

# PWANI UNIVERSITY

## STAFF PROFILE FORM



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<b>Title</b> Professor	<b>First Name</b> Nicholas	<b>Surname</b> Odongo
<b>Middle Names</b>  Edwin	<b>Address:</b>  P. O. Box 195 – 80108 Kilifi, Kenya  <b>Email:</b> <a href="mailto:n.odongo@pu.ac.ke">n.odongo@pu.ac.ke</a>  <b>Tel:</b> +254 41 7525 100/2/3/4/6 extn 340 (bus); + 254 700 929 611 (cell)	
<b>DEPARTMENT</b>	Department of Animal Sciences	
<b>SCHOOL</b>	School of Agriculture	
<b>DESIGNATION</b>	Associate Professor of Ruminant Nutrition & Chair of Department	
<b>Academic Qualifications</b>		
<p>- Post-doctoral training, 2003-2007, Department of Animal and Poultry Science, University of Guelph, Ontario, Canada</p> <p>- PhD in Ruminant Nutrition with minors in (i) statistics and experimental designs and (ii) tropical animal production, 1998-2001, University of Guelph, Ontario, Canada. Thesis topic: Livestock's contribution to phosphorus cycling in smallholder agriculture in Kenya.</p> <p>- MSc in Animal Nutrition, 1988-1989, University of Aberdeen, Scotland, United Kingdom. Thesis topic: Use of distillers' dark grain as a feed for young artificially reared calves.</p> <p>- BSc in Agriculture, 1983-1986, University of Nairobi, Kenya.</p>		

## Research

I am a ruminant nutritionist with a special interest in sustainable intensification of crop-livestock production systems through the efficiency use of locally available feed resources for a climate-smart and food-secure future.

## Publications

### Journal Articles

1. Parra-Garcia, A., A.Z.M. Salem, M.M.Y. Elghandour, Camacho, L.M. and N.E. **Odongo**. 2017. Potential impact of prickly pear cactus flour and *Salix babylonica* extract on cecal fermentation and methane production in horses. In press. *Agroforestry Systems*, <http://dx.doi.org/10.1007/s10457-016-0051-8>
2. Elghandour, M.M.Y., A.E. Kholif, A. Hernández, A.Z.M. Salem, M. Mellado and N.E. **Odongo**. 2017. Effects of organic acid salts on ruminal biogas production and fermentation kinetics of total mixed rations with different maize silage to concentrate ratios. *J. Cleaner Production*, 147: 523 – 530. <http://dx.doi.org/10.1016/j.jclepro.2017.01.078>
