

**THE ECOLOGICAL AND ECONOMIC BENEFITS OF RICE-DUCK-PIG
FARMING SYSTEM AT THE FUTURE RICE FARM OF PHILRICE**

ANDREA N. ADRIANO

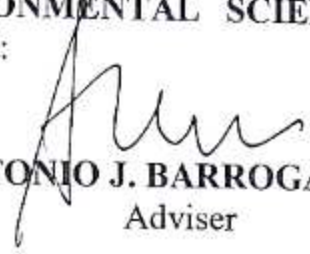
An Undergraduate Thesis Submitted to the Faculty of the Department of Environmental
Science, College of Arts and Sciences, Central Luzon State University,
Science City of Muñoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the Degree of


**BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE
(Sustainable Agriculture)**

FEBRUARY 2020

ACCEPTANCE SHEET

This undergraduate thesis entitled "THE ECOLOGICAL AND ECONOMIC BENEFITS OF RICE-DUCK-PIG FARMING SYSTEM AT THE FUTURE RICE FARM OF PHILRICE," prepared and submitted by ANDREA N. ADRIANO, in partial fulfillment of the requirements for the degree of BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE (SUSTAINABLE AGRICULTURE), is hereby accepted:


ANTONIO J. BARROGA, Ph.D.
Adviser


LUZVIMINDA S. QUITOS, Ph.D.
Critic

1-22-2020

Date Signed

Date Signed


LUZVIMINDA S. QUITOS, Ph.D.
Department Research Coordinator

1-22-2020

Date Signed

Accepted as partial fulfillment of the requirements for the degree of BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE (SUSTAINABLE AGRICULTURE):


SHARON E. LAZARO, Ph.D.
Chair, Department of Environmental Science


KRISTINE GRACE D WAING, M.Sc.
College Research Coordinator

22 January 2020

Date Signed

1/23/2020

Date Signed


EVARISTO A. ABELLA, Ph.D.
Dean, College of Arts and Sciences

Date Signed

BIOGRAPHICAL SKETCH

The author of this thesis was born on February 08, 1999 in Barangay Palusapis, Science City of Muñoz, Nueva Ecija. She was the eldest daughter of Mr. Domingo P. Adriano and Mrs. Norma N. Adriano, and the sibling of Ms. Andrelle N. Adriano. When she was a young and until now, her dreams were to give happiness and inspiration to the other people and to have an own simple and happy family someday. When she was on her elementary stage until now in college stage, she always brings the thought that her parents tell her “be good and nice to other people”. Because it is the key to have a true friendship.

The journey of her life wasn't easy, there were a good times and bad times, but in the end of the day she decided to become happy no matter what happen in her life. And she knows that things happen for a reason and all things work for good.

In how many years living here on Earth, there are many challenges and problems that she encountered in life. But she never gives up, because she knew that there's challenges and problems, make her, strong and her faith was becoming tested. She also knew that all challenges and problems was not just challenges and problems, but it just a blessing, a blessing came from Almighty God. Most of us didn't recognized it as blessing because they will not already satisfy what they want. This blessing called “blessing in disguised”. This “blessing in disguised” give us people a lesson in life that we can give us a wisdom.

All this challenges and problems that she encountered became a way to mold her character, became strong and became a better person, she was now Andrea N. Adriano.

ACKNOWLEDGMENT

The author extends her deepest and sincere gratitude to Almighty God, for the wisdom, diligence and faith provided to her to finish this study.

Endless thanks to the Philippine Rice Research Institute, with special mention to the former Project Manager of Future Rice Farm, the late Mr. Roger F. Barroga for the experimental venue and providing the much-needed logistics and financial support for the conduct of her research activities.

Much appreciation to the Department of Environmental Science, for their support, kindness and guidance towards a relevant study that generates new knowledge on rice duck pig farming system at the same time protecting the environment.

Deepest thanks to his adviser, Dr. Antonio J. Barroga, the all-out support, encouragement and motivation to pursue this study.

To her critic and her Department Research Coordinators, Sir Roberto D. Pelayo, Ma'am Ma. Johanna J. De Dios, Dr. Luzviminda S. Quito, Ma'am Criselda Francisco, Dr. Sharon E. Lazaro, for their constructive comments toward the further improvement of her manuscript, for their scholarly scrutiny of her research work and for his support and pieces of advice towards improvement of the manuscript.

