PIUS MWANGI NDEGWA

EDUCATION

PhD, Biological & Agricultural Engineering, University of Georgia, Athens, Georgia, 1999.

MS, Agricultural Engineering, University of Georgia, Athens, Georgia, 1990.

BS, Agricultural Engineering, University of Nairobi, Nairobi, Kenya, 1986.

EMLOYMENT HISTORY

07/10 – Now: Associate Professor, Washington State University, Pullman, WA.
08/04 – 07/10: Assistant Professor, Washington State University, Pullman, WA.
10/01 – 08/04: Assistant Researcher, Oklahoma State University, Stillwater, OK.
08/99 – 10/01: Postdoctoral Associate, University of Minnesota, Waseca, MN
09/95 – 08/99: Research/Teaching Assistant, University of Georgia, Athens, GA.

HONORS and AWARDS

1. Bestowed membership: The Honor Society of Agriculture: Gamma Sigma Delta, 1989.
2. Superior ASAE Paper Award: Top 2.5% of papers published in the Trans. of the ASAE, 2002.
3. Lead Author: **Top 25 Hottest Articles** in Biosystems Engineering in 2012. Article full citation "**Ndegwa, P.M.**, A.N. Hristov, J. Arogo, R.E. Sheffield. 2008. A review of ammonia emissions mitigation techniques for concentrated animal feeding operations. Biosystems Engineering 100(4):453-469)."
4. Lead Author: **1st out of 20 2013 most cited article** of the all articles published in Biosystems Engineering from 2008 to 2013 - extracted from SciVerse Scopus. Article full citation "**Ndegwa, P.M.**, A.N. Hristov, J. Arogo, R.E. Sheffield. 2008. A review of ammonia emissions mitigation techniques for concentrated animal feeding operations. Biosystems Engineering 100(4):453-469)."
5. Co-Author: **9th out 20 2013 most cited papers (November)** of the Canadian Journal of Animal Science entitled "Review: Ammonia emissions from dairy farms and beef feedlots." Authors: A.N. Hristov, M. Hanigan, A. Cole, R. Todd, T.A. McAllister, P.M. Ndegwa, A. Rotz.

PROFESSIONAL ORGANIZATIONS

1) Member Engineer: American Society of Agricultural & Biological Engineers (ASABE), 1999 – Present.
2) Associate member: Kenyan Society of Agricultural Engineers (KASE), 1992 - Present.
3) Member: Air & Waste Management Association (AWMA), 2011 – Present.

PROFESSIONAL REGISTRATION

Professional Engineer Intern, Minnesota License # 123230.

SEMINARS and INVITED PRESENTATIONS

1. CAFO Air Quality Status/Updates. EPA Region 10 AFO/CAFO Workshop. Portland, Oregon, Dec. 17, 2010.
2. The National Air Emissions Monitoring Study (NAEMS). Regional Dairy Air Quality Issues. Yakima Regional Clean Air Agency, Yakima, WA, August 12, 2010.
3. Air Quality Research in Washington. Washington Dairy Federation Annual Meeting. Everet, WA, Nov. 3, 2010.

4. Ammonia Mitigation Strategies (BMPs). Western Regional Odor and Air Quality Education Workshop. Albuquerque, New Mexico (October, 2008).
5. Air Quality Legislation in Oregon & Washington. Western Regional Odor and Air Quality Education Workshop. Albuquerque, New Mexico (October, 2008).
6. Ammonia and PM emissions from animal feeding operations (AFOs). Columbia Plateau PM_{10} Project Annual Meeting, Pullman, Washington (December, 2008).
7. Livestock Industry: Environmental, Health & Legislation Issues. Yakima County Air Quality Meeting, Yakima, Washington (August, 2008).
8. Anaerobic digestion 101: Nutrient Transformation, Nutrient Management & Benefits. Anaerobic Digestion Workshop, Tacoma, Washington (July, 2008).
9. Ammonia: The Air-Water Interface – An Inaugural air quality presentation Sponsored by Ammonia Webcast Air Quality Education in Animal Agriculture Project and the Livestock and Poultry Environmental Learning Center Series. Link: http://www.extension.org/pages/Ammonia,_The_Air-Water_Interface (June, 2008)
10. Ammonia emissions mitigation techniques for concentrated animal feeding operations. Mitigation Air Emissions from Animal Feeding Operations: Exploring the advantages, Limitations, and Economics of mitigation technologies, Des Moines, Iowa (May, 2008).
11. Anaerobic digestion 101: Nutrient Transformation, Energy Production, and Carbon Credits. Pacific Northwest Animal Nutrition Conference, Portland, Oregon (October, 2007).
12. Ammonia -What's All the Fuss? Pacific Northwest Animal Nutrition Conference, Portland, Oregon (October, 2007).
13. Present and future of air quality research in the State of Washington and the National Emissions Monitoring Study: Volunteered presentation at the Annual Meeting of the Washington State Dairy Industry in Chelan, WA (October, 2006).
14. Air Quality Research in Washington: Invited presentation at the Western Dairy Air Quality Symposium, Las Vegas, NV (March, 2006).
15. Odor management plans for dairy operation: Volunteered presentation at the Washington State Dairy Industry Annual meeting at Skamania Lodge in Stevenson, WA (November, 2005).
16. Vermicomposting of biosolids: Invited presentation at the Department of Biological & Agricultural Engineering seminar series, Athens, Georgia (Winter 1999).
17. Modeling composting systems: Invited guest lecturer for a Systems Simulation Class in the Department of Biological and Agricultural Engineering, Athens, Georgia (Fall, 1998).
18. Swine manure management research at the Southern Research & Outreach Center: Volunteered presentation to a group of visiting pork producers and educators from around Minnesota at FARM-AMERICA, Waseca, Minnesota (September, 2000).
19. Research towards better management of animal waste and odor control. Invited seminar at the Department of Animal Science - winter seminar series (February 2002).
20. Enhanced removal of phosphorus from swine manure using low-level aeration treatments. Invited presentation at the Oklahoma Manure Management Information Team Monthly seminars (August 2002).
21. Research Opportunities in Animal Waste Management. Invited seminar at the Department of Animal Science – Freshmen Seminar Series (April 2003).

PROFESSIONAL & PUBLIC SERVICES

A. Associate Editor:

1. Transactions of American Society of Biological & Agricultural Engineers (ASABE): 2009 – Present.
2. Applied Engineering in Agriculture: 2009 – Present.

B. *Ad hoc* Technical Review for the Following Scientific Journals:-

1. Journal of Bioresource Technology.
2. Journal of Applied Environmental Science and Public Health.
3. Transactions of the American Society of Engineering (ASAE).
4. Applied Engineering in Agriculture.
5. Biosystems Engineering.
6. Biochemical Engineering.
7. Canadian Biosystems Engineering.
8. Process Biochemistry
9. Environmental Technology
10. CGIR Ejournal
11. Water Research
12. Applied Microbiology and Biotechnology
13. Journal of Environmental Quality.
14. Atmospheric Environment.

C. *Ad hoc* Research Proposals Review for:

1. USDA-SBIR Animal Waste Management Program.
2. NIWR-USGS National Competitive Grants Program.
3. SDSU Research Foundation - California Energy Commission: Energy Innovations Small Grant (EISG).
4. Western SARE – Farmer/Rancher Grant Applications.
5. Western SARE – Professional & Producer Grant Applications.
6. The Danish Council for Strategic Research – Programme Commission for Sustainable Energy and Environment: International Service.
7. Chile Government: National Commission for Scientific and Technological Development (CONICYT) and the Superior Council of the National Fund for Scientific & Technological Development (FONDECYT) – International Service.

