CENTRAL LUZON STATE UNIVERSITY

REFRIGERATED HANDLING CONDITION ON POST MORTEM GOAT TESTICLES AND ITS INFLUENCE ON THE QUALITY OF EPIDIDYMAL SPERM

HANNAH LEI MONTERO HARADA

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

BACHELOR OF SCIENCE IN BIOLOGY

JUNE 2017

HANNAH LEI M.HARADA
BS Biology 2017

Republic of the Philippines
CENTRAL LUZON STATE UNIVERSITY
Science City of Muñoz, Nueva Ecija

COLLEGE OF ARTS AND SCIENCES
Department of Biological Sciences

APPROVAL SHEET

The Undergraduate Thesis entitled: **REFRIGERATED HANDLING CONDITION ON POST MORTEM GOAT TESTICLES AND ITS INFLUENCE ON THE QUALITY OF EPIDIDYMAL SPERM** prepared and submitted by **HANNAH LEI MONTERO HARADA** in partial fulfilment of the requirements for the degree of BACHELOR OF SCIENCE IN BIOLOGY is hereby approved and accepted.

CYNTHIA C. DIVINA, Ph.D.
Adviser
JUNE 06, 2017
Date Signed

LERMA C. OCAMPO, DVM, Ph.D.
Co-Adviser
JUNE 07, 2017
Date Signed

CORNELIO FRANCIS M. CRUZ, M.Sc.
Critic
JUNE 08, 2017
Date Signed

RICH MILTON R. DULAY, M.Sc.
Department Research Coordinator
JUNE 09, 2017
Date Signed

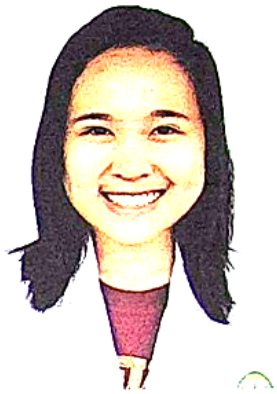
Accepted in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN BIOLOGY.**

EVARISTO A. ABELLA, Ph.D.
Department Chair
JUNE 10, 2017
Date Signed

ANNA MARIA LOURDES S. LATONIO, Ph.D.
College Research Coordinator
JUNE 10, 2017
Date Signed

MYRNA R. UMAGAT, Ph.D.
Dean
JUNE 11, 2017
Date Signed

BIOGRAPHICAL SKETCH



PERSONAL INFORMATION

Name : HANNAH LEI M. HARADA
Birthdate : November 06, 1995
Birthplace : San Jose City, Nueva Ecija
Address : Mabini Ext. Science City of Muñoz, Nueva Ecija
Religion : Catholic
Civil Status : Single
Parents : Hiromu Harada
: Elizabeth Montero-Harada

EDUCATIONAL BACKGROUND

TERTIARY (A.Y. 2013-2017) : Central Luzon State University
Science City of Muñoz, Nueva Ecija, Philippines
Bachelor of Science in Biology

(A.Y. 2016-2017) : University of Tsukuba
Tsukuba Science City, Ibaraki Prefecture, Japan
College of Agro-Biological Resource Sciences
Exchange International Student in Biology

SECONDARY : San Sebastian School
Science City of Muñoz, Nueva Ecija, Philippines

ELEMENTARY : Muñoz Central School
Science City of Muñoz, Nueva Ecija

ON-THE-JOB TRAINING/APPRENTICESHIP

Philippine Carabao Center, National Headquarters and Genepool, Science City of Muñoz, Nueva Ecija
June 13-July 15, 2016

Apprenticeship in Molecular Laboratory and Tissue Culture Laboratory c/o DA-Biotech Program
Philippine Rice Research Institute, Maligaya, Science City of Muñoz, Nueva Ecija
April 6-14, 2015

Apprenticeship in Animal Nutrition Laboratory and Animal Health and Biosafety
Philippine Carabao Center, National Headquarters and Genepool, Science City of Muñoz, Nueva Ecija
June 07-June 10, 2016

SEMINARS ATTENDED

Direct Seeding: A Response to Economical and Technological Challenges in Rice Farming
Central Luzon State University, Science City of Muñoz, Nueva Ecija
September 7, 2013

Symposium on Current Trends in Food Safety and Quality Assurance
University Gymnatorium, Central Luzon State University, Science City of Muñoz, Nueva Ecija
August 30, 2014

10th National Biotechnology Week Celebration
Theme: Edukasyon sa Bioteknolohiya: Pagyamanin para sa Kinabukasan Natin
CHED Building, C.P. Garcia Avenue, UP Diliman, Quezon City
November 24, 2014

1st CLSU-University of Tsukuba Bilateral Student Research Congress
College of Arts and Sciences Little Theatre, Central Luzon State University, Science City of Muñoz, Nueva Ecija
March 5, 2015

ASEAN Academic Students Research Summit "Harmonizing the ASEAN Integration through Research and Innovation"
College of Arts and Sciences Little Theatre, Central Luzon State University, Science City of Muñoz, Nueva Ecija
March 25, 2015

Paradigm Shift from "One QTL-One Candidate Gene": Multiple Genes Regulate a QTL for Rice Yield under Drought
PhilRice Central Experiment Station, Maligaya, Science City of Muñoz,

Nueva Ecija
April 6, 2015

Symposium on HIV: AIDS "Survival of the Fittest. The Human Culture Media"
University Auditorium, Central Luzon State University, Science City of Muñoz, Nueva Ecija
November 21, 2015

Symposium on Philippine Biodiversity and the National Museum
University Auditorium, Central Luzon State University, Science City of Muñoz, Nueva Ecija
March 22, 2016

Fulbright Information Session Program
Guest House, Central Luzon State University, Science City of Muñoz, Nueva Ecija
April 8, 2016

24th Psychology Students Research Congress with the theme "Usaping Pampulitika sa Lenten g Sikolohiya"
University Auditorium, Central Luzon State University, Science City of Muñoz, Nueva Ecija
April 29, 2016

2016 R4D In-House Review
Philippine Carabao Center, National Headquarters and Genepool, Science City of Muñoz, Nueva Ecija
June 27-28, 2016

Scientific Interlude of a Rooster and a Mushroom (A Seminar on Innovative Research)
Biotechnology and Analytical Laboratory, Department of Biological Sciences , College of Arts and Sciences, Central Luzon State University, Science City of Muñoz, Nueva Ecija
January 21, 2017

Technical Seminar on "Animal Genetic Resources in Japan and an International Collaboration (A SATREPS PROJECT"
Briefing room, Ground Floor LBC Building, Philippine Carabao Center, National Headquarters and Genepool, Science City of Muñoz, Nueva Ecija
February 15, 2017

Special Lecture on Cryobanking of Animal Genetic Resources
RET Amphitheatre, Central Luzon State University, Science City of Muñoz,

Nueva Ecija
February 15, 2017

MEMBERSHIP

Biology Supreme Student Council
Secretary
S.Y. 2015-2016

Biological Society
Lifetime Member
Since 2016

International Society for Southeast Asian Agricultural Sciences, Inc. (ISSAAS)
Philippines Chapter
Student Member
2016

Trans-ASEAN Global Agenda Education (TAG)-
ASEAN International Mobility for Students (AIMS)
2016

ACKNOWLEDGEMENT

The researcher would like to express her deepest gratitude to all who have been her inspiration and source of strength towards the degree.