3. Kholif, A.E., M.M.Y. Elghandour, A.Z.M. Salem, A. Barbabosa, O. Marquez, and N.E. **Odongo**. 2017. The effects of three total mixed rations with different concentrate to maize silage ratios and different levels of microalgae *Chlorella vulgaris* on *in vitro* total gas, methane and carbon dioxide production. In press. *J. Agric. Sci. (Camb)*, <http://dx.doi.org/10.1017/S0021859616000812>
4. Gado, H.M., M.M.Y. Elghandour, M. Cipriano, N.E. **Odongo** and A.Z.M. Salem. 2017. Rumen degradation and nutritive utilization of wheat straw, corn stalks and sugarcane bagasse ensiled with multi-enzymes. *J. Applied Animal Research*. 45: 485 – 489. <http://dx.doi.org/10.1080/09712119.2016.1217866>
5. Hernandez, A., A.E. Kholif, R. Luog-Coyote, M.M.Y. Elghandour, Cipriano, M., Rodriguez G.B., N.E. **Odongo** and A.Z.M. Salem. 2017. The effect of garlic oil, xylanase enzyme and yeast on biomethane and carbon dioxide production from 60-d old Holstein dairy calves fed a high concentrate diet. *J. Cleaner Production*, 142: 2384 – 2392. <http://dx.doi.org/10.1016/j.jclepro.2016.11.036>
6. Elghandour, M.M.Y., M. Mellado, A.E. Kholif, A.Z.M. Salem, A. Barbabosa, S. Ballinas, A. Esquivel and N.E. **Odongo**. 2016. Fecal gas production of ten common horse feeds supplemented with *Saccharomyces cerevisiae*. *J. Equine Veterinary Science*. 47: 1 – 8. <http://dx.doi.org/10.1016/j.jjevs.2016.07.008>
7. Elahi, M.Y., H. Kargar, M.S. Dindarlou, A.E. Kholif, M.M.M.Y. Elghandour, S. Rojas-Hernández, N.E. **Odongo** and A.Z.M. Salem. 2016. The chemical composition and *in vitro* digestibility evaluation of almond tree (*Prunus dulcis* D. A. Webb syn. *Prunus amygdalus*; var. Shokoufeh) leaves versus hulls and green versus dry leaves as feed for ruminants. In Press: *Agroforestry Systems*. <http://dx.doi.org/10.1007/s10457-016-9964-5>
8. Velázquez, A.E., A.E. Kholif, M.M.Y. Elghandour, A.Z.M. Salem, R.M. de Oca Jiménez, A.B. Pliego, N.E. **Odongo**, J.L. Bórquez, M. Cipriano and J. Olivares. 2016. Effect of partial replacement of steam rolled corn with soybean hulls or prickly pear cactus in the horse's diet in the presence of live *Saccharomyces cerevisiae* on *in vitro* fecal gas production. *J. Equine Veterinary Science*. 42: 94 – 101. <http://dx.doi.org/10.1016/j.jjevs.2016.04.008>
9. Lu, Q., J. Wu, M. Wang, C. Zhou, X. Han, E.N. **Odongo**, Z. Tan and S. Tang. 2016. Effects of dietary addition of cellulase and a *Saccharomyces cerevisiae* fermentation product on nutrient digestibility, rumen fermentation and enteric