D. Proposal Review Panelist for:

1. 2008 & 2009 USDA-SBIR: Animal Manure Management Program.
2. 2010 USDA-NIFA: Climate Change Program.

E. Committees Served/Serving:

1. Departmental: Awards Committee: Chair, 2007 – 2010; Member 2010 - Present.
2. Departmental: Graduate Studies Committee, 2004 – 2010; Co-Coordinator 2010 - Present.
3. Departmental: LAWREE Group Lead, 2010 – Present.
4. Departmental: Advisor: ASABE Student Club, 2012 – Present.
5. Regional: PNWCA Odor and Air Quality Committee, 2006 – Present.
6. National: Awards Committee – Publication: American Society of Biological and Agricultural Engineers (ASABE), 2013 – Present.
7. National: Session Organizer and Moderator: Design of Anaerobic Lagoons for Animal Waste Management at the American Society of Biological and Agricultural Engineers (ASABE) Annual Meeting in Portland, Oregon, 2006.
8. National: Committee Member: Air Quality Session – American Society of Biological and Agricultural Engineers (ASABE), 2005 – Present.

9. National: Committee Member: Animal Waste Management - American Society of Biological and Agricultural Engineers (ASABE), 2001 – Present.
10. National: Committee Member: Revision of the Federation of Animal Science (FASS) Animal Care and Use Guide (aka Ag Guide or "Guide for the care and use of agricultural animals in agricultural research and teaching"), 2007 – 2008.

PROFESSIONAL DEVELOPMENT

1. Participated in a 12-Week Productive Proposal Writing Track Coordinated by OGRD, Pullman, WA, October 2009- February 2010
2. Attended 2 day EPA workshop on Pacific Northwest Nutrient Management in Portland, Oregon, December 14-17, 2010.
3. Grant Writing Seminar: Attended this full-day workshop organized by OGRD, Pullman, WA (October 5, 2006).
4. Attended a "Water Quality Workshop" focusing on issues in the Pacific Northwest in Moscow, Idaho; October 24, 2006.
5. Attended a 2-hour "Promotion and tenure workshop" organized by the Provost's office on September 7, 2006.
6. Participated in the November Mission to DC trip to meet with various National Program Leaders at various Federal Agencies to enhance proposals success: 2 days, 16th and 17th November, 2005.
7. Attended a two-day "USDA-Grant writing workshop" in Moscow, ID: September 28 & 29th, 2005.
8. Attended a two-day training workshop on "Open path gaseous emission measurements from livestock operations" in Twin Falls, ID: August 25 - 26, 2005.
9. Attended a half-day seminar on "WTC grant program" at OGRD, WSU, Pullman: February 8, 2005.
10. Attended a half-day 'hands on' workshop on "Creating your own web page" offered by WSU Library information Services, July 26, 2005.
11. Attended a half-day workshop on "Writing Large Proposals" organized by OGRD, WSU (February 24, 2005).
12. Workshop in ID, WA, three days, August 01 – 04, 2005: UV Sentry Emission Monitoring Training including: Classroom instruction on Open-Path UV monitoring system coupled with 3-D anemometer and bLS Modeling software: System operation, calibration, and field testing.
13. Power Point Presentations: Attended a two-hour course on "the use of PowerPoint to augment Teaching, Research and Extension", Jan., 2005 organized by the Human Resource Services, WSU.
14. Odor Assessment: Attended a two-day hands-on "Odor Assessment Workshop" conducted by the University of Idaho Extension in Boise, Idaho (October 13 - 14, 2004).
15. Good Laboratory Practices (GOPs): A two-day seminar-cum-workshop on good laboratory practices, April 2004 (Oklahoma State University).
16. Training in the Professoriate: A series of eight 2-hour seminars offered for beginning university faculty, teaching assistants, and graduate students who wish to pursue a faculty career or to know more about the responsibilities and duties associated with faculty work at the university level (Spring 2004, Oklahoma State University).
17. Grant Writing Seminar and Workshops: "Writing winning grants"; Oklahoma State University, 2-day workshop, November, 2003.
18. Review of PE Examination: A four-hour review of PE examination organized by ASAE during the 2002 conference in Chicago.

SCHOLARLY MATERIALS

Books & Book Chapters

1. **Ndegwa, P. M.**, A. N. Hristov, and J. A. Ogejo. 2011. Chapter 6 - Ammonia Emission from Animal Manure: Mechanisms and Mitigation Techniques. In press, *In* Z. He, ed. Environmental Chemistry of Animal Manure. Nova Science Publishers, Hauppauge, NY.
2. Mitloehner, F., J. Swearengen, L. Jacobson, C. Gooch, **P. Ndegwa**. 2009. Chapter 3 - Husbandry, Housing, and Biosecurity. In: Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. Federation of Animal Science Societies, 14-28.

Refereed Journal Articles

1. Zeb, I., J. Ma, C. Frear, Q. Zhao, **P. Ndegwa**, Y. Yao, G.K. Kafle. 2016. Recycling separated liquid-effluent to dilute feedstock in anaerobic digestion of dairy manure. Energy (Accepted).
2. Neerackal, G.M., P. M. Ndegwa, H. S. Joo, J. H. Harrison. 2016. Manure-pH management for mitigating ammonia emissions from dairy barns and liquid manure storages. Applied Engineering in Agriculture (Accepted).
3. Wenlong, C., V. Vaddella, S. Biswas, K. Perkins, C. Clay, T. Wu, Y. Zheng, **P. Ndegwa**, P. Pandey. 2016. Assessing the changes in *E. coli* levels and nutrient dynamics during vermicomposting of food waste under lab and field scale conditions. Environ. Sci. Pollut. Res. Int. 23(22):23195-23202.
4. Khalil, T.M., S.S. Higgins, **P.M. Ndegwa**, C.S. Frear, C.O. Stöckle. 2016. Assessing the effect of different treatments on decomposition rate of dairy manure. Journal of Environmental Management. 182:230-237.
5. Wang, X., **P.M. Ndegwa**, H.S. Joo, G.M. Neerackal, C.O. Stöckle, H. Liu, J.H. Harrison. 2016. Indirect method versus direct method for measuring ventilation rates in naturally ventilated dairy houses. Biosystems Engineering 144: 13-25.
6. Neerackal, G.M., **P.M. Ndegwa**, H.S. Joo, X. Wang, C.S. Frear, J.H. Harrison, M.W. Beutel. 2016. Potential application of *Alcaligenes faecalis* strain No. 4 in mitigating ammonia emissions from dairy wastewater. Bioresource Technology 206: 36-42.
7. Wang, X., **P.M. Ndegwa**, H.S. Joo, G.M. Neerackal, J.H. Harrison, C.O. Stöckle, H. Liu. 2016. Reliable Low-cost devices for monitoring ammonia concentrations and emissions in naturally ventilated dairy barns. Environmental Pollution 208(B): 571-579.
8. Chen, Y., J.H. Harrison, **P. Ndegwa**, D. Wilks, L. VanWieringen, W. Chalupa, F. Sun. 2016. Case Study: Effect of strategic ration balancing on the efficiency of milk protein production and environmental impact of dairy cows in a commercial herd. The Professional Animal Scientist 32(1): 115-133.
9. Joo, H.S., **P.M. Ndegwa**, X. Wang, A.J. Heber, J.-Q. Ni, E.L. Cortus, J.C. Ramirez-Dorronsoro, B.W. Bogan, L. Chai. 2015. Ammonia and hydrogen sulfide concentrations and emissions for naturally-ventilated freestall dairy barns. Trans. ASABE 58(5): 1321-1331.
10. Joo, H.S., K. Park, K. Lee, **P. Ndegwa**. 2015. Mass concentration coupled with mass loading rate for evaluating $PM_{2.5}$ pollution status in the atmosphere: a case study based on dairy barns. Environmental Pollution 207: 374-380.
11. Neerackal, G.M., **P.M. Ndegwa**, H.S. Joo, X. Wang, J.H. Harrison, A.J. Heber, J.-Q. Ni, C. Frear. 2015. Effects of anaerobic digestion and solids separation on ammonia emissions from stored and land applied dairy manure. Water, Air, & Soil Pollution 226(9):301.