First and foremost, the author offers her praise and gratitude to Almighty God, the Father to whom she owe her very existence and all the blessings and opportunities He generously give.

To her adviser, Dr. Cynthia C. Divina whom the author is gratefully indebted, thank you very much for all the invaluable guidance and support that pushed and encouraged her in doing research.

The researcher would like to thank Dr. Lerma C. Ocampo, her co-adviser who provided her an excellent atmosphere for doing research as well as excellent guidance, support and patience.

She is highly indebted to her critic, Mr. Cornelio Francis M. Cruz, for his willingness to participate in the final defense committee at the last moment and his helpful criticisms.

To Mr. Rich Milton R. Dulay, who was always ready to lend a helping hand especially in improving her researches, the author is highly indebted.

Besides her thesis committee, a very special gratitude goes to Ma'am Karen Judan-Cruz who first believed and supported her. The author appreciates you in a lot of special ways.

To the faculty of the Department of Biological Sciences who helped her chase her

dreams, the author is most grateful for the rewarding university experience she had.

To the DA-Biotech Scholarship Program which helped her in this journey towards this degree, thank you very much. The author is very grateful to the funding sources that allowed her to pursue this research. Most especially, the author thanks this prestigious scholarship program for believing in her vast potentials.

The author owes a debt of gratitude to all the officials of Science City of Muñoz Slaughterhouse and San Leonardo Municipal Slaughterhouse, for assistance in the collection of samples.

The author would like to thank the Reproductive Biotechnology and Physiology Laboratory Unit, Philippine Carabao Center and the Department of Agriculture-Bureau of Agricultural Research for making this research in full realization.

To Ms. Aika, Ms. Mau and Mr. EJ, every result described in this thesis was accomplished with the help and support of all of you and without your efforts, my job would have undoubtedly been more difficult.

The author sincerely thanks Dr. Seung Won Kang and Dr. Atsushi Asano who expanded her view on conservation of species. She greatly benefited from their keen scientific insights.

All her professors in University of Tsukuba especially the TAG-AIMS family, thank you so much. In particular, she is grateful to her academic advisor Dr. Nakao Nomura with his colleagues, Ms. Gwen, Ms. Shizuka Ms. Hani and Uncle Tak.

She has been blessed with a friendly and cheerful group of fellow students who provided a friendly and cooperative atmosphere. The author thanks her fellow lab mates

(Julius and Ivan) for all the stimulating discussions and for all the fun they have had, her special friends Alexandra, Alfred, Angelli, Anna, Ann-Gillean, Carlo, Cristy, Chin, Kuya James Kennard, Lianne, Maorin, Pau, Poleng and Ruth who supported her along the way. The author is very blessed to have her best friends, Airah and Jeno who fully supported, loved and helped her in all the levels in her life.

Finally, the author expresses her very profound gratitude to her family who have provided her unconditional love and motivation. They have provided her unfailing support and continuous encouragement throughout her years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

This thesis is heartily dedicated to her life-coach, her late grandmother Lordes.

HANNAH LEI MONTERO HARADA

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABSTRACT

HARADA, HANNAH LEI MONTERO, Bachelor of Science in Biology, Department of Biological Sciences, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, June 2017. **REFRIGERATED HANDLING CONDITION ON POST MORTEM GOAT TESTICLES AND ITS INFLUENCE ON THE QUALITY OF EPIDIDYMAL SPERM**

Manuscript No: BIO-M-2nd17-035

Adviser: Cynthia C. Divina, Ph.D.
Co-Adviser: Lerma C. Ocampo, DVM, Ph.D.

The goal of cryoconservation is to provide a parallel effort to conserve and utilize valuable germplasms for the envisaged genetic improvement. Selected, pedigreed and trained semen donors such as large ruminants are utilized in the Philippines for breed conservation. However, for small ruminants not trained for semen collection, an alternative option is to use epididymal sperm. In this study, slaughterhouse-derived testicle utilization (n=12) was performed to examine the influence of 5-8°C handling temperature during 4h (Group 1) and 24 h (Group 2) of transport on the quality and survivability of epididymal sperm across fresh, pre-freeze and post-thaw treatments. Epididymal sperm from dissected cauda epididymis were recovered in a buffered base media composed of Tris, citric acid monohydrate, lactose and raffinose (TCLR). After centrifugation, the average sperm pellet volume of Group 1 and 2 were 430µL and 150µL with a mean sperm concentration of $340.5x10^7$ per ml and $302.5x10^7$ per ml. The proportions of live perm were 90.5% and 84.67% with 60% initial motility that served as criteria to proceed cryopreservation. Sperms were diluted with TCLR buffer containing

20% egg yolk (v/v) and 7% glycerol (v/v) at a sperm concentration of $200x10^6$ sperm per ml. After 2-2.5 hours of equilibration in the refrigerator, microscopic evaluation of sperm under pre-freeze treatment still showed ideal and acceptable results. After subjecting the samples to cryopreservation (-196°C), post thaw motility score of frozen epididymal sperm had a major decrease while fluorescence based live sperm assay SYBR/PI yielded 27.17 and 28.25%. Despite of loss of quality especially motility due to alterations of the physical environment and sperm aging, samples were qualified for IVF and ICSI. Thus, refrigerating the testicles before laboratory processing is a good option in rescuing valuable goat sperm reserves.

LITERATURE CITED

ABDOU, M.S.S., MOUSSA, M.H.G., RAGAB, R.S.A. and A.A. EL-MENOUFY. (1985). On the regional histology of the ductus epididymidis in the buffalo (*Bubalus bubalis*). Anatomia, Histologia, Embryologia: Journal of Veterinary Medicine Series C, 14: 226.

ABDY, K. and P. TAJIK. (2012). The effect of citric acid and citrate on protoplasmic droplet of bovine epididymal sperms. In Veterinary Research Forum, 2: 260–264.

AGRICULTURAL RESEARCH COUNCIL. (2006). The indigenous goat breeds of SA. Retrieved from http://www.arc.agric.za/home.asp?pid=2701.

AGUADO, M.J., GARDE, J., MADRIADANO, J.M., PEREZ, S., GARRIDO, D. and V. MONTORO. (1994). Congelacio´n post mortem de semen de epidıdi´mo de morueco. In: Proceedings of the 7th Jornadas International Reproductive Animals, IA, Murcia, Spain, 283.

AHMAD, K. and R.A. CHAUDHRY. (1980). Cryopreservation of buffalo semen. The Veterinary Record, 106(9): 199-201.

AHMAD, M., AHMAD, K.M. and A. KHAN. (1986). Cryopreservation of buffalo spermatozoa in Tris (hydroxymethyl-aminomethane). Pakistan Veterinary Journal, 6: 1–3.

AISEN, E.G., MEDINA, V.H. and A. VENTURINO. (2002). Cryopreservation and post-thawed fertility of ram semen frozen in different trehalose concentrations. Theriogenology, 57: 1801–1808.