Immense thanks also for the valuable manpower and 24- hour security provided by the animal caretaker, Kuya Dong, and farm worker, Kuya Sony, Mang Donat, Kuya Jomar and all Security Guards on Duty of Future Rice Farm and Zero Waste Pig Farm (ZWAP), respectively, without them, the success of this study would not be possible.

To her parents Domingo P. Adriano and Norma N. Adriano, and to her siblings Andrelle N. Adriano for the continuing support, encouragement unconditional love, trust, care, guidance, and protection. Their emotional and spiritual advises made her strong and prepared to hurdle this critical challenge in her life.

Finally, to all her teachers, classmates, friends and Cadet officers of the CLSU ROTC Unit for the friendship and motivation. To all those who were not mentioned but continued praying for her to achieve her goals, they will always be remembered.

TABLE OF CONTENTS

	PAGE
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF EQUATION	xi
LIST OF APPENDIX FIGURES	xii
ABSTRACT	xiv
INTRODUCTION	1
Background of the Study	1
Objectives of the Study	2
Significance of the Study	2
Scope and Limitations of the Study	3
Time and Place of the Study	3
REVIEW OF RELATED LITERATURE	4
Rice	4
Rice Industry	4
Domestic Production of Rice	6
Duck	7
Importance of Duck	7
Domestic Production of Duck	7
Rice-Duck Farming System	8
History of Rice-Duck Farming System	8
Pioneer of Rice-Duck Farming System in Asia	9
Rice-Duck Farming System in the Philippines	9
Rice-Duck Farming System Association in the Philippines	10
Economic Benefits of Rice-Duck Farming to the Farmers	11
Importance of Rice-Duck Farming System in the Environment	11
Golden Apple Snail <i>Pomacea Canaliculata</i> (Lamarck)	12

History of Golden Apple Snail (<i>Pomacea Canaliculata</i>)	12
Ecology of Golden Apple Snail (<i>Pomacea Canaliculata</i>)	13
Impact of Golden Apple Snail (<i>Pomacea Canaliculata</i>) in the Philippines	13
Biological Control	14
Chemical Control	15
Integrated Pest Management	16
Weed	16
Insect	18
Organic Farming	20
Inorganic Farming	22
Organic Rice Farming in the Philippines	22
Livestock Production	24
History of Future Rice Farm	25
METHODOLOGY	27
Study Area	27
The Integration Concepts of the Rice-Duck-Pig Farming System	27
Data Gathering for Flora & Fauna in Rice-Duck-Pig Farming System	29
Data Gathering e in the Rice-Duck-Pig Farming System for Weed and Pest Abundance	29
Data Gathering for Economic Benefits of Rice-Duck-Pig Farming System	30
Data Gathering for Ecological Benefits of Rice-Duck-Pig Farming System	30
RESULTS AND DISCUSSION	32
The Integration Concepts of Rice-Duck-Pig Farming System	32
Flora and Fauna in the Rice-Duck-Pig Farming System	40
Effect of Ducks Rice-Duck-Pig Farming System on Weed and Pest Abundance	48
Economic Benefits of Rice-Duck-Pig Farming System	52
Ecological Benefits of Rice-Duck-Pig Farming System	57
Nutrient Supplying Ability of Duck Manure in Rice- Duck- Pig Farming System	57
Reduced the Emission of Greenhouse Gases and Enriched the Biodiversity of Species	58
Disposal of Waste Coming from the Piggery	58
Occupational Hazard and Food Security	59

SUMMARY, CONCLUSION AND RECOMMENDATION	61
Summary	61
Conclusion	62
Recommendation	62
LITERATURE CITED	63
APPENDICES	74

LIST OF TABLES

TABLE		PAGE
1	Farm management practices of integrated rice-duck-pig farming system	39
2	Common and scientific names of identified flora in the rice-duck-pig farming system	41
3	Common and scientific names of identified fauna in the rice-duck-pig farming system	43
4	Rice- duck- pig farming system production expense for palay pales	52
5	Rice- duck- pig farming system production expense for milled rice	55

LIST OF FIGURES

FIGURES		PAGE
1	The zero-waste pig farming of i rice-duck-pig farming system	32
2	Odorless pig barn in the rice-duck-pig farming system	33
3	Nutrient supply from OEMC treated biogas and pig barn litter bed	34
4	Substrates of the vermicomposting area in the rice-duck-pig farming system	35
5	Paddy field rice duck grazing in the integrated rice-duck-pig farming system	36
6	Organic vegetable production in the rice-duck-pig farming system	37
7	Mutha	41
8	Barnyard Grass	42
9	Damselfly	43
10	Lady bug	45
11	Snail	46
12	Comparative Photo of the (a) paddy field with plenty of weeds, and (b) another one with barely no weeds	48
13	Photo of duck feasting on insects	51