12. Page, L.H., J.-Q. Ni, H. Zhang, A.J. Heber, N.S. Mosier, X. Liu, H.-S. Joo, **P.M. Ndegwa**, J.H. Harrison. 2015. Reduction of volatile fatty acids and odor offensiveness by anaerobic digestion and solid separation of dairy manure during manure storage. J. Environmental Management 152: 91-98.
13. Joo, H.S., **P.M. Ndegwa**, A.J. Heber, B.W. Bogan, J.-Q. Ni, E.L. Cortus, J.C., Ramirez-Dorronsoro. 2015. Greenhouse gas emissions from naturally ventilated freestall dairy barns. Atmospheric Environment 102: 384–392.
14. Sun, F., J.H. Harrison, **P.M. Ndegwa**, K. Johnson. 2014. Effect of manure treatment on ammonia emissions during storage under ambient environment. Water, Air, & Soil Pollution 225(9).
15. Koirala, K., **P.M. Ndegwa**, H.S. Joo, C. Frear, C.O. Stockle, J.H. Harrison. 2014. Effects of suspended solids characteristics and concentration on ammonia emission process from liquid dairy manure. Trans. ASABE 57(2): 661-668.
16. Sun, F., J.H. Harrison, **P.M. Ndegwa**, K. Johnson. 2014. Effect of manure treatment on ammonia and greenhouse gases emissions following surface application. Water, Air, & Soil Pollution 225: 1923.
17. Joo, H.S., **P.M. Ndegwa**, A.J. Heber, B.W. Bogan, J.-Q. Ni, E.L. Cortus, J.C., Ramirez-Dorronsoro. 2014. A direct measurement of gaseous emissions from naturally ventilated dairy barns. Atmospheric Environment 86: 176–186.
18. Page, L.H., J.-Q. Ni, A.J. Heber, N.S. Mosier, X. Liu, H.-S. Joo, **P.M. Ndegwa**, J.H. Harrison. 2014. Characteristics of volatile fatty acids in stored dairy manure before and after anaerobic digestion. Biosystems Engineering 118: 16-28.
19. Koirala, K., **P.M. Ndegwa**, H.S. Joo, C. Frear, C.O. Stockle, J.H. Harrison. 2013. Impact of anaerobic digestion of liquid dairy manure on ammonia volatilization process. Trans. ASABE 56(5): 1959-1966.
20. Joo, H.S., **P.M. Ndegwa**, A.J. Heber, J.-Q. Ni, B.W. Bogan, J.C. Ramirez-Dorronsoro, E.L. Cortus. 2013. Particulate matter dynamics in naturally ventilated freestall dairy barns. Atmospheric Environment. 69: 182-190.
21. Vaddella, V.K., **P.M. Ndegwa**, A. Jiang, J.L. Ullman. 2013. Mass transfer coefficients of ammonia for liquid dairy manure. Atmospheric Environment 66: 107-113.
22. Liaw, S.S., Z. Wang, **P. Ndegwa**, C. Frear, S. Ha, C.Z. Li, M. Garcia-Perez. 2012. Effect of temperature on the yield and properties of bio-oils obtained from the auger pyrolysis of douglas fir wood. Analytical and Applied Pyrolysis 93:52-62.
23. Vaddella, V.K., **P.M. Ndegwa**, H.S. Joo. 2011. Ammonia loss from simulated post-collection storage of scraped and flushed dairy-cattle manure. Biosystems Engineering 110:291-296.
24. Vaddella, V.K., **P.M. Ndegwa**, A. Jiang. 2011. An Empirical model for ammonium ion dissociation in liquid dairy manure. Transactions of the ASABE 54(3): 1119-1126.
25. Pandey, P.K., **P.M. Ndegwa**, R. Alldredge, M. Pitts. 2011. Efficacies of inocula on the startup of anaerobic reactors treating dairy manure under stirred and unstirred conditions. Biomass and Bioenergy 35: 2705-2720.
26. Hristov, A.N., M. Hanigan, A. Cole, R. Todd, T. McAllister, **P.M. Ndegwa**, A. Rotz. 2011. Ammonia emissions from dairy farms and beef feedlots: A review. Canadian Journal of Animal Science 91:1-35.
27. Vaddella, V.K., **P.M. Ndegwa**, H. Joo, J.L. Ullman. 2010. Impact of separating dairy cattle excretions on ammonia emissions. Journal of Environmental Quality 39:1807-1812.
28. Angle, M., A.N. Hristov, A.N., S. Zaman, C. Schneider, **P. M. Ndegwa**, V.K. Vaddella. 2010. Effect of dietary concentrate on rumen fermentation, digestibility, and nitrogen in dairy cows. Journal of Dairy Science 93:4211-4222.

29. Pandey, P.K., **P.M. Ndegwa**, R. Alldredge, M. Pitts. 2010. Modeling effects of granules on the start-up of anaerobic digestion of dairy wastewater with Langmuir and Extended Freundlich Equations. Bioprocess and Biosystems Engineering 33:833-845.
30. Angle, M., A.N. Hristov, A.N., S. Zaman, C. Schneider, **P. M. Ndegwa**, V.K. Vaddella. 2010. The effect of ruminally degraded protein on rumen fermentation and ammonia losses from manure in dairy cows. Journal of Dairy Science 93(4):1625-1637.
31. Hristov, A.N., S. Zaman, M. Vander Pol, **P. Ndegwa**, L. Campbell, S. Silva. 2009. Nitrogen losses from dairy manure estimated through nitrogen mass balance and chemical markers. Journal of Environmental Quality 38:2438-2448.
32. **Ndegwa, P.M.**, V. Vaddella, A.N. Hristov, H.S. Joo. 2009. Measuring concentrations of ammonia in ambient air or exhaust air stream using acid traps. Journal of Environmental Quality 38:647-653.
33. Hristov, A.N., M. Vander Pol, M. Agle, S. Zaman, C. Schneider, **P. Ndegwa**, V.K. Vaddella, K. Johnson, K. Shingfield, S.K.R. Karnati. 2009. Effect of lauric acid and coconut oil on ruminal fermentation, digestion, ammonia losses from manure, and milk fatty acid composition in lactating cows. Journal of Dairy Science **92:5561-5582.**
34. Joo, H.S., **P.M. Ndegwa**, M. Shoda, C. Phae. 2008. Bioremediation of oil-contaminated soil using Candida catenulata and foodwaste. Environmental Pollution 156(3): 891-896.
35. **Ndegwa, P.M.**, A.N. Hristov, J. Arogo, R.E. Sheffield. 2008. A review of ammonia emissions mitigation techniques for concentrated animal feeding operations. Biosystems Engineering 100(4):453-469.
36. **Ndegwa, P.M.**, D.W. Hamilton, J.A. Lalman, H.J. Cumba. 2008. Effects of cycle-frequency and temperature on the performance of anaerobic sequencing batch reactors (ASBRs) treating swine waste. Bioresource Technology 99(6): 1972-1980.
37. Chowdhury, N., J. A. Lalman, R. Seth, **P.M. Ndegwa**. 2007. Biohydrogen production by mesophilic anaerobic of glucose in the presence of linoleic acid. Environmental Engineering-ASCE 133 (12): 1145-1152.
38. **Ndegwa, P.M.**, L. Wang, V.K. Vaddella. 2007. Potential strategies for process control and monitoring of stabilization of dairy wastewaters in batch aerobic treatments systems. Process Biochemistry 42(9): 1272-1278.
39. **Ndegwa, P.M.**, L. Wang, V.K. Vaddella. 2007. Stabilization of dairy wastewater using limited-aeration treatments in batch reactors. Biosystems Engineering 97(3): 379-385.
40. Templer J, J.A. Lalman, N. Jing, **P.M. Ndegwa**. 2006. Influence of C18 long chain fatty acids on hydrogen metabolism. Biotechnology Progress 22(1): 199-207.
41. Zhu, J., A. Luo, **P.M. Ndegwa**. 2006. Effect of microbial additives combined with aeration on reduction of nutrients in swine manure. Transactions of the ASABE 49(1): 203-280.
42. Hamilton, D.W., I.N. Kourtchev, **P.M. Ndegwa**, H.J. Cumba. 2006. Methane and carbon-dioxide from simulated anaerobic swine manure treatment under summer conditions. Transactions of the ASABE 49(1): 157-165.
43. **Ndegwa, P.M.**, D.W. Hamilton, J.A. Lalman, H.J. Cumba. 2005. Optimization of anaerobic sequencing batch reactors (ASBR) treating dilute swine slurries. Transactions of the ASAE 48(4): 1575-1583.
44. Zhu J, Luo A, Zhou Y, **Ndegwa P.M.**, Schmidt DR. 2004. The age effect of dairy feedlots on manure nutrient seepage in loam soils. Biosystems Engineering 89 (2): 223-229.
45. **Ndegwa, P.M.,** 2004. Solids separation enhances reduction of organic strength of swine manure