ALA UD, D., CHAUDHRY, R.A. and K. AHMAD. (1981). Effect of different extenders on freezability of buffalo semen. Pakistan Veterinary Journal, 1: 59–61.

AL-GHALBAN, A.M., TABBAA, M.J. and KRIDLI, R.T. (2004). Factors affecting semen characteristics and scrotal circumference in Damascus bucks. Small Ruminant Research, 53(1): 141-149.

AMANN, R.P. (1999). Issues affecting commercialization of sexed sperm. Theriogenology, 52(8): 1441-1457.

AN, T.Z., WADA, S., EDASHIGE, K., SAKURAI, T. and M. KASAI. (1999). Viable spermatozoa can be recovered from refrigerated mice up to 7 days death. Cryobiology, 38: 27-34.

ANDERSON, S. (2003). Animal genetic resources and sustainable livelihoods. Ecological Economics, 45: 331-339.

ANEL, L., GUERRA, C., ALVAREZ, M., ANEL, E., MARTI´NEZ, A. and C. RODRIGUEZ. (2001). Post-mortem spermatozoa recovery in roe deer (*Capreolus capreolus*): differences between pre-rutting and rutting season. Theriogenology, 55: 380.

ANNAKUL, N., SUWIMONTEERABUTR, J., SINGLOR, J., PHUTIKANIT, N., THARASANIT T. and M. TECHAKUMPHU. (2011). Effect of equex STM paste on the quality and motility characteristics of post thawed cryopreserved goat semen. Thai Journal of Veterinary Medicine, 41(3): 345-351.

AX, R.L., DALLY, M., DIDION, B.A., LENZ, R.W., LOVE, C.C., VARNER, D.D., HAFEZ, B. and M.E. BELLIN. (2000). Semen Evaluation. In: Hafez B and Hafez ESE. Reproduction in Farm Animals.7th Edition Philadelphia: Lea and Febiger, 365-375.

AZIZ, M.A. (2010). Present status of the world goat populations and their productivity. Lohmann Information, 45(2): 42.

BARTELS, P., LUBBE, K., KILIAN, I., FRIEDMANN, Y., VAN DYK, G. and D. MORTIMER. (2000). In vitro maturation and fertilization of lion (*Panthera leo*) oocytes using frozen-thawed epididymal spermatozoa recovered by cauda epididymectomy of an immobilized lion. Theriogenology, 53: 325.

BEARDEN, H.J. and J.W. FUQUAY. (1997). Applied Animal Reproduction. 4th Edition. New Jersey: Prentice Hall, Upper Saddle.

BHATTACHARYYA, H.K. and A. AKAND. (2010). Testicular biometry and epididymal sperm reserve in local sheep of Kashmir valley. Theriogenology. A Journal of the Kenya Veterinary Association, 34.

BELTRAN, M.A.G., ATABAY, E.P., ATABAY, E.C., CRUZ, E.M., AQUINO, F.P. and L.C. CRUZ. (2013). Optimized extenders for cryopreservation of buck semen for artificial insemination. Philippine Journal of Veterinary and Animal Science, 39(1): 1-10.

BERTOL, M.A.F., WEISS, R.R., THOMAZ-SOCCOL, V., KOZICKI, L.E., FUJITA, A.S., ABREU, R.A.D. and K.T. GREEN. (2013). Viability of bull spermatozoa collected from the epididymis stored at 18-20° C. Brazilian Archives of Biology and Technology, 56(5): 777-783.

BESTER, N. (2006). Effect of different dietary energy levels on productive and repro-

ductive traits in Dorper rams. MSc dissertation, Bloemfontein, University Free State.

BISWAS, D., BARI, F.Y., SHAMSUDDIN, M. and M.M. RAHMAN. (2002). Determination of glycerol percentages for preserving the black bengal buck (*Capra hircus*) spermatozoa for long time. Pakistan Journal of Biological Sciences, 5(6): 715-718.

BLASH, S., MELICAN, D. and W. GAVIN. (2000). Cryopreservation of epididymal sperm obtained at necroscopsy from goats. Theriogenology, 54: 899-905.

BLOCKHUIS, J. (1962). Artificial insemination in the goat. Ed) J. P. Maule. The semen of animals and artificial insemin-ation. Commonwealth Bureau of Genetics, 252-262.

BONDOC, O.L. and M.B. BEJO. (1994). BLUP evaluations of birth weight and weaning weight in different breed groups of meat-type goats. Philippine Journal of Veterinary and Animal Sciences, 20 (1-2): 15-25.

BONDOC, O.L. (1998). Biodiversity of livestock and poultry genetic resources in the Philippines, Los Baños: Institute of Animal Sciences-College of Arts and Sciences/ University of the Philippines Los Baños and Philippine Council for Agriculture, Forestry and Natural Resources Research and Development/Department of Science and Technology, 141.

BONDOC, O.L. (2002). National Goat Breeders' Catalogue, Fourth Issue. The Philippine Goat Breed Registry, Institute of Animal Sciences-College of Arts and Sciences, University of the Philippines Los Baños-College of Arts and Sciences.

BONDOC, O.L., GOMEZ, I.V., GARCIA, B.R., BELTRAN, E.D., ROXAS, N.P., ABANTO1, O.D., RAPUSAS, M.D.R. and B.C. GOMEZ. (2003). Comparative analysis of carcass yield and quality, physical, chemical and sensory properties of chevon from different breeds of goats (*Capra Hircus*). Philippine Journal of Veterinary and Animal Sciences, 29(1): 25-36.

BONDOC, O.L. (2005). The Philippine goat breed registry in relation to genetic improvement and conservation. The Philippine Agricultural Scientist, 88(2): 179-191.

BRAUN, J., TORRES-BOGGINO, F., HOCHI, S. and N. OGURI. (1994). Effect of seminal plasma on motion characteristics of epididymal and ejaculated stallion spermatozoa during storage at 5°C. Dtsch Tierarztl Wochenschr, 101: 319–22.

BUDWORTH, P.R., AMANN, R.P. and R.H. HAMMERSTEDT. (1987). A micro-

computer-photographic method for evaluation of motility and velocity of bull sperm. Journal of Dairy Science, 70: 1927-1936.

BUMANLAG, A.C. (2015). Cryopreservation of native or non-descript goat epididymal sperm through LN2 Vapor Cooling (Undergraduate thesis). Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines.

BUMANLAG, A.C., HARADA, H.L.M., DIVINA, C.C., OCAMPO, M.B. and L.C. OCAMPO. (2017). Sperm motility assessment of epididymal sperm from post mortem goat testicles held at 5°C. Entomology and Applied Science Letter, 4(2): 16-18.

CENTRAL LUZON STATE UNIVERSITY-SMALLRUMINANT CENTER (2017). The goat industry in the Philippines (Unpublished sources).

CHACON, J., PEREZ, E. and H. RODRIGUEZ-MARTINEZ. (2002). Seasonal variations in testicular consistency, scrotal circumference and spermiogramme parameters of extensively reared brahman (*Bos indicus*) bulls in the tropics. Theriogenology, 58: 41–50.