LIST OF EQUATIONS

EQUATIONS		PAGES
1	Gross net income	30
2	Return on investment	30
3	Payback period	30

LIST OF APPENDIX FIGURES

APPENDIX FIGURE		PAGE
1	Location map of the research area	74
2	High Tech Climate Smart Integrated Zero Waste Pig Farming	75
3	Variety of Seed	76
4	Brooding of ducks	76
5	Preparation for zero waste pig house	76
6	30 Heads of pig inside the zero wastes pig house	76
7	Land Preparation	77
8	Transplanting using mechanical trans-planter	77
9	Installation of Fence	77
10	Installation of duck housing	77
11	Introduction of 54 ducks in the rice paddy field	78
12	Septic tank of ZWAP which sludge came from	78
13	Sludge coming from wallowing pool of zero wastes pig	78
14	Putting sludge into the rice paddy field	78
15	With drawing of ducks in the rice paddy field	79
16	Harvesting of palay	79
17	Site visited by adviser	79
18	The different flora that was found in CLSU paddy herding area by (Claro,2019)	80

ABSTRACT

ADRIANO, ANDREA N., Department of Environmental Science, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **February 2020**, **THE ECOLOGICAL AND ECONOMIC BENEFITS OF RICE-DUCK-PIG FARMING SYSTEM AT THE FUTURE RICE FARM OF PHILRICE.**

Adviser: ANTONIO J. BARROGA, Ph.D.

A rice-duck-pig farming system integrated to an existing ICT- enable (IOT), climate smart with air quality sensors from a 30 head Zero Waste Pig (ZWAP) housing system was described in this study. Fifty-four ducks at two weeks old were introduced in a 485.76 m² mesh net fenced enclosed paddy field, when the rice plants were fourteen days old after day of transplanting to document the ecological benefits. The investment cost and net profit derived from fresh palay and organic milled rice sales recorded to demonstrate its economic benefits. Result demonstrated an ecological benefits of rice-duck-pig farming system as evidence by the presence of ducks in the rice paddy field, resulting to reduction in weeds and pest in the paddy field. Considering a fresh palay yield of 85.4 kg with the duck's feces and pig slurry as the main source of fertilizer, the nutrient supplying effect of rice-duck-pig farming system was therefore demonstrated. Finally, a net income from palay sales was Php 872.00 and Php 4,890.00 for organic milled rice was realized indicating the economic benefits. Therefore, the integrated rice-duck-pig farming system can be recommended as a feasible and environmentally friendly farming system due to its ecological and economic benefits.

Keywords: rice- duck- pig farming system; organic fertilizer.

LITERATURE CITED

- Ahmad, A. A., Radovich, T. J. K., Nguyen, H. V., Uyeda, J., Arakaki, A., Cadby, J., Paull, R., Sugano, J. & Glenn. (2016). Use of organic fertilizers to enhance soil fertility, plant growth, and yield in a tropical environment. Retrieved from <https://www.intechopen.com>.
- Arif, M., Ali, K., Jan, M. T., Shah, Z., Jones, D. L., & Quilliam, R. S., (2016). Integration of biochar with animal manure and nitrogen for improving maize yields and soil properties in calcareous semi-arid agroecosystems. *Field Crop Research*, 195, 28–35. doi.org/10.1016/j.fcr.2016.05.01
- Asaka, A., & Sato, Y. (1987). Feeding inhibitory efficiency of cartap and bensultap against the apple snail, *pomacea canaliculata*. *Japanese Journal of Applied Entomology and Zoology*, 31(4), 339-343. dx.doi.org/10.1303/jjaez.31.339
- Asian Farmers Association for Sustainable Rural Development, (2010). In the news (Philippines): *NGO promotes Ducks as Solution to global warming, rice insufficiency*. Retrieved from tucp.org.ph.
- Atienza, L. M., Rodriguez, M. D. P., Babilonia, D. R., Guimary, M., & Rebancos, C. (2015). Food safety study of duck eggs produced along Laguna Lake areas, Philippines. *Journal of Nutrition & Food Science*. 13(3), 1-5. doi:10.4172/2155-9600.S3-005
- Barroga, R. M. (2006). *Rice monoculture and rice-duck farming system in Bukidnon: a comparative analysis*. A Dissertation Presented to Faculty of Graduate School Polytechnic University of the Philippines Sta. Mesa, Manila.
- Basu, M. (2018). Ducks wade through paddy fields to bump up profits. Retrieved from <https://india.mongabay.com>.
- Birkhofer, K., Liebbach, A., Wise, D. H., & Scheu, S. (2008). Generalist predators in organically and conventionally managed grass-clover fields: implications for conservation biological control. *Annual of Applied Biology* 153, 271–280.
- Boggs, L. C., Kennedy, A. C., & Reganold, J. P. (2000). Organic and biodynamic management effects on soil biology. *American Journal of Soil Science Society*, 64(5), 1651-1659. Doi:10.2136/sssaj2000.6451651x
- Brett, M. T. (1989). Zooplankton communities and acidification processes (a review). *Water, Air, and Pollution*, 44, 387-414. doi.org/10.1007/BF00279267
- Briggs, S. A., & Rachel, C. (1992). Basic guide to pesticides: their characteristics and hazards: their characteristics & hazards. Retrieved from <https://www.bookdepository.com>.