subjected to aeration treatments. Transactions of the ASAE 47(5):1659-1666.

46. Zhu, J., A. Luo, Y. Zhou, **P.M. Ndegwa**, D. Schmidt. 2004. Nutrient seepage from operating turkey buildings with a litter system. Water, Air, and Soil Pollution 155(1-4): 87-101.
47. **Ndegwa, P.M.,** 2004. Limitations of orthophosphates removal during anaerobic batch treatment of piggery slurry. Biosystems Engineering 87(2):201-208.
48. Zhu, J**., P.M. Ndegwa**, Zhang. 2004. Manure sampling procedures and nutrient estimation by the hydrometer method for gestation pigs. Bioresource Technology 92(3):243-250.
49. **Ndegwa, P.M.**, J. Zhu, A. Luo. 2003. Effects of bioreactor temperature and time on odor-related parameters in aerated swine manure slurries. Environmental Technology 24(8): 1007-1016.
50. **Ndegwa, P.M.**, J. Zhu, A. Luo, D.W. Hamilton. 2003. Enhanced phosphorus removal from swine manure in aerated batch reactors. Transactions of the ASAE 46(3): 797-803.
51. Zhu, J., **P.M. Ndegwa,** A. Luo. 2003. Temperature effects on pig manure under low-level batch aeration. The International Journal of Environmental Studies 60(5): 523-533.
52. **Ndegwa, P.M.**, J. Zhu. 2003. Sampling procedures for piggery slurry in deep pits for estimation of nutrient content. Biosystems Engineering 85(2): 239-248.
53. **Ndegwa, P.M.** 2003. Solids separation coupled with batch-aeration treatment for odor control from liquid swine manure. Environmental Science & Health. B38(5): 631-643.
54. Zhu, J., Z. Zhang, **P. M. Ndegwa**. 2003. Using a soil hydrometer to measure the nitrogen and phosphorus contents in pig slurries. Biosystems Engineering 85(1): 121-128.
55. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2003. Discussions and closure to "Effects of solids levels and chemical additives on removal of solids and phosphorus in swine manure". Environmental Engineering-ASCE 129(5): 485-487.
56. Zhu, J., **P. M Ndegwa**, Z. Zhang. 2003. Settling characteristics of nursery pig manure and nutrient estimation by the hydrometer method. Environmental Science & Health, B38(3): 379-390.
57. Zhu, J., A. Luo, Y. Zhou, **P.M. Ndegwa**, D. Schmidt. 2002. Barn age impact on nutrient leaching from turkey barns built on clay loam soils. Transactions of the ASAE 45(6): 1971-1976.
58. **Ndegwa, P.M.**, J. Zhu, A. Luo. 2002. Influence of temperature and time on phosphorus removal in swine manure during batch aeration. Environmental Science & Health, B38(1): 73-87.
59. Luo, A., J. Zhu, **P.M. Ndegwa**. 2002. Influence of anaerobic pre-conditioning on phosphorus removal in swine manure by aeration. Water, Air, and Soil Pollution 140(1-4): 219-230.
60. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2002. Stratification of solids, nitrogen and phosphorus in swine manure in deep pits under slatted floor**s**. Bioresource Technology 83(3): 203-211.
61. Zhu, J., **P.M. Ndegwa,** A. Luo. 2002. Bacterial responses to temperature during aeration of pig slurry. Journal of Environmental Science & Science, B37(3): 265- 275.
62. Luo, A., J. Zhu, **P.M. Ndegwa**. 2002. Removal of carbon, nitrogen, and phosphorus in pig manure by continuous and intermittent aeration at low redox potentials. Biosystems Engineering 82(2): 209-215.
63. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2002. Effects of solids separation and time on the production of odorous compounds in stored pig slurry. Biosystems Engineering 81(1): 127-133.
64. Thompson, S.A, **P.M. Ndegwa,** W.C. Merka, A. B. Webster. 2001. Reduction in manure weight and volume using an in-house layer manure composting system under field conditions. Applied Poultry Research 10(3): 255-261.

65. Zhu, J., **P.M. Ndegwa,** A. Luo. 2001. Effect of solid-liquid separation on BOD and VFAs in swine manure. J. Environmental Technology 22(10): 1237-1243.
66. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2001. Effect of batch aeration-treatment on the solubility of phosphorus in pig manure. Agricultural Engineering Res. 80(4): 365-371.
67. Zhu, J., A. Luo, **P.M. Ndegwa**. 2001. Raising pH by low level aeration for soluble phosphorus removal from swine manure. Transactions of the ASAE 44(2): 391-396.
68. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2001. Effects of solids levels and chemical additives on removal of solids and phosphorus in swine manure. Environmental Engineering-ASCE 127(12): 1111-1115.
69. Luo, A., J. Zhu, **P.M. Ndegwa**. 2001. Phosphorus transformations in swine manure during continuous and intermittent aeration processes. Transactions of the ASAE 44(4): 967-972.
70. **Ndegwa, P.M.**, S.A.Thompson. 2001. Integrating composting and vermicomposting in the treatment and bioconversion of biosolids. Bioresource Technology 76(2): 107-112.
71. Zhu, J., A. Luo, **P.M. Ndegwa**. 2001. The Effect of limited aeration on swine manure phosphorus removal. Environmental Science & Health, B36(2): 209-218.
72. **Ndegwa, P.M.,** S.A.Thompson. 2000. Effects of C-to-N ratio on vermicomposting of biosolids. Bioresource Technology 75(1): 7-12.
73. Zhu, J., **P.M. Ndegwa,** A. Luo. 2000. Changes in swine manure solid components during storage relating to separation efficiency. Applied Engineering in Agriculture 16(5): 571-575.
74. **Ndegwa, P. M.**, S. A. Thompson, W. C. Merka. 2000. A Dynamic simulation model of in-situ composting of caged-layers' manure. Compost Sci. & Utilization 8(3): 190-202.
75. **Ndegwa, P.M.**, S.A. Thompson, K.C. Das. 1999. Effects of stocking density and feeding level on vermicomposting of biosolids. Bioresource Technology 71(1): 5-12.
76. **Ndegwa, P. M.**, S. A. Thompson, W. C. Merka. 1991. Fractionation of poultry litter for enhanced utilization. Transactions of the ASAE 34(3): 992-997.