CHAUHAN, M.S. and S.R. ANAND. (1990). Effect of egg yolk lipids on the freezing of goat semen. Theriogenology, 34(5): 1003–1013.

CHINNAIYA, G.P. and N.C. GANGULI. (1980). Freezability of buffalo semen in different extenders. Transboundary and Emerging Diseases, 27(7): 563-568.

CIERESZKO, A., OTTOBRE, J.S. and J. GLOGOWSKI. (2000). Effects of season and breed on sperm acrosin activity and semen quality of boars. Animal Reproduction Science, 64(1), 89-96.

COMIZZOLI, P., MERMILLOD, P., COGNIE, Y., CHAI, N., LEGENDRE, X. and R. MAUGE. (2001). Successful in vitro production of embryos in the red deer (*Cervus elaphus*) and the sika deer (*Cervus nippon*). Theriogenology, 55: 649–59.

COOPER, T.G. (2005). Cytoplasmic droplets: The good, the bad or just confusing. Human Reproduction, 20: 9-11.

DARAMOLA, J.O., ADELOYE, A.A., FAYEYE, T.R., FATOBA, T.A. and A.O. SOLADOYE. (2006). Influence of photoperiods with or without melatonin on spermiograms in West African dwarf bucks. World Journal of Zoology, 1(2): 86-90.

DEVENDRA, C. and M. BURNS. (1983). Goat production in the tropics. Commonwealth Agriculture Bureaux Farmham House, United Kingdom, 183.

DHAMI, A.J. and S.B. KODAGALI. (1990). Freezability, enzyme leakage and fertility of buffalo spermatozoa in relation to the quality of semen ejaculates and extenders. Theriogenology, 34(5): 853-863.

DHAMI, A.J. and K.L. SAHNI. (1993). Effect of extenders, additives and deep freezing on the leakage of lactic dehydrogenase from cattle and buffalo spermatozoa. Indian Journal of Animal Science, 63: 251–256.

DUBEUF, J.P. and J. BOYAZOGLU (2009). An international panorama of goat selection and breeds. Livestock Science, 120: 225–231.

ENSMINGER, M.E. and R.O. PARKER. (1986). Sheep and Goat Science, Fifth Edition. Danville, Illinois: The Interstate Printers and Publishers Inc.

ESPLANA, R.E., ABAO, L.N.B. and R.M. VASQUEZ. (2007). Development in the Supply Chain of the Philippine Goat Industry: An Assessment. Retrieved from https://www.econ-jobs.com/research/46420-Development-in-the-Supply-Chain-of--the-Philippine-Goat-Industry-An-Assessment-.pdf

ESTESO, M.C., FERNANDEZ-SANTOS, M.R., SOLER, A.J. and J.J. GARDE. (2003). Head dimensions of cryopreserved red deer spermatozoa are affected by thawing procedure. Cryo Letters, 24: 261–268.

EXTENSION ORGANIZATION. (2012). Influence of daylength. Season impacts reproduction influence of daylength. Retrieved from http://articles.extension.org/pages/19372/season-impacts-reproduction-influence-of-day length.

FAWCETT, D.W. and D.H. PHILLIPS. (1969). Observations on the release of spermatozoa and on changes in the head during passage through the epididymis. Journal of Reproduction and Fertility, 6: 405-408.

FERNÁNDEZ-SANTOS, M.R., SOLER, A.J., RAMÓN, M., ROS-SANTAELLA, J.L. and A. MAROTO-MORALES. (2011). Effect of post mortem time on post-thaw characteristics of Spanish ibex (*Capra pyrenaica*) spermatozoa. Animal Reproduction Science, 129, 56–66.

FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS STATISTICS (FAOSTAT). (2008). FAOSTAT database. Retrieved from http://ref.data.fao.org/database

FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS (FAO). (2012). Cryoconservation of animal genetic resources. FAO Animal

Production and Health Guidelines No. 12. Rome. 222. Retrieved from http://www.fao.org/3/a-i3017e.pdf

FOOTE, R. (2000). Fertilizing ability of epididymal sperm from dead animals. Journal of Andrology, 21: 355.

FRIEDMANN, Y., LUBBE, K., KILIAN, I., GROBLER, D. and R. DENNISTON. (2000). Changes in motility and morphological characteristics of African buffalo (*Syncerus caffer*) sperm during storage of the epididymis. Theriogenology, 53:332.

GACITUA, H. and A. ARAV. (2005). Successful pregnancies with directional freezing of large volume buck semen. Theriogenology, 63:931-938.

GALL, C. (1996). Goat breeds around the world. CTA, Margraf/Food and Agriculture Organization. Weikersheim, Germany, 186.

GALLON, F., MARCHETTI, C., JOUY, N. and P. MARCHETTI. (2006). The functionality of mitochondria differentiates human spermatozoa with high and low fertilizing capability. Fertility and Sterility, 86:1526–1530.

GANAIE, B.A., ISLAM, R. and M.Z. KHAN. (2009). Epididymal sperm reserve in rams with different testicular and epididymal weight. Indian Journal of Small ruminants. 15(1): 51-54.

GARCIA-MACIAS, V., MARTINEZ-PASTOR, F., ALVAREZ, M., GARDE, J.J., ANEL, E., ANEL, L. and P. DE PAZ. (2006). Assessment of chromatin status (SCSA®) in epididymal and ejaculated sperm in Iberian red deer, ram and domestic dog. Theriogenology, 66, 1921–1930.

GARDE, J., AGUADO, M., PEREZ, S., GARRIDO, D., PEREZ-GUZMAN, M. and V. MONTORO. (1994). Physiological characteristics of epididymal spermatozoa from post-mortem rams. Theriogenology, 41: 203.

GARDE, J., PEREZ, S., AGUADO, M., AYLLON, E., GARRIDO, D. and V MONTORO. (1995). Live birth of hybrid (O. musimon X O. aries) lambs following intrauterine insemination in domestic sheep with mouflon semen obtained 40 h postmortem. Theriogenology, 43: 218.

GARDE, J., ORTIZ, N., GARCIA, A., GALLEGO, L., LANDETE, C.T. and A. LOPEZ. (1998). Postmortem assessment of sperm characteristics of the red deer during the breeding season. Archives of Andrology, 41: 195-202.

GARNER, D.L. and E.S.E. HAFEZ. (2000). Spermatozoa and seminal plasma. Reproduction in Farm Animals, 7: 96-109.

GAUTANE, J.J., BALAGAN, E.J.Y., MANAOIS II, F.V., OCAMPO, M.B. and L.C. OCAMPO. (2016). Characteristics of epididymal sperm recovered from slaughterhouse derived testes of nondescript/native goats in the Philippines. Journal of Agricultural Technology, 12(2): 215-228.

GERBER, D., IRONS, E., ARLOTTO, A., and D. COOPER. (2001). Quality and freezability of epididymal semen from African buffalo (*Syncerus caffer*) under field conditions. Theriogenology, 55: 384.

GLOBAL INVASIVE SPECIES DATABASE. (2017). Downloaded from http://www.iucngisd.org/gisd/search.php on 12-06-2017.

