R. W., and D. T. Gardiner. 2007 American Society of Civil Engineers, USA. p. 619. *Soils in our environment*. 9th edition. Prentice Hall-Inc., Upper Saddle River, New Jersey 07458. ISBN 0-13-020036-0; Table 15-6, page 452.
- Molina, J.; Sikora, M.; Garud, N.; Flowers, J. M.; Rubinstein, S.; Reynolds, A.; Huang, P.; Jackson, S.; Schaal, B. A.; Bustamante, C. D.; Boyko, A. R.; Purugganan, M. D. (2011). "Molecular evidence for a single evolutionary origin of domesticated rice". *Proceedings of the National Academy of Sciences* 108 (20): 8351.
- Moorman, F.M. 1978. Morphology and classification of soils on which rice is grown; In: *Soils and rice*. IRRI, Philippines.
- Murphy L.R., Kinsey S.T. and Durako M.J., 2003. Physiological effects of short-term salinity changes on *Ruppia maritima*. *Aquatic Botany* 75: 293-309.
- Netondo G.W., Onyango J.C. and Beck E., 2004. Sorghum and salinity: II. Gas exchange and chlorophyll fluorescence of sorghum under salt stress. *Crop Science* 44: 806- 811.
- P.Merkley, Richard G. Allen., 2007 Biological and irrigation Engineering department.
- Pheng, S, B Khiev, C Pol and GC Jahn (2001). "Response of two rice cultivars to the competition of *Echinochloa crus-gali* (L.) P. Beauv". *International Rice Research Institute Notes (IRRN)* 26 (2): 36-37.
- Ponnamperuma F.N., 1984. Role of cultivar tolerance in increasing rice production on saline lands. In: *'Salinity Tolerance in Plants: Strategies for Crop Improvement* (Ed. R.C. Staples & G.A. Toenniessen), Wiley International, New York'. pp. 255-271.

Preap, V; Zalucki, MP and Jahn, GC (2006). "Brown planthopper outbreaks and management". *Cambodian Journal of Agriculture* 7 (1): 17-25.

Rahman M., Soomro U.A., Haq M.Z. and Gul S., 2008. Effects of NaCl salinity on wheat (*Triticum aestivum* L.) cultivars. *World Journal of Agriculture Science* 4(3): 398- 400.

Rajendra Prasad, 1999. A text book of Rice Agronomy. Jain Brothers, New Delhi.

Resources Research, Vol. 38, No. 4:

Rogers M.E., Colmer T.D., Frost K., Henry D., Cornwall D., Hulm E., Hughes S., Nichols P.G.H. and Craig A.D., 2009. The influence of NaCl salinity and hypoxia on aspects of growth in *Trifolium* species. *Crop Pasture Science* 60: 71-82.

S. Suthipradit, C. Kuntha, S. Lorlowhakarn, and J. Rakngan [eds.] "Sustainable Agriculture; Possibility and Direction" Bangkok (Thailand): National Science and Technology Development Agency.

Sairam R.K. and Tyagi A., 2004. Physiology and molecular biology of salinity stress tolerance in plants. *Current Science* 86: 407-421.

Saleh J. and Maffoun M., 2008. Interactive effect of NaCl levels and Zinc sources and levels on the growth and mineral composition of rice. *Journal of Agriculture Science and Technology* 10: 325-336.

Santosh Kumar Garg, 1998 Irrigation engineering and hydraulic structure; Khana Publishers, Delhi

Savary, S.; Horgan, F.; Willocquet, L.; Heong, K.L. (2012). "A review of principles for sustainable pest management in rice". *Crop Protection* 32: 54. doi:10.1016/j.cropro.2011.10.012.

Schafer, W. M. 1983, Irrigation water quality in Montana. Montana State University Coop. Ext. Serv., Montguide MT8373.

seedling leaves in response to salt stress. *Acta Physiologiae Plantarum* 30(2): 135-142

Singleton G, Hinds L, Leirs H and Zhang Zh (Eds.) (1999) "Ecologically-based rodent management" ACIAR, Canberra. Ch. 17, pp. 358-371 ISBN 1-86320-262-5

Smith, Bruce D. (1998) *The Emergence of Agriculture*. Scientific American Library, A Division of HPHLP, New York, ISBN 0-7167-6030-4

State University. Cooperative Extension Agriculture 506.

Tanji, K.K. 1990. Agricultural Salinity Assessment and Management. Manuals and Reports on Engineering Practice Number 71.

UCCC (University of California Committee of Consultants). Guidelines for Interpretations of water Quality for Irrigation. Technical Bulletin, University of California Committee of Consultants; California, USA pp. 20-28; 1974

Wang, Li-Ping; Shen, Jun; Ge, Lin-Quan; Wu, Jia-Cai; Yang, Guo-Qin; Jahn, Gary C. (2010). "Insecticide-induced increase in the protein content of male accessory glands and its effect on the fecundity of females in the brown planthopper *Nilaparvata lugens* Stål (Hemiptera: Delphacidae)". *Crop Protection* 29 (11): 1280. doi:10.1016/j.cropro.2010.07.009.

Xin, Zhaojun; Yu, Zhaonan; Erb, Matthias; Turlings, Ted C. J.; Wang, Baohui; Qi, Jinfeng; Liu, Shengning; Lou, Yonggen (2012). "The broad-leaf herbicide 2,4-dichlorophenoxyacetic acid turns rice into a living trap for a major insect pest and a parasitic wasp". *New Phytologist* 194 (2): 498-510. doi:10.1111/j.1469-8137.2012.04057.x. PMID 22313362.