Published Abstracts

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Extension Publications/Presentations

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2. Joo, H.S., **P.M. Ndegwa**, G.M. Neerackal, X. Wang, J.H. Harrison. 2015. Manure Management Practices for Mitigation of Gaseous Emissions from Naturally Ventilated Dairy barns. Proceedings for Waste to Worth 2015 "Advancing Sustainability in Animal Agriculture," March 30 – April 3.
3. Neerackal, G.M., H.S. Joo, **P.M. Ndegwa**, J.H. Harrison. 2015. Mitigating Ammonia Emissions from Dairy Barns through Manure-pH Management. Proceedings for Waste to Worth 2015 "Advancing Sustainability in Animal Agriculture," March 30 – April 3.
4. Wang, X., H.S. Joo, G.M. Neerackal, **P.M. Ndegwa**. 2015. Direct versus Indirect Methods for Ventilation Rates Measurement in Naturally Ventilated Livestock Buildings. Proceedings for Waste to Worth 2015 "Advancing Sustainability in Animal Agriculture," March 30 – April 3.
5. **Ndegwa P.** 2014. Expert clarifies differences between human waste & livestock manure. Dairyland News, Yakima Valley and Whatcom Editions.
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7. Joo H., **P. Ndegwa**, J. Harrison, E. Whitefield, A. Heber, J. Ni. 2013. Potential air quality impacts of anaerobic digestion of dairy manure. From Waste to Worth: "Spreading" Science and Solutions. From Waste to Worth: "Spreading" Science and Solutions; April 1-5, 2013; Denver, Colorado.
8. Embertson N., G. Pruitt, H. Tahat, **P. Ndegwa**. 2013. Model of a Successful Regulatory-Industry Partnership to Address Air Emissions from Dairy Operations in Yakima, WA. From Waste to Worth: "Spreading" Science and Solutions. From Waste to Worth: "Spreading" Science and Solutions; April 1-5, 2013; Denver, Colorado.
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19. **Ndegwa, P.M.** 2008. AD101 – Nutrient Transformations, Nutrient Management, and Benefits (PPT).
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23. **Ndegwa, P.M.,** M. Gamroth. 2008. Air Quality Legislation in Oregon & Washington (PPT)
24. Sheffield, R.E, M. Gamroth, **P.M. Ndegwa.** 2006. Odor Management Plan for Northwest Pacific: Idaho, Oregon, and Washington (Handbook).
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Published Conference Papers/Presentations

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2. Zeb, I., J. Ma, C. Frear, **P. Ndegwa**. 2016. Separated-effluent recycling in the anaerobic digestion process: effects of ammonia and salinity. ASABE Annual International Conference. Orlando, Florida, July 17 - 20.
3. Zeb, I., G.K. Kafle, X. Xue, **P.M. Ndegwa**. 2016. Modelling ammonia inhibition for anaerobic digestion of dairy manure with acclimated and un-acclimated seed. ASABE Annual International Conference. Orlando, Florida, July 17 - 20.
4. Wang, X., H.S. Joo, G.M. Neerackal, **P.M. Ndegwa**. 2015. Direct versus indirect methods for ventilation rates measurement in naturally ventilated livestock buildings. ASABE Annual International Conference. Paper number 152188289; New Orleans, Louisiana, July 26 - July 29.
5. Wang, X., H.S. Joo, G.M. Neerackal, **P.M. Ndegwa**, L. Yu, Y. Ma, H. Liu. 2015. A Simplified Direct Method for Determining Ventilation Rates in Naturally Ventilated Dairy Barns. ASABE Annual International Conference. Paper number 125188315; New Orleans, Louisiana, July 26 - July 29.
6. Wang, X., H.S. Joo, G.M. Neerackal, **P.M. Ndegwa**, J.H. Harrison. 2015. Passive Samplers for Monitoring Ammonia Emissions in Naturally Ventilated Dairy Barns. ASABE Annual International Conference. Paper number 125188318; New Orleans, Louisiana, July 26 - July 29.

7. G.M. Neerackal, H.S. Joo, X. Wang, **P.M. Ndegwa**. 2015. Enhanced Biological Treatment for Mitigating Ammonia and Odor Emissions from Dairy Wastewaters. ASABE Annual International Conference. Paper number 152186218; New Orleans, Louisiana, July 26 - July 29.
8. Joo, H.S., **P.M. Ndegwa**, A.J. Heber, B.W. Bogan, J.-Q. Ni, E.L. Cortus, J.C., Ramirez-Dorronsoro. 2014. A direct measurement of gaseous emissions from naturally ventilated dairy barns. ASABE and CSBE/SCGAB Annual International Conference. Paper number 1895745; Montreal, Quebec, Canada, July 13 - 17.
9. Neerackal, G.M., H.S. Joo, **P.M. Ndegwa,** J.H. Harrison. 2014. Manure-pH management for mitigating ammonia emissions from manure-flush dairy barns. ASABE and CSBE/SCGAB Annual International Meeting. Paper number 1892636; Montreal, Quebec, Canada, July 13-17.
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11. Wang X., H. S Joo, G. Neerackal, **P. Ndegwa**, J. Harrison, A. Heber, J. Ni. 2013. Effects of anaerobic digestion and application methods on ammonia emission from land applied dairy manure. ASABE Annual International Conference. Paper number 131593443; Kansas City, Missouri, July 21 - July 24. (doi: http://dx.doi.org/10.13031/aim.20131593443).
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16. Joo, H.J., **P.M. Ndegwa**, J. Harrison, E. Whitefield, A.J. Heber, J.Q. Ni. 2012. Emissions of ammonia and greenhouse gases (GHG) from anaerobically digested and undigested dairy manure systems. ASABE Annual International Meeting**.** Paper number 121337962; Dallas, Texas, Jul. 29 – Aug. 1. (doi: 10.13031/2013.41853).
17. Joo, H.S., **P.M. Ndegwa**, A.J. Heber, J.Q. Ni, W.W. Bogan, J.C. Ramirez-Dorronsoro, E. Cortus. 2012. Ammonia and hydrogen sulfide emissions from naturally ventilated free-stall dairy barns. ASABE Annual International Meeting**.** Paper number 121337963; Dallas, Texas, Jul. 29 – Aug. 1. (doi: 10.13031/2013.41854).
18. Page, L., J.Q. Ni, A.J. Heber, N.S. Mosier, X. Liu, H.S. Joo, H.S., **P.M. Ndegwa**. 2012. Effect of anaerobic digestion on volatile fatty acids in dairy manure. ASABE Annual International Meeting**.** Paper number 121337674; Dallas, Texas, Jul. 29 – Aug. 1. (doi: 10.13031/2013.42164).