GLORIA, A., CONTRI, A., DE AMICIS, I., ROBBE, D. and A. AUGUSTO. (2011). Differences between epididymal and ejaculated sperm characteristics in donkey. Animal Reproduction Science, 128: 117–122.

GOOVAERTS, I.G.F., HOFLACK, G.G., VAN SOOM, A., DEWULF, J., NICHI, M., DE KRUIF, A. and P.E.J BOLS. (2006). Evaluation of epididymal semen quality using the Hamilton–Thorne analyser indicates variation between the two epididymides of the same bull. Theriogenology, 66: 323–330.

HAFEZ, E.S.E. (1993) Reproduction in Farm Animals, 6th edition. Philadelphia: Lea and Febiger.

HAFEZ, E.S.E. (1998). Reproduction in Farm animals. 7th edition, Lea and Febiger, Philadelphia, London.

HARAYAMA, H., SHIBUKAWA, T., MIYAKE, M., KANNAN, Y. and S. KATO. (1996). Fructose stimulates shedding of cytoplasmic droplets from epididymal boar spermatozoa. Reproduction, fertility and development, 8(7): 1039-1043.

HEROLD, F.C., AURICH, J.E., and D. GERBER. (2004). Epididymal sperm from the African buffalo (*Syncerus caffer*) can be frozen successfully with AndroMed and with Triladyl but the addition of bovine seminal plasma is detrimental. Theriogenology, 61: 715–24.

HEWITT, D., LEAHY, R., SHELDON, I. and G. ENGLAND. (2001). Cryopreservation of epididymal dog sperm. Animal Reproduction Science, 67: 101–111.

HISHINUMA, M., SUZUKI, K. and J. SEKINE. (2003). Recovery and cryopreservation of sika deer (*Cervus nippon*) spermatozoa from epididymides stored at 4°C. Theriogenology, 59: 813–20.

HOLT, W. (2000). Fundamental aspects of sperm cryobiology: the importance of species and individual differences. Theriogenology, 50: 47–50.

HOLTZ, W. and D. SMIDT. (1976). The fertilizing capacity of epididymal spermatozoa in the pig. Journal of Reproductive Fertility, 46: 227-232.

HORAN, A.H. and J.M. BEDFORD. (1972). Development of the fertilizing ability of spermatozoa in the epididymis of the Syrian hamster. Journal of Reproduction and Fertility, 30: 417-420.

HORI, T., ICHIKAWA, M., KAWAKAMI, E. and T. TSUTSUI. (2004). Artificial insemination of frozen epididymal sperm in beagle dogs. The Journal of Veterinary Medical Science, 66: 37–41.

HOSEINZADEH-SANI, S.K-A., BARATI, F. and M.K. MAHABADY. (2013). The effects of ex-vivo cold-storage on cryopreservation of the goat (*Capra hircus*) epididymal sperm. Iranian Journal of Reproductive Medicine, 11(9): 747-752.

HOUDEAU, E., FURSTOSS, V., FORGERIT, Y., BONNE, J.L. and B. LEBOEUF. (2008). Short duration insemination with frozen semen increases fertility rate in nulliparous dairy goats. Journal of Animal Science, 2(10): 1496−1500.

IJAZ, A., HUNTER, A.G. and E.F. GRAHAM. (1989). Identification of the capacitating agent for bovine sperm in egg yolk-test semen extender. Journal of Dairy Science, 72(10): 2700-2706.

IKEDA, H., KIKUCHI, K., NOGUCHI, J., TAKEDA, H., SHIMADA, A., and T. MIZOKAMI. (2002). Effect of preincubation of cryopreserved porcine epididymal sperm. Theriogenology, 57: 1309–1318.

IRDANI, T., FORTUNATO, A. and R. TORRE. (2013). Bio-preservation and biobanking for nematode species by ultra-rapid cooling. CryoLetters 34 (2), SLTB Annual Meeting, 2012: 174-216.

JAINUDEEN, M.R. and S. DAS. (1982). Effect of level of glycerol, rates of freezing and thawing on the survival of buffalo spermatozoa in straws. In: Jainudeen MR, Omar AR (eds), Proceedings of Asian-Australian Animal Science Congress, Serdang, Malaysia.Penerbit University, Kuala Lumpur, Malaysia, 409–411.

JIMENEZ, F., PUCHADES, S., GADEA, J., VICENTE, J.S. and M.P. CASTRO. (2005). Effect of semen collection method on pre- and post-thaw Guirra ram spermatozoa. Theriogenology, 64: 1756–1765.

KAABI, M., PAZ, P., ALVAREZ, M., BOIXO, J.C., ROUISSI, H., HERRAEZ, P.,

ANEL, E. and L. ANEL. (2003). Effect of epididymis handling conditions on the quality of ram spermatozoa recovered post mortem. Theriogenology, 60: 1249-1259.

KARAGIANNIDIS, A., VARSAKELI, S. and G. KARATZAS. (2000). Characteristics and seasonal variations in the semen of Alpine, Saanen, and Damascus goat bucks born and raised in Greece. Theriogenology. 53: 1285–1293.

KARJA, N.W.K., RESPATY, E.M.A., NURAINI, I., PRIHATNO, S.A. and S. GUSTARI. (2010). Characteristic of frozen-thawed epididymal spermatozoa and refrigerated storage of ram spermatozoa. Journal of the Indonesian Tropical Animal Agriculture, 35(1): 63–67.

KIKUCHI, K., NAGAI, T., KASHIWAZAKI, N., IKEDA, H., NOGUCHI, J., SHIMADA, A., SOLOY, E. and H. KANEKO. (1998). Cryopreservation and ensuing in vitro fertilization ability of boar spermatozoa from epididymides stored at 4°C. Theriogenology, 50: 615–623.

KISHIKAWA, H., TATENO, H., and R. YANAGIMACHI. (1999). Fertility of mouse spermatozoa retrieved from cadavers and maintained at 4°C. Journal of Reproduction and Fertility, 116: 217–22.

KRZYWINSKI, A. (1981). Freezing of postmortem collected semen from moose and red deer. Acta Theriologica, 26: 424–426.

KOZDROWSKI, R., DUBIEL, A., BIELAS, W. and M. DZIĘCIOŁ. (2007). Two protocols of cryopreservation of goat semen with the use of computer-assisted semen analysis system. Acta Veterinaria Scandinavica, 76: 601-604.

LAMBIO, A.L, SEVILLA, C.C., CAPITAN S.S., KHAREL, M. and D.R. SABULARSE. (1992). Genetic polymorphisms on serum proteins and isoenzymes in Philippine native goats. Phil. J. Vet. Anim. Sci. 18(3): 223-228.

LAMBRECHTS, H., VAN NIEKERK, F., COETZER, W., CLOETE, S. and H.G. VAN DER. (1999). The effect of cryopreservation on the survivability, viability and motility of epididymal African buffalo (*Syncerus caffer*) spermatozoa. Theriogenology, 52: 1241–9.

LIVESTOCK DEVELOPMENT COUNCIL. (2001). Proceeding: 1st Small Ruminant Congress. Central Luzon State University.