- CABI, (2019a). *Pomacea canaliculata* (golden apple snail). Retrieved from <https://www.cabi.org/isc/datasheet/68490>.
- CABI, (2019b). *Rhyzopertha dominica* (lesser grain borer). Retrieved from <https://www.cabi.org>.
- Cagauan, A. G, Joshi, R. C. (2002). Golden apple snail *pomacea spp.* in the Philippines: review on levels of infestation, control methods, utilization and future research directions. *Journal of Agriculture and Life Sciences*, 37, 7-32.
- Carlsson, N., Kestrup, A., Martensson, M., & Nyström, P. (2004). Lethal and non-lethal effects of multiple indigenous predators on the invasive golden apple snail (*pomacea canaliculata*). *Freshwater Biology*, 49(10), 1269-1279. doi:10.1111/j.1365-2427.2004.01269.x
- Castillo L.V., & Casal C. M. V, (2006). Golden apple snail utilization in small-scale aquaculture in the Philippines. In: global advances in ecology and management of golden apple snails. Retrieved from <https://www.worldfishcenter.org/content/golden-apple-snail-utilization-small-scale-aquaculture-philippines-0>.
- Chang, H. S., Dagaas, C., De Castro, N., Ranola, R., Lambio, A., & Malabayuabas, M. L (2003). An overview of Philippine duck industry. Retrieved from http://ageconsearch.umn.edu/bitstream/57842/2/2003_chang1.pdf.
- Cheung, Y. H., & Wong, M. H. (1983). Utilisation of animal manures and sewage sludges for growing vegetables. *Agricultural Wastes*, 5(2), 63–81. doi.org/10.1016/0141-4607(83)90086-0
- Claro, C. (2019). *Chemical Characterization of Flora and Fauna for Itik Pinas (Anas platyrynchos Linn). Raised Under Range Management System During Dry Season*. An undergraduate thesis manuscript to be presented in partial fulfillment of the requirements for graduation with the degree of Bachelor of Science in Agriculture major in Animal Science from Central Luzon State University, Science City of Muñoz, Nueva Ecija.
- Cowie, R. (2013) *Pomacea canaliculata* (golden apple snail). Retrieved from <https://www.cabi.org>.
- Cruz, M. S., Joshi, R. C. (2001). Efficacy of commercial molluscicide formulations against the golden apple snail *pomacea canaliculata* (lamarck). *Philippine Agricultural Scientist*, 84 (1), 51-55.
- Cruz, MA. C. D. (2017). PH ramps up organic rice export. Retrieved from <https://www.google.com>.

