



## Precision Agriculture: Development and Assessment of Integrated Practices for Kentucky Producers

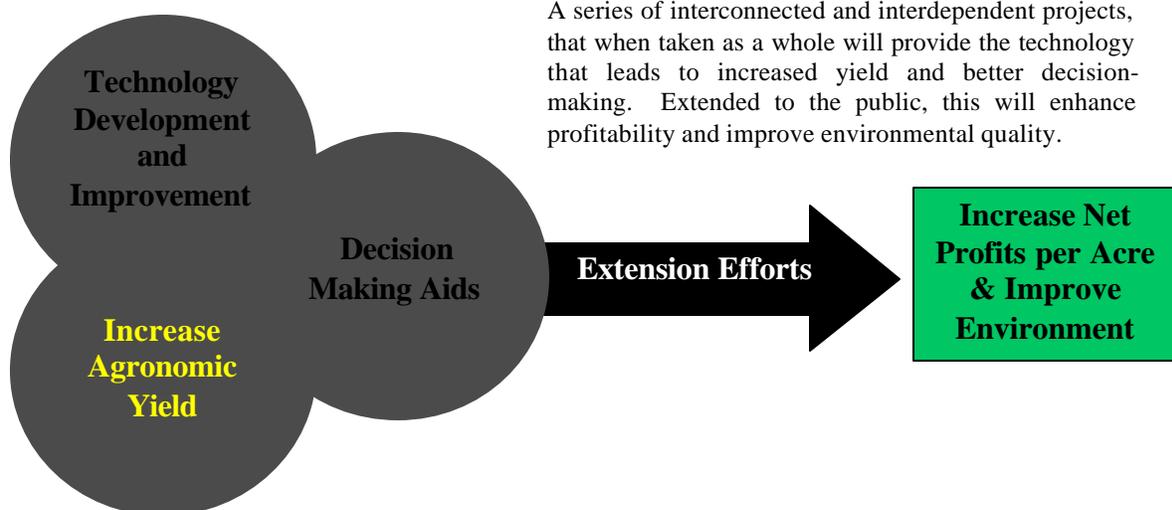
### 2003 Research Publication Report

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Beginning in 1992, the University of Kentucky has been researching Precision Agriculture techniques, evaluating the impact of such methodology and developing these into systematic tools to improve the efficiency of farm management.<sup>1</sup> This primary mission to “develop and assess precision agriculture equipment and technologies for implementation on Kentucky farms to enhance profitability and improve environmental quality” has resulted in much success. This document is intended to provide a list of the academic activities that have been undertaken to date by reporting on professional and extension publications and presentations. The research projects summarized herein represent the collective effort of over 40 researchers at UK and countless cooperators throughout Kentucky. Nonetheless, it does not completely reflect the accomplishments in this area. Many research efforts are just now completing their project’s duration. Thus, this report is intended to be a work in progress and will be updated and kept current with annual addendums.

A multi-disciplinary research team has integrated efforts within the Biosystems and Agricultural Engineering, Agronomy, and Agricultural Economics departments at the University of Kentucky to focus on this mission. Graphically described below are their objectives in this mission.

#### Objectives



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## **I. Extension Publications**

### **a. Numbered Publications**

- Hancock, D.W., T.S. Stombaugh, and B.K. Koostra. 2003. Mapping the Farm. Extension Publication. PA-7-Draft. Univ. of Kentucky. Lexington, KY. (In Review)
- Mueller, T.G., D.W. Hancock, and T.S. Stombaugh. 2003. Advances in Remote Sensing. Extension Publication. PA-8-Draft. Univ. of Kentucky. Lexington, KY. (In Review)
- Mueller, T.G., D.W. Hancock, and T.S. Stombaugh. 2003. Remote Sensing. Extension Publication. PA-6-Draft. Univ. of Kentucky. Lexington, KY. (In Review)
- Murdock, L.W., P. Howe, R. Forsythe, and K. Scott. 2003. Why yields vary in fields with karst topography. Extension Publication. PA-9-Draft. Univ. of Kentucky. Lexington, KY. (In Review)
- Shearer, S.A., J.P. Fulton, S.G. McNeill, S.F. Higgins, and T.G. Mueller. 1999. Elements of Precision Agriculture: Basics of Yield Monitor Installation and Operation. Extension Publication. PA-1. Univ. of Kentucky. Lexington, KY.
- Stombaugh, T.S. 2002. Lightbar Guidance Aids. Extension Publication. PA-3. Univ. of Kentucky. Lexington, KY.
- Stombaugh, T.S. 2002. Choosing the Right Lightbar. Extension Publication. PA-4. Univ. of Kentucky. Lexington, KY.
- Stombaugh, T.S., T.G. Mueller, S.A. Shearer, C.R. Dillon, and G.T. Henson. 2001. Guidelines for Adopting Precision Agricultural Practices. Extension Publication. PA-2. Univ. of Kentucky. Lexington, KY.
- Stombaugh, T.S., S.A. Shearer, and J.P. Fulton. 2002. GPS Simplified. Extension Publication. PA-5. Univ. of Kentucky. Lexington, KY.