LIVESTOCK RESEARCH DIVISION, DOST-PCAARRD S&T MEDIA SERVICE. (2016). Goats' meat: sure bet in building rural assets. Retrieved from

http://www.pcaarrd.dost.gov.ph/home/portal/index.php/quick-information-dispatch/2685-goats-meat-sure-bet-in-building-rural-assets

LOPES, G., SOARES, L., FERREIRA, P. and A. ROCHA. (2015). Tris-egg yolk-glycerol (TEY) extender developed for freezing dog semen is a good option to cryopreserve bovine epididymal sperm cells. Reproduction in Domestic Animals, 50: 97-103.

LOPEZ-SEBASTIAN, A., GONZALEZ-BLUES, A., CARRIZOSA, J.A., URRUTIA, B., DIAZ-DELFA, C., SANTIAGO-MORENO, J. and A. GOMEZ-BRUNET. (2007). New oestrus synchronisation and artificial insemination protocol for goats based on male exposure, progesterone and cloprostenol during the nonbreeding season. Theriogenology, 68: 1081-1087.

LUBBE, K., BARTELS, P., KILIAN, I., FRIEDMANN, Y. and R.A. GODKE. (2000) epididymal spermatozoa when cryopreserved with two different cryodiuents or stored at 4 8C. Theriogenology, 53: 338.

MACLEOD, J. and R.Z. GOLD. (1951). The male factor in fertility and infertility (IV. Sperm morphology in fertile and infertile marriage). Fertility and Sterility, 2(5): 394-414.

MALO, A.F., GARDE, J.J., SOLER, A.J., GARCIA, A.J., GOMENDIO, M. and E.R. ROLDAN. (2005). Male fertility in natural populations of red deer is determined by sperm velocity and the proportion of normal spermatozoa. Biology of Reproduction, 72: 822–829.

MAMUAD, F.V., VENTURINA, E.V. and H. SAITO. (2004). Collection, processing and handling buffalo semen. Water Buffaloes and Beef Cattle Improvement Project (WBBCIP). A Joint-JICA Assisted Project of the Philippine Carabao Center and the Bureau of Animal Industry Philippines.

MAMUAD, SR. H.V., VENTURINA, E.V., MORUSO, R.T. ATABAY, E.C. and K. KUDO. (2005). Artificial insemination manual for water buffaloes. Water Buffaloes and Beef Cattle Improvement Project (WBBCIP). A Joint-JICA Assisted Project of the Philippine Carabao Center and the Bureau of Animal Industry Philippines.

MARTINEZ-PASTOR, F., GUERRA, C., KAABI, M., DIAZ, A.R., ANEL, E., HERRAEZ, P., DE PAZ, P. and L. ANEL. (2004). Decay of sperm obtained from epididymes of wild ruminants depending on post-mortem time. Theriogenology, 63: 24–40.

MARTINEZ-PASTOR, F., DIAZ-CORUJO, A.R., ANEL, E., HERRAEZ, P., DE

PAZ, P. and L. ANEL (2005). Post mortem time and season alter subpopulation characteristics of Iberian red deer epididymal sperm. Theriogenology, 64: 958–974.

MARTINEZ-PASTOR, F., GUERRA, C., KAABI, M., GARCIA-MACIAS, V., DE PAZ, P. and M. ALVAREZ. (2005). Season effect on genitalia and epididymal sperm from Iberian red deer, roe deer and Cantabrian chamois. Theriogenology, 63: 1857–75.

MARTINEZ-PASTOR, F., GARCIA-MACIA, V., ALVAREZ, M., CHAMORRO, V., HERRAEZ, P., DE PAZ, P. and L. ANEL. (2006). Comparison of two methods for obtaining spermatozoa from the cauda epididymis of Iberian red deer. Theriogenology, 65: 471–485.

MARTINEZ-PASTOR, F., MATA-CAMPUZANO, M., ALVAREZ-RODRIGUEZ, M., ALVAREZ, M., ANEL, L. and P. DE PAZ. (2010). Probes and techniques for sperm evaluation by flow cytometry. Reproduction in Domestic Animals, 45(2): 67–78.

MARTINEZ, R.R.D., HERNANDEZ, J., REYNA, L. and R. SANTOS. (2007). Intrauterine insemination with frozen-thawed semen in Creole goats, synchronized in oestrous during the non-breeding season. Research Journal of Animal Sciences, 1(3): 76-80.

MARTINS, C.F., RUMPF, R., PEREIRA, D.C. and M.N. DODE. (2007). Cryopreservation of epididymal bovine spermatozoa from dead animals and its uses in vitro embryo production. Animal Reproduction Science. 101(3-4): 326-331.

MARTINS, C.F., DRIESSEN, K., MELO COSTA, P., CARVALHO-NETO, J.O., DE SOUSA, R.V., RUMPF, R. and M.N. DODE. (2009). Recovery, cryopreservation and fertilization potential of bovine spermatozoa obtained from epididymides stored at 5°C by different periods of time. Animal Reproduction Science, 116: 50–57.

MATHAROO, J.S., and M. SINGH. (1980). Revivability of buffalo-spermatozoa after deep freezing the semen using various extenders. Transboundary and Emerging Diseases, 27(5): 385-391.

MCMILLAN, W., SHACKELL, G., VISHWANATH, R., FIELDEN, E. and J. SMITH. (1998). Comparative reproductive performance. Reproductive management of grazing ruminants in New Zealand, 12: 43–64.

MEUWISSEN, M.P.M., HUIME, R.B.M. and J.B. HARDAKER. (1999). Income Insurance in European Agriculture Scientific Report EU-Project, European Economy No. 2, DGII, Brussels, 95.

MITCHELL, T. (2003). Agfact A7.2.2, 1st edition. New South Wales-Department of Agriculture Division of Animal Production, Dubbo, 1: 2.

MOLINIA, F.C., EVANS, G., QUINTANA, C. and W.M.C. MAXWELL. (1994). Effect of monosaccharides and disaccharides in Tris-based diluents on motility, acrosome integrity and fertility of pellet frozen ram spermatozoa. Animal Reproduction Science, 36: 113-122.

MOORE, H.D.M. (1995). Post-testicular sperm maturation and transport in the excurrent duct. In: Grudzinskas, J.G., Yovich, J.L. (Eds.), Gametes—The Spermatozoon. Cambridge University Press, 140–157.

MORAI, R.N., MUCCIOLO, R.G., GOMES, M.L., LACERDA, O., MORAES, W. and N. MOREIRA. (2002). Seasonal analysis of semen characteristics, serum testosterone and fecal androgens in the ocelot (*Leopardus pardalis*), margay (*L. wiedii*) and tigrina (*L. tigrinus*). Theriogenology, 57: 2027–41.

NAGAI, T., TAKAHASHI, T., MASUDA, H., SHIOYA, Y., KUWAYAMA, M., FUKUSHIMA, M., IWASAKI, S. and A. HANADA. (1988). In-vitro fertilization of pig oocytes by frozen boar spermatozoa. Journal of Reproduction and Fertility, 84: 585-591.