- Darby, P. C., Bennetts, R. E., Miller, S. J., & Percival, H. F. (2002). Movements of florida apple snails in relation to water levels and drying events. *Wetlands*, 22, (3) 489-498.
- Das, B. B., & Dkhar, M. S. (2011). Rhizosphere microbial populations and physiochemical properties as affected by organic and inorganic farming practices. *American -Eurasia Journal of Agriculture and Environmental Science*, 10(2), 140-158.
- Debach, P., & Rosen, S. (1991). Biological control by natural enemies. *Journal of Tropical Ecology*, 8(2), 216. doi.org/10.1017/s0266467400006374
- Fabe, B. (2013). *Climate change: reporting lens from Asia*. Retrieved from <https://www.climatechanges.asia/rice-farmers-need-pitch-in>.
- Fernando, N. C. (2016). Survey of Insect in Organic and Inorganic Rice Farming. An Undergraduate Thesis, Central Luzon State University, Nueva Ecija, Philippines.
- Food and Fertilizer Technology Center, (1996). Asia productivity organization. Retrieved from <http://unfao.koha-ptfs>.
- FAO, (2002). Organic agriculture and rural poverty alleviation: potential best practices in Asia. Retrieved from <http://agris.fao.org/agris-search/search.do?recordID=GB2013200059>.
- FAO, (2013). Greenhouse gas emissions from pig and chicken supply chains – a global life cycle assessment. Retrieved from <http://www.fao.org>.
- FAO, (2018). Rice Market Monitor. Retrieved October 25, 2019 from <http://www.fao.org>.
- Furuno, T. (2001). The power of duck (integrated rice-duck farming). *Tagari Publications*. Retrieved from <https://www.schwabfound.org>.
- Gazey, P. (2019). Soil acidity. Retrieved from <http://soilquality.org>.
- Gregorich, E. G., Carter, M. R., Angers, D. A., Monreal, C. M., Ellert, B. H., (1994). Towards a minimum data set to assess soil organic matter quality in agricultural soils. *Canadian Journal Soil Science*, 74, 367-385. doi:22.52.231.1001/22/20
- Guia, J. (2012). Nueva Ecija: The food bowl and rice granary of Central Luzon. Retrieved from <https://www.vigattintourism.com>.

- Halwart, M. (1994). The golden apple snail *pomacea canaliculata* in Asia rice-farming systems: present impact and future threat. *International Journal of Pest Management*, 40 (2), 199-206. doi.org/10.1080/09670879409371882
- Hillstrom, M. L. & Lindroth, R. L. (2008). Elevated atmospheric carbon dioxide and ozone alter forest insect abundance and community composition. *Insect Conservation and Diversity* 1(4), 233-241.
- Hole, D. G., Pekins, A. J., Wilson, J. D., Alexander, I. H., Grice, P. V., & Evans, A. D. (2005). Does organic farming benefits biodiversity. *Biological Conservation*, 122, 113-130. doi:10.1016/j.biocon.2004.07.018
- Holm, L. G., Pancho, J. V., Herberger, J. P., & Plucknett, D. L. (1991). A geographic atlas of World weeds. Malabar, Florida, USA: Krieger Publishing Company.
- Hossain, S. T. (2017). Shaik Tanveer Hossain, Vice-President IFOAM Asia, Bangladesh. *research institute of organic agriculture*. Retrieved from <https://www.organic-research>.
- Huffaker, C. B., & Messenger, P. S. (1976). Theory and practices of biological control. academic press Inc. pp. 17-18.
- Ingels, J. E. (1994). Ornamental horticulture: science operation management. State University of New York, College of Agriculture. Delma Publishing Inc. 2nd ed. 34 pp.
- IRRI, (1995). Modeling the impact of climate change on rice production in Asia. Retrieved from <http://books.irri.org>.
- IRRI, (2002). Rice almanac: source book for the most important economic activity on Earth. Retrieved from <http://books.irri.org>.
- IRRI, (2017). Towards a more resilient and competitive philippines rice industry: lesson from the past three decades. Retrieved from <http://books.irri.org>.
- Jahn, G. C., Almazan, L. P., & Pacia, J. (2005). Effect of nitrogen fertilizer on the intrinsic rate of increase of the rusty plum aphid, *hysteroneura setariae* (thomas) (homoptera: aphididae) on rice (*oryza sativa* l.). *Environmental Entomology*, 34 (4), 938-943. doi.org/10.1603/0046-225X-34.4.938
- Khan, H. I. (2018). Appraisal of biofertilizers in rice: to supplement inorganic chemical fertilizer. *Rice Science*, 34(4), 938-943. doi.org/10.1016/j.rsci.2018.10.006
- Lampkin, N. H. (1994). Organic farming and agricultural sustainability. Retrieved from <https://ideas.repec.org>.