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25. **Ndegwa, P.M.**, V.K. Vaddella, A.N. Hristov, H.S. Joo. 2009. Revisiting the method for measuring ammonia concentrations in ambient air or exhaust air stream using acid traps. Proceedings of the Air and Waste Management Association's Annual Conference and Exhibition; Detroit, MI, USA; June 16-19; 4: 2678-2689.
26. **Ndegwa, P.M.**, H.S. Joo, A.J. Heber, J.C. Ramirez-Dorronsoro, E.L. Cortus, J.-Q. Ni, W.W. Bogan. A method for determining gaseous emissions from naturally ventilated freestall dairy barns. Air & Waste Magt Association's Annual Conf. & Exhibition, to be held in Detroit, MI, June 16-19, 2009.
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30. Hamilton, D.W., M.E. Murie, A.M.A Khan, **P.M Ndegwa**. 2008. Vermicomposting of poultry litter: process optimization. ASABE Annual International Meeting. Paper number 084896; Providence, Rhode Island, June 29 - July 2; (doi: 10.13031/2013.24712).
31. **Ndegwa, P.M.**, A.N. Hristov, J. Arogo, R.E. Sheffield. 2008. Ammonia emissions mitigation techniques for concentrated animal feeding operations. Mitigation Air Emissions from Animal Feeding Operations: Exploring the advantages, Limitations, and Economics of mitigation technologies. May 19-21, Des Moines, Iowa.
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Measurement Methods and Technology, pp 530-534.

33. Heber, A.J., B.W. Bogan, J.-Q. Ni, T.T. Lim, J.C. Ramirez-Dorronsoro, E.L. Cortus, C. A. Diehl, S.M. Hanni, C. Xiao, K.D. Casey, C.A. Gooch, L.D. Jacobson, J. A. Koziel, F.M. Mitloehner, **P. M. Ndegwa**, W. P. Robarge, L. Wang, R. Zhang. 2008. The National Air Emissions Monitoring Study: Overview of barn sources. Livestock Enviroment VIII – The Proceedings of the 8th International Symposium (ILES VIII), Iguassu Falls, Brazil, Aug. 31-Sept. 4, pp 199-206.
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37. Hamilton, D.W., S.D. Carter, **P.M. Ndegwa**, H.J. Cumba. 2005. Emission of nitrogenous gases from simulated swine manure stabilization ponds. ASAE Paper No. 054030. ASAE International Meeting, Tampa, Florida, USA.
38. Zhu, J., Z. Zhang, **P. M. Ndegwa**. 2003. Evaluation of the hydrometer method to determine swine manure nutrient content. Presented and published in proceedings of the 9th International Symposium on Animal, Agric. and Food Processing Wastes. Oct. 12-15, 2003, Durham, NC.
39. **Ndegwa, P.M**., J. Zhu. 2003. Novel procedures for accurate sampling of swine manures. Presented and published in proceedings of the 9th International Symposium on Animal, Agricultural and Food Processing Wastes. October 12-15, 2003, Durham, NC.
40. Hamilton, D.W, I.N. Kourtchev, **P.M. Ndegwa**, H.J. Cumba, F. Gioelli. 2003. Simulation of anaerobic/facultative lagoon performance using a 1,000-liter pilot facility. ASAE Paper No. 034155. ASAE International Meeting, Las Vegas, Nevada, USA (doi: 10.13031/2013.13897).
41. **Ndegwa, P.M.,** 2003. Limitations of orthophosphates removal from swine manure during batch-aeration treatments. ASAE Paper No. 034153. ASAE International Meeting, Las Vegas, Nevada, USA. (doi: 10.13031/2013.13895).
42. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2002. Enhanced phosphorus removal in swine manure using aerated batch-reactors. ASAE Paper No. 024097. ASAE-CIGR Congress Annual International Meeting, Chicago, Illinois, USA. (doi: 10.13031/2013.9539).
43. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2001. Temperature effects on phosphorus removal in swine manure under aeration treatment. ASAE Paper No. 012276. ASAE International Meeting, Sacramento, California, USA.
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45. **Ndegwa, P.M.,** J. Zhu, A. Luo. 2000. Solids-liquid separation of swine manure for odor control. ASAE International Meeting, Technical Papers: Engineering Solutions for a New Century, Milwaukee, WI, USA; 2: 4359-4371.
46. Luo, A., J. Zhu, **P.M. Ndegwa**. 2000. Fluctuations of phosphorus in swine manure during anaerobic and aerobic processes. ASAE International Meeting, Technical Papers: Engineering Solutions for a New Century, Milwaukee, WI, USA; 2: 4053-4863.

47. Luo, A., J. Zhu, **P.M. Ndegwa**. 2000. Isolation of bacteria able to utilize odorous compounds as sole carbon and energy source from swine manure. ASAE International Meeting, Technical Papers: Engineering Solutions for a New Century, Milwaukee, WI, USA; 2: 5099-5106.
48. **Ndegwa, P.M**, S.A. Thompson, W.C. Merka. 1999. A Dynamic simulation model of in-situ composting of caged layers' manure. Presented at Southern Poultry Science Society Conference on Avian Diseases, January 18-19, 1999 (Abstract S7).
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50. Thompson, S.A, W.C. Merka, **P.M. Ndegwa**. 1997. In-house deep-litter manure management system. ASAE Paper No.974070. ASAE Annual International Meeting, Minneapolis, MN, Aug. 10-14, vol. 3, 6p.
51. Thompson, S.A., W.C. Merka, **P.M. Ndegwa**. 1991. Fractionation of poultry litter for enhanced utilization. Presented at Conference on Environmentally Sound Agric. Orlando, FL, 16-18 April.

Web-pages Developed:

1. Western Region Dairy Odor and Air Quality Education Program at the following link: http://www.bsyse.wsu.edu/ndegwa/main/WOAQ/WOAQhome.html

Thesis and Dissertations:

1 **Ndegwa, P.M.** 1999. Enhancing Composting and Bioconversion of Organic-Waste. Ph.D. - Thesis: Department of Biological & Agric. Engineering, University of Georgia, Athens, Georgia, USA.

2 **Ndegwa, P.M.** 1990. Fractionation of Poultry Litter for Enhanced Utilization and Reduction of Environmental Pollution. MS-Thesis: Department of Biological & Agricultural Engineering, University of Georgia, Athens, Georgia, USA.

3 **Ndegwa, P.M.** 1986. Gasification of corncobs to fuel a standard stationary gasoline engine. BS-Thesis: Department of Agricultural Engineering, University of Nairobi, Kenya.

Citations in Popular Press:

1. Farm ammonia emissions insignificant compared to wood stoves, vehicle emissions. January 2016, Dairyland News; Yakima Valley Edition.
2. Ammonia emissions below levels of concern for human health. December 12, 2015 WSU Dairy Newsletter.
3. Cutting manure emissions earns WSU student kudos in poster contest. May 6, 2015, WSU College of Agricultural, Human, and Natural Resource Sciences, Press Release.
4. Expert clarifies differences between human waste and livestock manure. August 2014, Dairyland News; Yakima Valley and Whatcom Editions.
5. Composted livestock manure produces nutrient-rich crop, pasture and home garden organic fertilizer. June 2014, Dairyland News; Yakima Valley and Whatcom Editions.
6. Like bugs, humans find certain smells can be an acquired taste. Washington State University Magazine. Spring 2013.

7. National Webcasts on air quality in animal agriculture begin. In: AG Answers – Business and Science of Agriculture: An Ohio State and Purdue Extension Partnership, June 2008.
8. Webcast on ammonia this Friday. In: Manure Manager, June 2008.
9. WSU Livestock Air Quality Program acquires state-of-the-art research equipment. In: Progressive Dairy Publishing, March 2007.
10. WSU Scientist Studying Dairy Emissions. In: AG WEEKLY, August 2007.
11. WSU Scientist Studying Dairy Emissions. July 13, 2007, WSU College of Agricultural, Human, and Natural Resource Sciences, Press Release.
12. Purdue Begins National Study Of Air Quality At Animal Feeding Operations. In: Medical News Today, June 2007.
13. Purdue Begins National Study Of Air Quality At Animal Feeding Operations. In: Cattlenetwork, June 2007.
14. WSU Scientist Studying Dairy Emissions. In: CAHNRS and WSU Extension Marketing and News Services, June 2007.