### **b. Factsheets**

- Hancock, D.W. (ed.) 2003. 2003 Research Report: Precision Agriculture in Kentucky - Developing and Assessing Precision Agriculture Technologies for Kentucky Producers. Univ. of Kentucky. Lexington, KY.
- Hancock, D.W. 2002. Precision Agriculture at the University of Kentucky. Univ. of Kentucky. Lexington, KY.
- Hancock, D.W. 2002. Precision Agriculture in Kentucky: Cooperating Researchers. Univ. of Kentucky. Lexington, KY.
- Hancock, D.W. 2002. Precision Agriculture in Kentucky: Research Projects and Findings. Univ. of Kentucky. Lexington, KY.

Hancock, D.W. 2002. The University of Kentucky's Precision Agriculture Research Committee. Univ. of Kentucky. Lexington, KY.

Hancock, D.W. 2003 (Ed.) Precision Agriculture User's Handbook – Version 1.0. [www.bae.uky.edu/precag/](http://www.bae.uky.edu/precag/) Univ. of Kentucky. Lexington, KY.

### **c. Newsletters/News Articles**

Hancock, D.W. 2003. (Ed.) Site Specific Issues: Spring Planting 2003. [www.bae.uky.edu/precag/](http://www.bae.uky.edu/precag/) Univ. of Kentucky. Lexington, KY.

Hancock, D.W. 2003. Keeping Better Records with Precision Agriculture. Topics in Precision Agriculture. [www.bae.uky.edu/precag/](http://www.bae.uky.edu/precag/) Univ. of Kentucky. Lexington, KY.

Hancock, D.W. 2002. (Ed.) Site Specific Issues: Harvest 2002. [www.bae.uky.edu/precag/](http://www.bae.uky.edu/precag/) Univ. of Kentucky. Lexington, KY.

Hancock, D.W. 2002. (Ed.) Site Specific Issues: Winter Planning 2002. [www.bae.uky.edu/precag/](http://www.bae.uky.edu/precag/) Univ. of Kentucky. Lexington, KY.

Hancock, D.W. 2002. Site-Specific Farming on Small Farms. Topics in Precision Agriculture. [www.bae.uky.edu/precag/](http://www.bae.uky.edu/precag/) Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. Driverless Tractors Save Time, Money. News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. KPAN Gives Farmers Networking Opportunities. News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. Producers Launch Kentucky Precision Ag Network. News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. New Technology Can Provide Improved Accuracy. News Releases. Univ. of Kentucky. Lexington, KY.

### **d. Radio Programs**

Stombaugh, T.S. 2002. Affording a GPS Receiver. Radio News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. Automatic Guidance. Radio News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. Choosing a Light Bar Guide for Your GPS System. Radio News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. Making Sense of Precision Agriculture Data. Radio News Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2002. Remote Sensing. Radio News Releases. Univ. of Kentucky. Lexington, KY.

### **e. Software Releases**

Powers, L. and S. Isaacs. 2000. Precision Farming Economic Worksheet. Software Releases. Univ. of Kentucky. Lexington, KY.

Stombaugh, T.S. 2003. GPS Field Area Program. Software Releases. Univ. of Kentucky. Lexington, KY.

## **II. Conference Presentations, Proceedings/Papers, Abstracts, Non-Refereed Publications**

Agouridis, C. T., T. S. Stombaugh, S. R. Workman, D. R. Edwards, B. K. Koostra. 2003. Examination of GPS collar capabilities and limitations for tracking animal movement in grazed watershed studies. ASAE Paper No. 032001, St. Joseph, MI:ASAE.

Barnhisel, R.I. and A. Moberly. 2003. Topography attributes and variable-rate seeding/nitrogen application effects on corn yield. Precision Agriculture in Kentucky: 1<sup>st</sup> Annual Conference. February 13, 2003. Louisville, KY.

Barnhisel, R.I. 2003. Variable-rate N and seeding in rolling terrain. InfoAg 2003. July 31-August 1. Indianapolis, IN.