NAKAGATA, N. (1992). Production of normal young following insemination of frozen-thawed mouse spermatozoa into fallopian tubes of pseudopregnant female. Experimental Animals, 41: 519-522.

NUTI, F. and C. KRAUSZ. (2008). Gene polymorphisms/mutations relevant to abnormal spermatogenesis. Reproductive biomedicine online, 16(4): 504-513.

OCAMPO, M.B, OCAMPO, L.C., REYES, R., SILVESTRE, J.Q. and E. VILLAR. (2002). Viability of frozen goat embryos using a modified minimum drop size technique of vitrification. Philippine Journal of Veterinary and Animal Sciences, 28(1): 46-55.

PACE, M.M. and E.F. GRAHAM. (1974). Components in egg yolk which protect bovine spermatozoa during freezing. Journal of Animal Science, 39: 1144-1149.

PAOLI, D., GALLO, M., RIZZO, F., BALDI, E., FRANCAVILLA, S., LENZI, A., LOM-BARDO, F. and L. GANDINI. (2011). Mitochondrial membrane potential profile and its correlation with increasing sperm motility. Journal of Reproduction and Fertility, 95: 2315-2319.

PARAWAN, O., OVALO, H., CURATIVO, V. and S. HIPOL. (1987). Study on the reproduction and production performance on native goat and 50%, 75% Philippine

Native and Anglo Nubian crossbreds at village conditions Philippine Journal of Veterinary and Animal Sciences, 13(4): 61.

PAULENZ, H., SÖDERQUIST, L. and R. PÉREZ-PÉ. (2002). Effects of different extenders and storage temperatures on sperm viability of liquid ram semen. Theriogenology, 57: 823-836.

PEÑA, F.J., JOHANNISSON, A., WALLGREN, M. and H. RODRIGUEZ-MARTINEZ. (2003). Assessment of fresh and frozen–thawed boar semen using an Annexin-V assay: a new method of evaluating sperm membrane integrity. Theriogenology, 60: 677–689.

PHILIPPINE STATISTICS AUTHORITY. (2016). Goat Industry Performance Report January-June 2016.

PURDY, P.H. (2006). A review on goat sperm cryopreservation. Small Ruminant Research, 63: 215–225.

PURSEL, V.G. and L.A. JOHNSON. (1975). Freezing of boar spermatozoa: fertilizing capacity with concentrated semen and a new thawing procedure. Journal of Animal Science, 40(1): 99-102.

RAHMAN, A.N.M.A., ABDULLAH, R.B. and W.E.W. KHADIJAH. (2008). A review of reproductive biotechnologies and their application in goat. Biotechnology, 7(2): 371-384.

RAMUKHITHI, F.V. (2011). Cryopreservation of South African indigenous goat semen. African Journal of Biotechnology, 10(77). http://doi.org/10.5897/AJB11.2034

RASUL, Z., ANZAR, M., JALALI, S. and N. AHMAD. (2000). Effect of buffering systems on post-thaw motion characteristics, plasma membrane integrity, and acrosome morphology of buffalo spermatozoa. Animal Reproduction Science, 59: 31–41.

RITAR, A.J., BALL, P.D. and P.J. O'MAY. (1990). Examination of methods for the deep freezing of goat semen. Reproduction Fertility and Development, 2: 27-34.

RITAR, A.J., MENDOZA, G., SALAMON, S. and I.G. WHITE. (1992). Frequent semen collection and sperm reserves of the male Angora goat (*Capra hircus*). Journal of Reproduction and Fertility, 95: 97-102.

SAITO, H., MATEO, R. and U. AMAGAN. (2004). Semen processing guide on beef cattle. WBBCIP. JICA. Philippine Carabao Center & Bureau of Animal Industry.

SALHAB, S.A., ZARKAWI, M., WARDEH, M.F., AL-MASRI, M.R. and R. KASSEM. (2001). Development of testicular dimensions and size, and their Relationship to age, body weight and parental size in growing Awassi ram lambs. Small Ruminant Research, 40: 187-191.

SANGEL, P.P., BONDOC, O.L., ROXAS, N.P., GARCIA, B.R., BELTRAN, E.D. and E.C. LAT. (2004). Study on the artificial insemination of normally cycling and heat-induced goats (*Capra hircus*) using fresh extended and cryopreserved semen. Philippine Journal of Veterinary and Animal Sciences, 30(2): 129-137.

SANKAI, T., TSUCHIYA, H. and N. OGONUKI. (2001). Short-term nonfrozen storage of mouse epididymal spermatozoa. Theriogenology, 55: 1759–68.

SANSONE, G., NASTRI, M.J.F. and A. FABBROCINI. (2000). Storage of buffalo (*Bubalus bubalis*) semen. Animal Reproduction Science, 62: 55–76.

SANTIAGO-MORENO, J., TOLEDANO-DÍAZ, A., PULIDO-PASTOR, A., GÓMEZ-BRUNET, A. and A. LÓPEZ-SEBASTIÁN. (2006). Birth of live Spanish ibex (*Capra pyrenaica hispanica*) derived from artificial insemination with epididymal spermatozoa retrieved after death. Theriogenology, 66: 283–291.

SHAKERI, M., ROSHANFEKR, H., MAMOEI, M. and K.H. MIRZADEH. (2008). Effect of epididymis handling conditions on the quality of ram spermatozoa recovered post-mortem. Asian Journal of Animal and Veterinary Advances, 3(6): 400-408.

SEVILLA, C.C. and M.B. BEJO. (1999). Reproductive and productive performance of indigenous, grade and purebred Anglo Nubian goats under Los Baños conditions. Proc. 36th PSAS Annual Convention. Oct. 21-22, 1999. The Heritage Hotel, Roxas Boulevard., Manila, 301-308.

SIMPSON, A.M., SWAN, M.A. and I.G. WHITE. (1987). Susceptibility of epididymal boar sperm to cold shock and protective action of phosphatidylcholine. Gamete Research, 17: 355-373.

SKINNER, J.D. (1971). The effect of season on spermatogenesis in some ungulates. J Reprod Fertil. 13: 29–37.

SKINNER, J.D., VAN ZYL, J.H.M. and J.A.H. VAN HEERDEN. (1973). The effect of season on reproduction in the black wildebeest and red hartebeest in South Africa. Journal of Reproduction and Fertility, 19:101–110.

SMITH, M.C. (1978). Some clinical aspects of caprine reproduction. The Cornell Veterinarian, 68:200-211.

SODERQUIST, L., JANSON, L., LARSSON, K. and S. EINARSSON. (1991). Sperm morphology and fertility in AI bulls. Journal of Veterinary Medicine Series A, 38: 534–543.

SOLER, A.J., PEREZ-GUZMAN, M.D. and J.J. GARDE. (2003). Storage of red deer epididymides for four days at 5°C: effects on sperm motility, viability, and morphological integrity. Journal of Experimental Zoology, 295: 188–99.

SONGSASEN, N., TONG, J. and S.P. LEIBO. (1998). Birth of live mice derived by in vitro fertilization with spermatozoa retrieved up to 24 h after death. Journal of Experimental Zoology, 280: 189-196.