RESEARCH GRANTS & CONTRACTS (Total Received **$3,754,559)**

As Principal Investigator ($2,110,922)

1. Ndegwa, P.M., L.R. Khot, G.K. Kafle. 2016. Rapid sensing of dairy manure nutrients for precision applications in agricultural production. CSANR and BIOAg program: $39,928 (Ndegwa's share: 53%).
2. Ndegwa, P.M., Y. Demissie, B. Woodbury, R.A. Eigenberg. 2015. Advanced monitoring of nutrients and salts seepage from dairy manure lagoons. WSDA – Dairy Nutrient Management Program: $116,985 (Ndegwa's share: 50%).
3. Ndegwa, P.M, H.S. Joo. 2014. Exploring the Next Generation of Manure Treatment Technologies for Sustainable Animal Agriculture and Enhanced Environmental Quality. WSU-ARC Emerging Issues Program: $49,520 (Ndegwa's share: 100%).
4. P. Ndegwa, P. 2012. Effects of co-digesting dairy manure with other substrates on H_2S content in the digester gas: Literature Review. WA dept. Ecology: $49,830 (Ndegwa's share: 100%).
5. Ndegwa, P.M., J. Harrison, A.J. H.S. Joo, J.S. Neibergs. 2011. Reduction of emissions from dairy operations via adoption of select multiple best management practices. USDA-NRCS: $410,491 (Ndegwa's share: 70%)
6. Ndegwa, P., H. Tahat, Gary Pruit. 2011. Pilot Project: Air Quality Management Policy and Best Management. Washington Dairy Products Commission: $30,000 (Ndegwa's share: 30%).
7. Ndegwa, P., J. Harrison, A.J. Heber, J. Ni. 2010. Impact of Anaerobic Digestion on Air Quality in a Community Anaerobic Digester. USDA-NRCS: $531,625 (Ndegwa's share: 60%).
8. Ndegwa, P., R. Grant, H.S. Joo. 2009. A Process-based model of ammonia emissions from open dairy manure storages. ARC-Investments in Future Success Programs, Washington State University: $30,000 (Ndegwa's share: 80%).
9. Ndegwa, P., H.S. Joo. 2009. A review of non-methane emissions from livestock production systems. Washington Dairy Products Commission: $5,000 (Ndegwa's share: 100%).
10. Ndegwa, P., H.S. Joo. 2008. Assessment of $UNLO_2K$ for the Treatment of Dairy Wastewater. AgraKey Solutions LLC: $19,720 (Ndegwa's share: 100%).
11. Ndegwa, P., R. Sheffield, F. Mitloehner, M. Gamroth, R. Hagevoort. 2007. Western odor and air quality education. USDA-Western SARE: $89,236 (Ndegwa share: 60%).
12. Ndegwa, P. 2007. Measurements of H_2S, NH_3, particulates, and VOCS in free-stall dairy barns in WA. Agricultural Air Research Council; The National Dairy Board; and The Dairy Research Institute: $491,587 ($246,136 in cash; $245,451 in equipment).
13. Ndegwa, P. 2006. Air Quality Research Instrumentation. Washington Dairy Products Commission: $12,000.
14. Ndegwa, P., D. Hamilton, R. Elliott. 2004. Improved Water Quality through Production and Utilization of Vermicomposted Poultry Litter. Rural Enterprises of Oklahoma, Inc. (REI): $185,000 (Ndegwa's share: 90%).
15. Ndegwa, P., H. Hamilton. 2003. Reducing Phosphorus (P) in Swine Manure to Minimize P-entry into P-impacted Watersheds Receiving such Manures during P-phytoremediation. Research, Oklahoma State University Environmental Institute Center for Water: $25,000.

16. Ndegwa, P., D. Hamilton, J. Lalman. 2002. Integrating Anaerobic Sequencing Batch Reactors (ASBRs) in the Treatment and Addition of Value to Swine Manures. Oklahoma State University Food and Agricultural Products Initiative Program: $25,000.

As co-Principal Investigator (1,643,637)

17. Harrison, J., P.M. Ndegwa, J. Stark, T. Nennich, G. Erickson, B. Richert, T. Applegate, R. Massey, M. De Hart, J. Heemstra, L. Whitefield. 2010. Decision aid tool to enhance adoption of feed management 592 practice standard-nutrient management planning economics FNMP. USDA-NRCS: $236,791 (Ndegwa's share: 5%).

18. Heber, A., B. Bogan, F. Mitloehner, P. Ndegwa, C. Gooch, L. Jacobson, T. Lim, R. Grant. 2009. Monitoring greenhouse gas emissions in a NV barn in WA. Dairy Management Inc. (DMI): $499,785 (Ndegwa's share: 10%).

19. Hardesty, L., Wu, J.Q., R. Hakjun, P.M. Ndegwa. 2008. Evaluating the Impacts of Conservation Practices on Watershed Health in a Salmon-Bearing Rangeland Watershed: Asotin Creek, Washington. USDA CSREES: $621,000 (Ndegwa's share: 6%).

20. Mann, K., A. Bary, J. Busboom, L. Carpenter-Boggs, C. Cogger, R. Dougherty, J. Harrison, J. Rentz, C. Miles, P. Ndegwa, M. Ostrom, J. Ullman, T. Waters, Z. Edwards, R.T. Peters. 2008. A farm-to-table approach to reduce the risk of foodborne pathogens integrating outreach and applied research. WSU-ARC: $50,000 (Ndegwa's share: 2%).

21. Meschke, S., P. Ndegwa, M. Yost. 2007. Characterization and quantification of bioaerosols in Confined Animal Feeding Operations. Pacific Northwest Agricultural Safety and Health Pilot Project: $25,000 (Ndegwa's share: 50%).

22. Hristov, A.N., P. Ndegwa. 2006. Feeding to Reduce Ammonia and Hydrogen Sulfide Air Emissions. United Dairymen of Idaho: $86601 (Ndegwa's share: 10%).

23. Carter, S., P. Ndegwa, D. Hamilton. 2003. Reduction of NH_3, CH_4, and CO_2Emissions from Swine Waste by Dietary Manipulation. National Pork Board: $24,500 (Ndegwa's share: 30%).

24. Lalman, J.A., W. W. Clarkson, P.M. Ndegwa. 2002. Treating swine waste using laboratory scale anaerobic sequencing batch reactors (ASBRs). Oklahoma State University Environmental Institute Center for Water Research: $49960 (Ndegwa's share: 40%).

25. Classen, J. J., S. K Liehr, D. W. Hamilton, P.M. Ndegwa. 2002. Nitrogen Emission Characterization from Full-Size and Simulated Swine Waste Treatment Lagoons. National Center for Manure and Animal Waste Management: $50,000 (Ndegwa's share: 25%).

EXTENSION COMPONENT: My Extension Program is guided by this LOGIC MODEL

SITUATION: The trend in animal agriculture in recent times include: (i) decrease in the number of farms, (ii) increase in the size of individual operations, and (iii) geographical or regional concentrations. These trends have evolved because of associated economies of scale but the huge volume of manure raises concerns towards air, soil, and water qualities in these regions.

MISSION: To improve environmental stewardship among dairy producers to protect soil, water, and air qualities in Washington State and the region.