- methane emissions in growing goats. *Arch. Anim. Nutr.*, 70:224 – 238. <http://dx.doi.org/10.1080/1745039X.2016.1163002>
10. Elghandour, M.M.Y., A.E. Kholif, S. Lopez, G.D. Mendoza, N.E. **Odongo** and A.Z.M. Salem. 2016. In vitro gas, methane and carbon dioxide productions of high fibrous diet incubated with fecal inocula from horses fed live yeasts in response to the supplementation with different yeast additives. *J. Equine Veterinary Science*. 38: 64 – 71.
  11. Salem, A.Z.M., S.B. Archundia, A.E. Kholif, M.M.Y. Elghandour and N.E. **Odongo**. 2016. The effect of feeding horses a high fiber diet with or without live yeast cultures supplementation on feed intake, nutrient digestion, blood chemistry, fecal coliform count and in vitro fecal fermentation. *J. Equine Veterinary Science*. 39: 12 – 19.
  12. Wang, Z., Z. He, K. Beauchemin, S. Tang, C. Zhou, X. Han, M. Wang, J. Kang, N. **Odongo**, Z. Tan. 2016. Comparison of two live *Bacillus* species as feed additives for improving in vitro fermentation of cereal straws. *Anim. Sci. J.* 87: 27 – 36.
  13. Wang, Z., Z. He, K. Beauchemin, S. Tang, C. Zhou, X. Han, M. Wang, J. Kang, N. **Odongo**, Z. Tan. 2016. Evaluation of different yeast species for improving in vitro fermentation of cereal straws. *Asian Australas. J. Anim. Sci.* 29: 230 – 240. <http://dx.doi.org/10.5713/ajas.15.0188>
  14. Rojo, R., A.E. Kholif, A.Z.M. Salem, M.M.Y. Elghandour, N.E. **Odongo**, R. Montes De Oca, N. Rivero and M.U. Alonso-Fresan. 2015. Influence of cellulase addition to dairy goat diets on digestion and fermentation, milk production and fatty acids content. *J. Agric. Sci. (Camb)*, 153: 1514–1523.
  15. Velázquez-Garduño, G., M.A. Mariezcurrena-Berasain, A.Z.M. Salem, A.T. Gutiérrez-Ibañez, L.R. Bernal-Martínez, D.L. Pinzón-Martínez, A.E. Kholif, N.E. **Odongo** and M.D. Mariezcurrena-Berasain. 2015. Effect of organic selenium-enriched yeast supplementation in finishing sheep diet on carcasses microbiological contamination and meat physical characteristics. *Ital J Anim Sci.*, 14: 443 – 447.
  16. Salem, A.Z.M., M.M.Y. Elghandour, A.E. Kholif, N.E. **Odongo**, F.J.P. Jiménez, R.M., I.A. Domínguez and J.A. Dibarrat. 2015. The effect of feeding horses a high fibre diet with or without exogenous fibrolytic enzymes supplementation on nutrient digestion, blood chemistry, faecal coliform count and in vitro faecal fermentation. *J. of Equine Veterinary Science*, 35: 735 – 743.
  17. Lu Q., Jiao J., Tang S., He Z., Zhou C., Han X., Wang M., Kang J., **Odongo** N.E., Tan Z. 2015. Effects of dietary cellulase and xylanase addition on digestion, rumen fermentation and methane emission in growing goats. *Arch Anim Nutr.*, 69: 251 – 266.
  18. Togtokhbayar N., Cerrillo M.A., Rodríguez G.B., Elghandour M.M., Salem A.Z., Urankhaich C., Jigjdpurev S., **Odongo** N.E., Kholif AE. 2015. Effect of exogenous xylanase on rumen in vitro gas production and degradability of wheat straw. *Anim Sci J.*, 86: 765 – 771.
  19. López, S., J. France, N.E. **Odongo**, R.A. McBride, E. Kebreab, O. AlZahal, B.W. McBride and J. Dijkstra. 2015. On the analysis of Canadian Holstein dairy cow lactation curves using standard growth functions. *J. Dairy Sci.*, 98: 2701 – 2712.
  20. He, Z.X., L.Y. Yang, W.Z. Yang, K.A. Beauchemin, S.X. Tang, J.Y. Huang, C.S. Zhou, X.F. Han, M. Wang, J.H. Kang, N.E. **Odongo** and Z.L. Tan. 2015. Efficacy of exogenous xylanases for improving in vitro fermentation of forages. *J. Agric. Sci. (Camb)*, 153: 538 – 553.
  21. Gameda, B.S., A. Hassen and N.E. **Odongo** (2014). Effect of application of fibrolytic enzyme products at different levels on in vitro ruminal fermentation of low quality feeds and total mixed ration. *Journal of Animal & Plant Sciences*, 24: 1293 – 1302.
  22. Salem, Abdelfattah Z M, Zhou Chuan-she, Tan Zhi-liang, Miguel Mellado, Moises Cipriano Salazar, Mona M M Y Elghandopur and Nicholas E **Odongo**. 2013. In vitro