- Levin P. (2006). Statewide strategic control plan for apple snail (*pomacea canaliculata*). Retrieved from <http://www.hear.org>.
- Liang, K. M., Zhang, J. E., Lin, T., Quan, G.M., & Zhao, B. L. (2012) A. Control effect of two batch- duck raising framing on rice diseases, insect pest and weeds in the paddy field. *Advance Journal of Food Science and Technology*, 4(5), 309-315.
- Lohner, T.W., & Fisher, W. (1990). Effects of ph and temperature on the acute toxicity and uptake of carbaryl in the midge, *Chironomus Riparius*. *Aquatic Toxicology*, 16 (4), 335-353. doi.org/10.1016/0166-445X(90)90045-Q
- Mader, P., Ma, P., Flie, A., Dubois, D., & Gunts, L. (2002). Soil fertility and biodiversity in organic farming. Washington, D. C. American Association for the Advancement of Science. Retrieved from <https://doi.org>.
- Mandavi, K., Singh, S. P, Dubey, A., Chaudary, M., & Dixit, R. (2006). Related efficiency of rice-fish-duck production under integrated and conventional farming system. *Asia Journal of Animal Science*, 11(1), 49-52. doi.org/10.15740/has/tajas/11.1/49-52
- Mantavani, J. R., Silveira, L. G. D., Landgraf, P. R. C., Santos, A. R. D., & Costa, B. D. S. (2017). Phosphorus rates and use of cattle manure in potted gerbera cultivation. *Ornamental Horticulture*, 23, 412–418.
- Martin, M. A. (2007). Pig manure as a low cost fertiliser. Retrieved from <https://www.google.com>.
- Men, B. X., Tinh, T. K., Preston, T. R., Ogle, R. B. & Lindberg, J. E. (1999). Use of local ducklings to control insect pests and weeds in growing rice field. *Livestock Research for Rural Development*, 11(2).
- Miller, H. B. (2007). Poultry litter induces tillering in rice. *Journal of Sustainable Agriculture*, 31(1), 1-12. doi.org/10.1300/J064v31n01_12
- Moe, K., Htwe, A. Z., Thu, T. T., Kajihara, Y., & Yamakawa, T. (2019). Effect on NKP status, growth, dry matter and yield of rice (*oryza sativa*) by organic fertilizer applied in field condition. Retrieved from www.mdpi.com.
- Mofidian, S., & Sadeghi (2015). Evaluation of integrated farming of rice and duck on rice grainyield in Gilan, Iran. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 63(4), 1161-1168. doi.org/10.11118/actaun201563041161

- Moller, H. B., Sommer, S. G., & Arhring, B. K. 2004. Methane productivity of manure, straw and solid fractions of manure. *Biomass Bioenergy*, 26(5), 485–495. doi.org/10.1016/j.biombioe.2003.08.008
- Narayan, D. S. (2005). Organic farming in India: relevance, problems and constraints. Mumbai India. Retrieved from <https://www.nabard.org>.
- National Geographic, (2010). Ladybugs. Retrieved from <https://www.google.com>.
- Ovawanda, E., Witjaksono, A., & Trisyono, Y. A. (2016). Insect Biodiversity in organic and non-organic rice ecosystem in the district of Bantul. *Journal Perlindungan Tanaman Indonesia*, 20 (1), 15–21. doi.org/10.22146/jpti.16619
- Pacamalan, J.A. (2009). Pioneer organic rice-duck industry value chain in the Philippines and a development consultant. Retrieved from <https://ph.linkedin.com>.
- Phelan, L. (1995). Soil fertility management and host preference by european corn borer, *ostrinia nubilalis* (hubner), on *zea may s l.*: a comparison of organic and conventional farming. *Agriculture, Ecosystems and Environment*, 56(10), 1-8.
- Phillips, J. R., Graues J. P., & Luttrell, R. G (1898). Insecticide resistance management: relationship to integrated pest management. *Pest Management Science*, 27(4), 45964. doi.org/10.1016/0167-8809(95)00640-0
- PhilRice, (2001). Management options for the golden apple snail. Retrieved from <http://www.wpplesnail.net>.
- PhilRice, (2012). Integrated nutrient management. Retrieved from www.pinoyrice.com.
- PhilRice, (2018). Terminal report: the future rice (promoting integrated solutions for future farming scenarios). Retrieved from www.philrice.gov.ph.
- Pimentel, D., Harvey, C., & Resosudarmo, P., (1995). Environmental and economic costs of soil erosion and conservation benefits. *Science*, 267, 1117–1123. doi: 10.1126/science.267.5201.1117
- Pingali, P. (2001). Environmental consequences of agricultural commercialization in Asia. *Development and the Environment in Asia*, 6 (4), 483-502. doi.org/10.1017/s1355770x01000274
- Preap, V., Zalucki, M. P. & Jahn, G. C. (2002). Effect of nitrogen fertilizer and host plant variety on fecundity and early instar survival of *nilaparvata lugens* (stål): immediate response. *Systematic Management Planthopper in East Asia*, 226, 163-180.