INPUTS	OUTPUTS		OUTCOMES - IMPACTS		
	Activities:	Participation:	Short Term:	Medium Term:	Long Term:
• Funding: Grants, gifts, allocations. • Time (25%). • Research (75%). • Partners (Other Relevant State Extension Specialists).	• Applied research & demonstrations. • Field days. • Workshops & meetings. • Fact sheets. • Webinars & videos. • Website. • Popular media (TV, radio, press). • Training of trainers. • Advisory boards & Task forces. • Farm visits & inspections.	• Producers. • Extension personnel (WSDA, NRCS, Conservation Districts, WSU). • Regulators (local and state). • Public or citizens.	• Increased awareness of impacts of dairies on the environment. • Expanded suite of BMPs for reducing air emissions and nutrient seepage. • Increased knowledge of BMPs available for protecting water, air, and soil pollutions. • Improved nutrient management plans (NMPs). • Inclusion of odor and air emissions to the NMPs.	• Adoption of BMPs to protect water. • Adoption of BMPs to protect air quality. • Adoption of BMPs to curb soil pollution. • Reduced complaints and lawsuits associated with dairy production.	• Improved water quality. • Improved air quality. • Uncontaminated soils. • Nearly zero complaints or lawsuits related to dairy industry. • Enhanced sustainability of the dairy industry.

CONTRAINTS: Effective environmental stewardship requires monetary investment, which negatively affects the producers bottom-line and profitability. The Producers thus may not be internally motivated to prioritize stewardship on their individual operations.

Assumptions	External Factors
• Cost-effective BMPs are available to the producers. • Some internal motivation towards environmental stewardship exists. • Some external motivations (regulations, lawsuits) for the producers exist. • Availability of grants/gifts/allocations to support these kinds of efforts/ programs.	• Credible research data associating human health to the dairy production. • Pressure from Environmental Activists. • Enforcement & enactment of regulations with respect to CAFOs. • Government incentives to producers towards this effort (EQIP grants, cheap loans, etc.)

Evaluation:

- Conduct before and after evaluations during workshops, trainings, webinars, and meetings.
- Gather data on adoption of BMPs at dairy operations during inspections and visits, and interviews with both producers and citizens.
- Gather data on the trends of complaints and lawsuits associated with dairy industry.
- Assess inclusion of odor, gaseous, and particulate emissions in the NMPs.
- Collect and analyze water and air quality trends in dairy producing areas in Washington State and the region.

SUMMARY OF MAJOR EXTENSION PROGRAMS AND ACTIVITIES

Major Extension Programs:

1. **Developer & Coordinator - Western Regional Odor and Air Quality Education Program:** This was a comprehensive program initiated in 2006 to train agricultural professionals on livestock odor and air quality issues in the western region. These trainees would then in turn integrate these programs in their regular extension education within their jurisdictions. It was a collaborative effort comprising of air quality specialists (Ndegwa and Harrison – WA, Sheffield and de Marti - ID, Mitloehner - CA, Hagevoort - NM, Gamroth - OR.) in Western US. The education resources developed are available from the program's website at http://bsyse.wsu.edu/ndegwa/main/WOAQ/WOAQhome.html.
2. **Member - Western Integrated Nutrition and Nutrient Management Education:** This Education Program was a joint effort amongst faculty from Washington State University, Oregon State University, and the University of Idaho. The program was under the leadership of Joe Harrison, Nutrient Management Specialist at Washington State University. The overall goal of the Education Project is to provide "Feed Nutrition and Manure Nutrient Managements" to Livestock and Poultry Professionals."
3. **Chair - Anaerobic digestion webpage development:** Dr. Ndegwa is Chair of a collaborative team of community of practice (CoP) on eXtension that is developing an anaerobic digestion webpage on eXtension. The eXtension forum is an interactive learning environment delivering the best, most researched knowledge from the smartest land-grant university minds across America. The eXtension forum connects knowledge consumers with knowledge providers. Development of this webpage on this forum will go along in providing credible science-based knowledge of anaerobic digestion technology.
4. **Member – Mitigation of Air Emissions from Dairy Operations:** The community in the Yakima Region of Washington State raised concerns over the potential adverse effects of air emissions from dairy operations. To address these concerns, the Yakima Regional Clean Air Agency (YRCAA) assembled a Dairy Work Group in August 2010 to draft policy for addressing air emissions through implementation of site-specific best management practices (BMPs) on dairy operations. This group consisted of: Producers; YRCAA personnel; Citizen Representative; Conservation District Experts; NRCS personnel; and Washington State University Personnel. The draft policy was completed in December 2010. To validate the policy, a "Pilot Research Project" was launched in February 2011 to gather information for one year to test the feasibility of implementing and determining policy effectiveness. The program was adopted in 2013 following successful pilot project. Implementation in 2014 and 2015 show that approximately 74% of dairy cows were brought under this program representing 41 out of 59 dairy farms. Of this total number, 85% to 90% were in compliance with the policy of this program.

TEACHING ACTIVITIES

Classes Taught/or Scheduled to Teach:

1. CE 584, Environmental Microbiology – Guest Lecturer, Fall 2005
2. BSysE 598, Graduate Seminar – Fall 2008 (50%)
3. BSysE 598, Graduate Seminar – Spring 2009 (50%)
4. BSysE 564, Agricultural Waste and Air Quality – Every other Spring (100%)
5. BSysE 598, Graduate Seminar – Spring 2013 (50%)

Graduate Students Supervised:

1. Pramod Pandey – MS; Graduated 2007.
2. Venkata Vaddella – PhD; Graduated 2010.
3. Kedar Koirala – PhD; Graduated 2013.
4. Timothy Ewing – MS, Graduated 2013.
5. Paul Gamble – MS; Graduated 2015.
6. Xiang Wang – PhD; Graduated 2015.
7. George M. Neerackal – PhD; 2015.
8. Iftikhar Zeb – PhD; Current.
9. Xiaoyun Xue – MS, Current.

Graduate Students Examining Committees:

10. Gilbert Gaboutloeloe – PhD; Member, Graduated 2006.
11. Jaime Mejias – PhD; Member, Graduated 2005.

Graduate students advisory Committees:

12. Simon Smith – PhD; Member; Graduated 2009.
13. Bo Hu – PhD; Member; Graduated 2007.
14. Craig Frear – PhD; Member, Graduated 2009.
15. Anping Jiang – PhD; Member, Graduated 2009.
16. Nicole Uslar Valle - PhD; Member, Graduated 2010.
17. Oisik Das – MS; Member, Graduated 2010.
18. Shi-Shen Liaw – PhD; Member, Graduated 2013.
19. Jingwei Ma – PhD; Member, Graduated 2012.
20. Shannon Mary Mitchell – PhD; Member, Graduated 2013.
21. Hussin Alshantiri – MS; Member, Graduated 2011.
22. Fei Sun – MS; Member, Graduated 2013.
23. Pierre Wiensel – PhD; Member, Graduated 2013.
24. Yaojing Qiu – MS, Graduated 2016.
25. Iin Parlina – MS, Graduated 2016.
26. Parish P. Nalawade, MS. Graduated 2016.
27. Tariq Mahmood Khalil – PhD; Member, Current.
28. Yanting Chen – PhD; Member, Current.

Post-doctoral Fellows Supervised:

1. Dr. Hung-Soo Joo; 2007-2014.
2. Dr. Simon Smith; 2012-2013.
3. Dr. Gopi K. Kafle; 2016-2017.

Committees related to teaching

1. Departmental Graduate Studies Committee.
2. Advisor, ASABE Student Club Chapter.