- ruminal gas production kinetics of four fodder trees ensiled with or without molasses and urea. *Journal of Integrative Agriculture*, 12: 1234 – 1242.
23. Díaz, A., M.D. Carro, C. Saro, I. Mateos, N.E. **Odongo** and M.J. Ranilla. 2013. *In vitro* evaluation of commercial fibrolytic enzymes for improving the nutritive value of low-quality forages. *Animal Nutrition and Feed Technology*, 13: 461-476.
  24. Tang, S.X., Y. Zou, M. Wang, A.Z.M. Salem, N.E. **Odongo**, C.S. Zhou, X.F. Han, Z.L. Tan, M. Zhang, Y.F. Fu, S.Q. Huang, Z.X. He and J.H. Kang. 2013. Effects of exogenous cellulase source on *in vitro* fermentation characteristics and methane production of crop straws and grasses. *Animal Nutrition and Feed Technology*, 13: 489-505.
  25. Salem, Abdelfattah Z M, Zhou Chuan-she, Tan Zhi-liang, Miguel Mellado, Moises Cipriano Salazar, Mona M M Y Elghandopur and Nicholas E **Odongo**. 2013. *In vitro* ruminal gas production kinetics of four fodder trees ensiled with or without molasses and urea. *Journal of Integrative Agriculture*. 12: 1234 – 1242.
  26. Elghandour, M.M.Y., A.Z.M. Salem, M. Gonzalez-Ronquillo, J.L. Bórquez, H.M. Gado, **N.E. Odongo** and C.G. Peñuelas. 2013. Effects of exogenous enzymes on *in vitro* gas production kinetics and ruminal fermentation of four fibrous feeds. *Anim. Feed Sci. Techno.* 179: 46 – 53.
  27. Rivero, N., A.Z.M. Salem, H.M. Gado, M.G. Ronquillo, A.B. Pliego, C.G. Peñuelas and N.E. **Odongo**. 2012. Effect of exogenous enzymes and *Salix babylonica* extract or their combination on haematological parameters in growing lambs. *Journal of Animal and Feed Sciences*. 21: 577 – 587.
  28. Gado, H.M., A.Z.M. Salem, N.E. **Odongo**, and B.E. Borhami. 2011. Influence of exogenous enzymes ensiled with orange pulp on digestion and growth performance in lambs. *Anim. Feed Sci. Techno.* 165: 131–136.
  29. **Odongo**, N.E., S. Lopez, R. McBride, E. Kebreab, O. AlZahal, B.W. McBride, M.H. Fathi Nasri, J. Dijkstra, and J. France. 2010. On the analysis of individual Canadian Holstein dairy cow lactation curve using empirical mathematical models. Submitted, *J. Dairy Sci.*
  30. Dijkstra, J., S. Lopez, A. Bannink, M.S. Dhanoa, E. Kebreab, N.E. **Odongo**, M. H. Fathi Nasri, U. K. Behera, D. Hernandez-ferrer, and J. France. 2010. Evaluation of a mechanistic lactation model using cow, goat and sheep data. *J. Agric. Sci. (Camb)*. 148: 249–262.
  31. Holtshausen, L., A. Chaves, K. Beauchemin, S. McGinn, T. McAllister, N.E. **Odongo**, P.R. Cheeke and C. Benchaar. 2009. Feeding saponin from *Yucca schidigera* and *Quillaja saponaria* to decrease enteric methane production and enhance milk production and composition in dairy cows. *J. Dairy Sci.* 92: 2809 – 2921.
  32. Ellis, J.L., E. Kebreab, N.E. **Odongo**, K. Beauchemin, S. McGinn, D. Nkrumah, R. Christopherson, B.W. McBride, E.K. Okine and J. France. 2009. Modeling methane production from beef cattle using linear and non-linear approaches. *J. Anim. Sci.* 87:1334 – 1345.
  33. Or-Rashid, M.M., N.E. **Odongo**, T.C. Wright, and B.W. McBride. 2009. Fatty acid profile of bovine milk naturally enhanced with docosahexaenoic acid. *J. Agric. Food Chem.*, 57: 1366 – 1371.
  34. **Odongo**, N.E., S. Greenwood, M.M. Or-Rashid, D. Radford, O. AlZahal, A.K. Shoveller, M.I. Lindinger, J.C. Matthews and B.W. McBride. 2009. Effects of nutritionally induced metabolic acidosis with or without glutamine infusion on acid-base balance, plasma amino acids and plasma non-esterified fatty acids in sheep. *J. Anim. Sci.* 87: 1077 – 1084.
  35. Osborne, V.R., N.E. **Odongo**, K.C. Swanson, J.P. Cant and B.W. McBride. 2009. Effects of supplementing glycerol and soybean oil in drinking water on feed and water intake, energy balance and production performance of periparturient dairy cows. *J. Dairy Sci.* 92: 698 – 707.