- Price, P. W., Denno, R. T., Eubank, M. D., Finke, D. L., & Kaplan, I. (2011). *Insect ecology: behavior, populations and communities*. Cambridge University Press, New York. 829 p.
- PSA, (2017). Rice and Corn Situation and Outlook Report. Retrieved October 15, 2018 from <https://psa.gov.ph/>.
- PSA, (2017). Duck Situation Report. Retrieved from <https://psa.gov.ph/>.
- PSA, (2018). Updates on July- September 2018 Palay and Corn Estimates Report. Retrieved from <https://psa.gov.ph/>.
- PSA, (2018). Duck Situation Report. Retrieved from <https://psa.gov.ph/>.
- Qin, Z., Zhao, B., Zhang, J. E., & Lou, S. (2011). Study on diversity of arthropod community in a rice-duck integrated farming in South China. *Journal of Resources and Ecology*, 2(2), 151-157.
- Rana, S. S., & Rana, M. C. (2016). Principles and practices of weed management. Retrieved from <http://hillagric.ac>.
- Ranamukhaarachchi, S. L., & Wickramasinghe, S. (2006). Golden apple snails in the World: introduction, impact, and control measures. Retrieved from <https://www.researchgate>.
- Rezaenejad, Y., Afyuni, M. (2001). Effect of organic matter on soil chemical properties and corn yield and element uptake. *Journal of Science and Technology Agricultural Nature Research*, 4, 19-29.
- Rowe, L., Berrill, M., Hollet, L., & Hall, R. J. (1989). The effects of short-term laboratory pH depressions on molting, mortality and major ion concentrations in the mayflies. *Stenonema Femoratum and Leptophlebia Cupida*. *Hydrobiologia*, 184, 89-97.
- Sanico, A. L., Peng, S., Laza, R. C., & Visperas, R. M. (2002). Effect of seedling age and seedling number per hill on snail damage in irrigated rice. *Crop Protection*, 21(2), 137-143. doi.org/10.1016/S0261-2194(01)00075-8
- SARE (Sustainable Agriculture Research & Education). (2012). How ecologically based pest management works. University of Maryland. Retrieved from <http://sare.org>.
- Shyaam. (2018). Takao Furuno- resource efficient farm design. Retrieved from <https://www.schwabfound.org>.

- Satpathi, C. R. & Mondal, A. (2016). Holistic survey on damselfly (anisoptera: odonata) diversity in rice ecosystem of eastern India. *International Research Journal of Natural Sciences*, 4 (4), 19-34.
- Settle, W. H., Ariawan, H., Astuti, E. T., Cahyana, W., Hakim, A. L., Hindayana, D., Lestari, A. S., Pajarningsih, & Sartanto. (1996). Managing tropical rice pests through conservation of generalist natural enemies and alternative prey. *Ecology* 77, 1975–1988. doi: 10.2307/2265694
- Srivastava, P., Srivastava, P. C., Singh, U. S. & Shrivastava, M. (2009). Effect of integrated and balanced nutrient application on soil fertility, yield and quality basmati rice. *Soil Science*, 55(3), 265-284. doi.org/10.1080of/03650340802477734
- Stellacci, A. M., Cristiano, G. Rubino, P., Lucia, B. D., & Cazzato, E. (2013). Nitrogen uptake, nitrogen partitioning and n-se efficiency of container- grown holmoak (*quercus ilex l.*) under different nitrogen levels and fertilizer sources. *Journal of Food Agriculture Environment*, 11, 132–137.
- Sutton, A. L., Jones, D. D., Joern, B. C., & Huber, D. M. (2001). Animal Manure as a plant nutrient resources. Purdue University, West Lafayette.
- Teo, S. S. (2001). Evaluation of different duck varieties for the control of the golden apple snail (*pomacea canaliculata*) in transplanted and direct seeded rice. *Crop Protection*, 20(7), 599-604.
- Timsina, J., & Connor, D. J. (2001). Productivity and management of rice–wheat cropping systems: issues and challenges. *Field Crop. Research*, 69, 93–132. doi: 10.1016/s0378-4290(00)00143-x
- The Plant List, (2010). A working list for all plant species. Retrieved from <http://webcache.googleusercontent.com/search?q=cache:http://www.theplantlist.org>.
- Theocharopoylos, A., Aggelopoulos, S., Papanagiotou, P., Melfou, K., & Papanagiotou, E. (2012). In sustainable farming systems vs. conventional agriculture: a socio-economic approach. Retrieved from <http://doi.org/ISBN978-953-51-01161>
- Villarta, A. (2017). Farmers field school on integrated rice-duck farming system launched. agricultural training institute in northern mindanao. *Agricultural Training Institute*. Retrieved from <http://ati.da.gov.ph>.
- Wada, T. (2004). Strategies of controlling the golden apple snail *pomacea canaliculata* (lamarck) (gastropoda: ampullariidae) in Japanese direct- sown paddy fields. *Journal of American Research*, 38 (2), 75-80. doi: 10.6090/jarq.38.75