SOSTARIC, E., AALBERTS, M., GADELLA, B.M. and T.A.E. STOUT. (2008). The roles of the epididymis and proteasomes in the attainment of fertilizing capacity by stallion sperm. Animal Reproduction Science, 107: 237–248.

SOUTHARD, L. (2003). Livestock, dairy, and poultry outlook. Electronic Outlook from the Economic Research Service. United States Department of Agriculture, 36.

STATUS OF THE PHILIPPINES' ANIMAL GENETIC RESOURCES-A COUNTRY'S REPORT. (2003). Retrieved from ftp://ftp.fao.org/docrep/fao/010/a1250e/annexes/ CountryReports/ Philippines.pdf

SUNDARARAMAN, M.N., KALATHARAN, J. and M.J. EDWIN. (2007). Attempts to achieve semen collections from incapacited Boer bucks by electroejaculation. Asian Journal of Animal and Veterinary Advances, 2(4): 244-246.

SUNDARARAMAN, M.N. and M.J. EDWIN. (2008). Changes in motility characteristics of goat spermatozoa during glycerol-equilibration and the relevance to cryopreservation. Asian Journal of Cell Biology, (1): 22-23.

SYNTIN, P. and B. ROBAIRE. (2001). Sperm structural and motility changes during aging in the brown Norway rat. Journal of Andrology, 22(2): 235-244.

TAMAYO-CANUL, J., ALVAREZ, M., MATA-CAMPUZANO, M., ÁLVAREZ-RODRÍGUEZ, M., DE PAZ, P., ANEL, L. and F. MARTINEZ-PASTOR. (2011). Effect of storage method and extender osmolality in the quality of cryopreserved epididymal ram spermatozoa. Animal Reproduction Science, 129: 188–199.

THUNDATHIL, J., PALASZ, A.T., BARTH, A.D. and R.J. MAPLETOFT. (2001). The use of in vitro fertilization techniques to investigate the fertilizing ability of bovine sperm with proximal cytoplasmic droplets. Animal Reproduction Science, 65: 181–192.

TRETIPSKUL, C., BURANAAMNUAY, K., KOONJAENAK, S., TUMMARUK, P. and M. TECHAKUMPHU. (2010). The use of computer-assisted sperm analysis (CASA) for discriminating a series of motility pattern of frozen-thawed boar semen. Thai Journal of Veterinary Medicine, 40(1): 25-30.

TULI, R.K. and W. HOLTZ. (1995). Effect of season on the freezability of Boer goat semen in the Northern temperate zone. Theriogenology, 43: 1359–1363.

TURNER, T.T. (1995). On the epididymis and its role in the development of the fertile ejaculate. Journal of Andrology, 16: 292–298.

TURRI, F., MADEDDU, M., GLIOZZI, T. M., GANDINI, G. and F. PIZZI. (2013). Effect of testicle postmortem storage on goat frozen-thawed epididymal sperm quality as a tool to improve gene banking in local breeds. Animal, 8(3): 440–447.

VALE, W. (2004). Semen Production for Artificial Insemination. In Pre-Congress training on the use of Reproductive Biotechniques in Water Buffaloes. Science City of Muñoz Nueva Ecija, Philippines: Food and Agriculture Organization, Philippine Carabao Center and Japan International Cooperation Agency, 45.

VALETE, E.J.P. (2013). Goat semen cryopreservation: effect of varying sperm concentration on the post-thaw liveability of frozen goat semen (Undergraduate thesis). Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines.

VALETE, E.J.P., MAYLEM, E.R.S., OCAMPO, M.B., ABELLA, E.A. and L.C. OCAMPO. (2015). Post Mortem Viability of Epididymal Sperm from Philippine Native Water Buffalo (*Bubalus bubalis*). Journal of Agricultural Technology, 11(8): 2283–2294.

VALETE, E.J.P., OCAMPO, L.C., AQUINO, F.P., CRUZ, K.G. and M.B. OCAMPO. (2016). Sperm concentration influences the post-thaw livability of frozen goat semen. Research Opinions in Animal and Veterinary Sciences, 6(5): 158-164.

VERGARA, K.G.B. (2013). Viability of extended goat semen stored at refrigerated condition (Undergraduate thesis). Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines.

VERRIER, E., DANCHIN-BURGE, C., MOUREAUX, S., OLLIVIER, L., TIXIER-BOICHARD, M., MAIGNEL, M.J., BIDANEL, J.P. and F. CLEMENT. (2003). What should be preserved: genetic goals and collection protocols for the French National Cryobank. In D. Planchenault, ed. Workshop on Cryopreservation

of Animal Genetic Resources in Europe. Paris, Bureau des Resources Génétiques, 79–89. Retrieved from http://dad.fao.org/cgi-bin/getblob.cgi?sid=-1,50005777

VILLAR, E.C., AGLIBUT, F.B., CASTILLO, L.S. and O.F. SISON. (1984). Performance of purebred, native and grade goats raised in confinement at the Philippine Rural Life Center goat herd. Philippine Journal of Veterinary and Animal Sciences, 10(1-2): 40.

WALTON, A. (1930). The effect of temperature on the survival in vitro of rabbit spermatozoa obtained from vas deferens. Journal of Experimental Biology, 7: 201-219.

WATSON, P.F. (1976). The protection of ram and bull spermatozoa by the low density lipoprotein fraction of egg yolk during storage at 5˚C and deep-freezing. Journal of Thermal Biology, 1(3): 137-141.

WATSON, P.F. (1979) The preservation of semen in mammals. In: Finn CA, editor. Reviews of reproduction biology. Oxford University Press, 283–350.

WATSON, P.F. (1981). Effects of cold shock on sperm cell membranes. Effects of Low Temperatures on Biological Membranes, 1981: 189-218.

YAMASHIRO, H., KUMAMOTO, K., WANG, H., YAMASHITA, Y. and T. TERADA. (2006). Effect of semen collection in extender solution on the characteristics of goat spermatozoa. Journal of Reproduction and Development, 52(3): 397-406.

YU, I. and S.P. LEIBO. (2002). Recovery of motile, membrane-intact spermatozoa form canine epididymides stored for 8 days at 4^0C. Theriogenology, 57: 1179–1190.

YULNAWATI, MAHESHWARI, H., HERDIS, and M. RIZAL. (2009). Viability and plasma membrane integrity of the spotted buffalo epididymal spermatozoa after thawing with the addition of dextrose into the extender. Biotropia- The Southeast Asian Journal of Tropical Biology, 16(1): 21–27.

ZARAZAGA, L.A., GUZMAN, J.L., DOMINGUEZ, C., PEREZ, M.C. and R. PRIETO. (2009). Effects of season and feeding level on reproductive activity and semen quality in Payoya buck goats. Theriogenology, 71: 1316-1325.

ZOMBORSZKY, Z., ZUBOR, T., TOTH, J. and P. HORN. (1999). Sperm collection from shot red deer stags (*Cervus elaphus*) and utilization of sperm frozen and subsequently thawed. Acta Veterinaria Hungarica, 47: 263–270.