36. Mainville, A.M., N.E. **Odongo**, W.J. Bettger, B.W. McBride and V.R. Osborne. 2009. Selenium uptake by ruminal microorganisms from organic and inorganic sources in dairy cows. *Can. J. Anim. Sci.* 89: 105-110.
37. Montanholi, Y.R., N.E. **Odongo**, K.C. Swanson, F.S. Schenkel, B.W. McBride, and S.P. Miller. 2008. Application of infrared thermography as an indicator of heat and methane production and its use in the study of skin temperature in response to physiological events in dairy cattle (*Bos Taurus*). *J. Thermal Biology* 33: 468 – 475.
38. Fathi Nasri, M.H., J. France, N.E. **Odongo**, S. Lopez, A. Bannink and E. Kebreab. 2008. Modelling the lactation curve of dairy cows using the differentials of growth functions. *J. Agric. Sci. (Camb)* 146: 633 – 641.
39. Greenwood, S.L., N.E. **Odongo**, O. AlZahal, K.C. Swanson, A.K. Shoveller, J.C. Matthews, and B.W. McBride. 2008. Amino acid profile and expression of the ubiquitin-mediated proteolytic pathway in lambs induced with metabolic acidosis. *J. Anim. Sci.* 86: 2651-2656.
40. Jalilvand, G., N.E. **Odongo**, A. Naserian, R. Valizadeh, F. Eftekhar Shahrodi, E. Kebreab and J. France. 2008. Effects of different levels of an enzyme mixture on in vitro gas production parameters of different forages. *Anim. Feed Sci. Techno.* 146: 289 – 301.
41. Jalilvand, G., A. Naserian, E. Kebreab, N.E. **Odongo**, R. Valizadeh, F. Eftekhar Shahroodi and J. France. 2008. An in situ dry matter and crude protein degradation kinetics of Iranian forages treated with three enzyme mixtures. *Arch. Zootec.* 57: 155 – 164.
42. Or-Rashid, M.M., N.E. **Odongo**, B. Subedi, P. Karki and B.W. McBride. 2008. The fatty acid composition of yak (*Bos grunniens*) cheese including conjugated linoleic acid and trans-18:1 fatty acids. *J. Agric. Food Chem.* 56: 1654 – 1660.
43. AlZahal, O., N.E. **Odongo**, M.M. Or-Rashid, T. Mutsvangwa, T.F. Duffield, G. Vessie, R. Bagg, P. Dick and B.W. McBride. 2008. Effects of monensin and dietary soybean oil on milk fat percentage and milk fatty acid profiles in lactating dairy cows. *J. Dairy Sci.* 91: 1166 – 1174.
44. Osborne, V.R., S. Radhakrishnan, N.E. **Odongo**, A.R. Hill and B.W. McBride. 2008. Effects of supplementing fish oil in the drinking water of dairy cows on production performance and milk fatty acid composition. *J. Anim Sci.* 86: 720 – 729.
45. Kebreab, E., N.E. **Odongo**, B.W. McBride, M.D. Hanigan and J. France. 2008. Phosphorus utilization and environmental and economic implications of reducing phosphorus pollution from Ontario dairy cows. *J. Dairy Sci.* 91: 241 – 246.
46. Ellis, J.L., J. Dijkstra, E. Kebreab, A. Bannink, N.E. **Odongo**, B.W. McBride, and J. France. 2008. Aspects of rumen microbiology central to mechanistic modeling of methane production in cattle. *J. Agric. Sci. (Camb)*. 146: 213 – 233.
47. **Odongo**, N.E., D. McKnight, A. KoekKoek, J.W. Fisher, P. Sharpe, E. Kebreab, J. France and B.W. McBride. 2007. Long-term effects of feeding diets without mineral phosphorus supplementation on the performance and phosphorus excretion in high-yielding dairy cows. *Can. J. Anim. Sci.* 87: 639 – 646.
48. **Odongo**, N.E., M.M. Or-Rashid, R. Bagg, G. Vessie, P. Dick, E. Kebreab, J. France and B.W. McBride. 2007. Long-term effects of feeding monensin on milk fatty acid profile in lactating dairy cows. *J. Dairy Sci.* 90: 5126 – 5133.
49. Osborne, V.R., N.E. **Odongo**, A.M. Edwards and B.W. McBride. 2007. Effects of photoperiod and glucose supplementation in the drinking water of neonatal dairy calves on performance. *J. Dairy Sci.* 90: 5199 – 5207.
50. Las, J.E., N.E. **Odongo**, M.I. Lindinger, O. AlZahal, A.K. Shoveller, J.C. Matthews and B.W. McBride. 2007. Effects of dietary acid challenge on regulation of acid-base balance in lambs. *J. Anim. Sci.* 85:2222 – 2229.
51. Ellis, J.L., E. Kebreab, N.E. **Odongo**, B.W. McBride, E.K. Okine and J. France. 2007. Prediction of methane production from dairy and beef cattle. *J. Dairy Sci.* 90:3456 – 3467.