- Wallace, G. D., & Rosen, L. (1969). Studies on eosinophilic meningitis. v. molluscan hosts of angiostrongylus cantonensis on pacific islands. *American Journal of Tropical Medicine and Hygiene*, 18(2), 206-216.
- Wang, M. C., & Yang, C. H. (2003). Type of fertilizer applied to a paddy–upland rotation affects selected soil quality attributes. *Geoderma* 114, 93–108. doi:10.1016/S0016-7061(02)00356-7
- Wasim, M. P. (2002). A study of rice in the major growing countries of the World their growth instability and World share. *Pakistan Economic and Social Review*, 40(2), 153-183.
- Weber, E. (2017). Invasive plant species of the World. Retrieved from <https://books.google.com.ph/>.
- Xiang, P. & Fu, Z.Q. (2006). Studies on technique of reducing methane emission in a rice-duck ecological system and the evaluation of its economic significance. *Agricultural Science in China*, 5(10), 758-766. doi.org/10.1002/jsfa.6223
- Xiong, D., Fang, K., Lou, Y., & Dai, X. (2014). Modeling of duck density and complex stocking time in rice-duck agro-ecosystem in terms of economic and ecological benefits. *Mathematical Problems in Engineering*. Retrieved from <https://www.hindawi.com>.
- Yamazaki, M., Yasuda, N., Yamada, T., Ota, K., & Kimura, M. (2004). Comparison of aquatic organism communities between paddy field under rice-duck (aigamo) farming and paddy fields under conventional farming. *Soil Science Nutrition.*, 50 (3), 375-383. doi.org/10.1080/00380768.2004.10408491
- Yang, J., Gao, W., & Ren, S. R. (2015). Long-term effects of combined application of chemical nitrogen with organic materials on crop yields, soil organic carbon and total nitrogen in fluvo-aquic soil. *Soil Tillage Research*, 151, 67–74.
- Yang, X., Zhang, Z., Gu, T., Dong, M., Peng, Q., Bai, L., & Li, Y. (2017). Quantitative proteomics reveals ecological fitness cost of multi-herbicide resistant banyardgrass (*Echinochloa crus-galli* (L.). Retrieved from <https://www.science.gov>.
- Yu, S. M., Jin, Q. Y., Ouyang, Y. N., & Xu, D. H. (2004). Efficiency of controlling weeds, insect pests and diseases by raising ducks in the paddy fields. *Chinese Journal of Biology*, 2. Retrieved from <http://en.cnki.com>.
- Zhang, J. E., Ouyang, Y., & Huang, Z. X. (2007). Characterization of nitrous oxide emission from a rice-duck farming system in south china. *Archives of Environmental Contamination and Toxicology*, 54(2), 167-172.

- Zhang, M. M, Zong, L. G., & Xie, T. Z. (2010). Effective of integrated organic duck-rice farming on the dynamic of the soil nutrient and associated economic benefits. *Chinese Journal of Eco- Agriculture*, 18(2), 256-260. doi.org/10.3389%2Ffpls.2017.00047
- Zhang, J. E., Xu, R., Chen, X., & Quan, G. (2009). Effect of duck activities on a weed community under a transplanted rice-duck farming system in southern china. *Weed Biology and Management*, 9(3). doi: 10.1111/j.1445-6664.2009.00346.x
- Zhang, M.M, Zong, L. G., & Xie, T. Z. (2010). Effective of integrated organic duck-rice farming on the dynamic of the soil nutrient and associated economic benefits. *Chinese Journal of Eco- Agriculture*, 18(2), 256-260.
- Zhong, W., & Cai, Z. (2007). Long-Term Effects of inorganic fertilizers long-term effects of inorganic fertilizers on microbial biomass and community functional diversity in a paddy soil derived from quaternary red clay. *Applied Soil Ecology*, 36, 84–91. doi.org/10.1016/j.apsoil.2006.12.001
- Zimdahl, R. L. (2010). A history of weed science in the United State. Retrieved from <https://books.google.com>.