52. Or-Rashid, M.M., N.E. **Odongo** and B.W. McBride. 2007. Fatty acid composition of ruminal bacteria and protozoa with emphasis on conjugated linoleic acid, *trans* vaccenic acid and odd-chain and branched-chain fatty acids. *J. Anim. Sci.* 85:1228 – 1234.
53. **Odongo**, N.E., K. Hyung-Ho, C. Hee-Chul, P. van Straaten, B.W. McBride and D. L. Romney. 2007. Improving rock phosphate availability through feeding, mixing and processing with composting manure. *Bioresource Technol.* 98: 2911 – 2918.
54. **Odongo**, N.E., R. Bagg, G. Vessie, P. Dick, M.M. Or-Rashid, S.E. Hook, J.T. Gray, E. Kebreab, J. France and B.W. McBride. 2007. Long-term effects of feeding monensin on methane production in lactating dairy cows. *J. Dairy Sci.* 90: 1781 – 1788.
55. **Odongo**, N.E., M.M. Or-Rashid, E. Kebreab, J. France and B.W. McBride. 2007. Effect of supplementing myristic acid in dairy cow rations on ruminal methanogenesis and milk fatty acid profile. *J. Dairy Sci.* 90: 1851 – 1858.
56. AlZahal, O., B. Rustomo, N.E. **Odongo**, T.F. Duffield and B.W. McBride. 2007. Technical note: A cordless system for continuous ruminal pH recording in dairy cows. *J. Anim. Sci.* 85: 213 – 217.
57. Jalilvand, G., A. Naserian, N.E. **Odongo**, E. Kebreab, R. Valizadeh, F. Eftekhari Shahrodi and J. France, 2007. Effects of abomasal infusion of cottonseed oil and dietary enzyme supplementation on dairy goats. *J. Anim. Feed Sci.* 16: 391 – 398.
58. Rustomo, B., O. AlZahal, N.E. **Odongo**, T.F. Duffield and B.W. McBride. 2006. Effects of rumen acid load from feed and forage particle size on ruminal pH, dry matter intake and milk production in the lactating dairy cow. *J. Dairy Sci.* 89: 4758 – 4768.
59. AlZahal, H., J.L. Benford, T. Widowski, J.P. Walton, J.C. Plaizier, T. Duffield, N.E. **Odongo** and B.W. McBride. 2006. Effects of frequency of feed delivery on dairy cattle behavior. *Professional Animal Scientist (ARPAS)*. 22: 80 – 83.
60. **Odongo**, N.E., E.V. Valdes and B.W. McBride. 2006. Technical note: Acidogenicity value and rumen acid load of common zoo animal feeds. *Professional Animal Scientist (ARPAS)*. 22: 194 – 199.
61. **Odongo**, N.E., O. AlZahal, M.I. Lindinger, T.F. Duffield, E.V. Valdes, S.P. Terrell and B.W. McBride. 2006. Effects of mild heat stress and grain challenge on acid-base balance and rumen tissue histology in lambs. *J. Anim. Sci.* 84: 447 – 455.
62. Rustomo, B., J.P. Cant, M.P. Fan, T.F. Duffield, N.E. **Odongo** and B.W. McBride. 2006. Acidogenic value of dairy feeds: I. The relationship between the acidogenic value of feeds and in vitro ruminal pH changes. *Can. J. Anim. Sci.* 86: 109 – 117.
63. Rustomo, B., O. AlZahal, J.P. Cant, M.P. Fan, T.F. Duffield, N.E. **Odongo** and B.W. McBride. 2006. Acidogenic value of dairy feeds: II. Effects of rumen acid load from dairy feeds on ruminal pH, fiber digestibility, dry matter intake and milk production in the lactating dairy cow. *Can. J. Anim. Sci.* 86: 119 – 126.
64. Shore, K.V., N.E. **Odongo**, T. Mutsvangwa, T.M. Widowski, J.P. Cant, W.J. Bettger and B.W. McBride. 2005. Phosphorus status of lactating dairy cows fed total mixed rations containing 0.24% vs. 0.36% phosphorus. *Can. J. Anim. Sci.* 85: 409 – 412.
65. Lunn, D.E., T. Mutsvangwa, N.E. **Odongo**, T.F. Duffield, R. Bagg, P. Dick, G. Vessie and B.W. McBride. 2005. Effect of monensin on meal frequency during sub-acute ruminal acidosis in dairy cows. *Can. J. Anim. Sci.* 85: 247 – 249.
66. Pendlebury, C., N.E. **Odongo**, A. Renjifo, J. Naelitz, E.V. Valdes and B.W. McBride. 2005. Acid-insoluble ash as a measure of dry matter digestibility in captive African elephants (*Loxodonta africana*). *Zoo Biol.* 24: 261 – 265.
67. **Odongo**, N.E., J. Tanner, D.L. Romney, J. Plaizier, P. van Straaten and B. McBride. 2002. The effects of supplementing Napier grass (*Pennisetum purpureum*) with rock phosphate, a commercial mineral mix and steamed bone meal on phosphorus absorption in cattle. *Trop. Ani. Hlth. Prod.* 34: 329 – 338.
68. **Odongo**, N.E., J. Plaizier, van Straaten and B. McBride. 2002. The effects of replacing dicalcium phosphate in chick rations with Busumbu rock phosphate on performance

and mechanical properties of bone in growing chicks. *Trop. Ani. Hlth. Prod.* 34: 349 – 358.

69. Esilaba, A.O., Ikombo, B.M., Kilewe, A.M., Miriti, J.M., **Odongo**, E.N., Mwangi, D.M., Kaiyare, J.M., Ademba, J.S. and Wanyama, E. 2002. Effects of grasses and legumes on soil chemical properties in Central Kenya. *E. Afr. Agric. For. J.* 68: 101 –110.
70. Wamuongo, J.W., Esilaba, A.O., Miriti, J.M., **Odongo**, E.N. and Kilewe, A.M. 1996. Multipurpose tree and shrubs in soil and water conservation in the highlands. *E. Afr. Agric. For. J.* 62: 129 – 137.
71. **Odongo**, E.N. and Njuho, P.M., 1990. The effects of mixtures of milk and gruel on calf performance. *E. Afr. Agric. For. J.* 56: 33 – 40.

#### Books

72. Salem, A.Z.M., N.E. **Odongo** & A.K. Pattanaik (eds). 2013. Exogenous enzymes in animal nutrition – benefits and limitations. *Animal Nutrition and Feed Technology*. 13 (3). ISBN: 0972-2963
73. **Odongo**, N.E., M. Garcia & G.J. Viljoen (eds), Sustainable Improvement of Animal Production and Health. Food and Agriculture Organization of the United Nations, Rome, 2010. ISBN 978-92-5-106697-3.

#### Book Chapters

74. **Odongo**, N.E., O. AlZahal, J.E. Las, A. Kramer, B. Kerrigan, E. Kebreab, J. France and B.W. McBride. 2008. Data capture: development of a mobile open-circuit ventilated hood system for measuring real-time gaseous exchange in cattle. In: *Mathematical Modelling in Animal Nutrition*. pg 225 – 240. Edited by J. France and E. Kebreab. CABI Publishing, Wallingford, UK.
75. Kebreab, E., D.M.S.S. Vitti, N.E. **Odongo**, L.A. Crompton and J. France. 2008. Modelling phosphorus metabolism. In: *Mathematical Modelling in Animal Nutrition*. Edited by J. France and E. Kebreab. CABI Publishing, Wallingford, UK.
76. Wright, T.C., N.E. **Odongo**, N.D. Scollan and B.W. McBride. 2007. Nutritional manipulation of functional foods derived from herbivores for human nutritional benefit. In: *Proceedings of the VII International Symposium on the Nutrition of Herbivores*. Herbivore Nutrition for the Development of Efficient, Safe and Sustainable Livestock Production. September 17 - 22, 2007, Beijing, China. pg 357 – 396. Eds. Q.X. Meng, J.X. Liu and W.Y. Zhu. China Scientific Press, Beijing, China.
77. Kebreab E., France J., McBride B.W., **Odongo** N., Bannink A., Mills J.A.N. and Dijkstra J. 2005. Evaluation of models to predict methane emissions from enteric fermentation in North American dairy cattle. In: *Nutrient Digestion and Utilization in Farm Animals: Modelling Approaches*. pg 299 – 313. eds., Kebreab E, Dijkstra J, Gerrits, W, Bannink A and France J. CABI Publishing, Wallingford, UK.

#### **Others:**

##### Papers in Conference Proceedings

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