Barnhisel, R.I., M.J. Bitzer, J.H. Grove, and S.A. Shearer. 1997. Agronomic benefits of varying corn seed populations: A central Kentucky study. Proceedings of Site Specific Management for Agriculture Systems. Third International Conference. Am. Society of Agronomy. 957-966.

Brommer, C. L. and W. W. Witt. 2002. Prediction of perennial weed occurrence using terrain modeling and soil attributes in Kentucky. Proc. Southern Weed Sci. Soc. 55:93.

Brommer, C. L. and W. W. Witt. 2001. Environmental and biological factors of perennial weed establishment in Kentucky no-till Fields. Proc. North Central Weed Sci. Soc. 56: (on CD, no page number to reference)

Brommer, C. L. and W. W. Witt. 2000. Impact of cultural practices on common pokeweed control in Kentucky no-till soybean production. Abstracts, Weed Science Society of America.

Brommer, C. L. and W. W. Witt. 2000. Correlation of soil factors on perennial weed occurrence in no-till fields. Proc. Southern Weed Science Society.

Burks, T.F., S.A. Shearer, and J.P. Fulton. 2000. Assessment of fertilizer application accuracy with the use of navigational aids. ASAE Paper No. 001154. Annual International Meeting, Midwest Express Center, Milwaukee, Wisconsin, July 9-12.

Burks, T.F., S.A. Shearer, C. J. Sobolik, and J.P. Fulton. 2000. Combine yield monitor test facility development. ASAE Paper No. 001084. Annual International Meeting, Midwest Express Center, Milwaukee, Wisconsin, July 9-12.

- Burks, T.F., S.A. Shearer, J.P. Fulton and C. J. Sobolik. 2001. Influence of dynamically varying inflow rates on clean grain elevator yield monitor accuracy. ASAE Paper No. 011182. Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Burks, T.F., S.A. Shearer, J.P. Fulton, and T. Stombaugh. 2002. Assessment of yield monitor accuracy using the ASAE X-587 Draft Test. Paper presented at the 6th International Conference on Precision Agriculture. Minneapolis, Minnesota. July 14-17, 2002.
- Coyne, M.S., E.M. Pena-Yewtukhiw, and J.H. Grove. 2001. Nitrate attenuation by stratified nitrate-reducing populations at restrictive layers within a soil. Agron. Abstr. 93: (on CD-ROM)
- Darr, M.J., T.S. Stombaugh, J.K. Ward, M.D. Montross. 2003. Handheld device for identity preservation during harvest. ASAE Paper No. 031103, St. Joseph, MI:ASAE.
- Debertin, D. 2003. The role of capital costs and farm size in precision farming adoption in Kentucky. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Dillon, C.R. 2002. A mathematical programming model for optimal management zone delineation in precision agriculture. AAEA Paper No.4483. Annual American Agricultural Economics Association Meeting, Long Beach, California, July 28-31, 2002.
- Dillon, C.R. 2003. Optimal management zone delineation. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Dillon, C.R., T. Mueller and S.A. Shearer. The value of innovative seed coatings to delay germination under field average and variable rate technology. Proceedings of the 6<sup>th</sup> International Conference on Precision Agriculture. Minneapolis, Minnesota. July 14-17, 2002. 1814-1827.
- Dillon, C.R. and S.A. Shearer. 2002. Using spatial data to make strategic decision for profitability and risk management. Presented poster. Proceedings of the 6<sup>th</sup> International Conference on Precision Agriculture. Minneapolis, Minnesota. July 14-17, 2002. 1859.
- Dillon, C.R. S.A. Shearer, and T.G Mueller. 2001. A mixed integer, nonlinear programming model of innovative variable-rate planting date with polymer seed coatings. AAEA Paper No.2657. Annual American Agricultural Economics Association Meeting, Chicago, Illinois, August 5-8, 2001.
- Dillon, C.R., J. Stull, S.G. Isaacs, S. Riggins and S.A. Shearer. 2001. Using GPS and economics to manage risk through CRP filter strips. Poster presented at the American Farm Bureau meeting. Orlando, FL. January 6-8, 2001.
- Dillon, C.R., J. Stull, S.G. Isaacs, S. Riggins and S.A. Shearer. 2000. An economic risk analysis of optimal GPS identified filter strips under varying land tenure arrangements. Poster presented at University of Kentucky GIS Day 2000. Lexington, KY. November 15, 2000.
- Dillon, C.R., L.A. Powers, and S.G. Isaacs. 2002. Strategic decision making using precision agriculture. Poster presented at the American Agricultural Economics Association annual meeting. Long Beach, California, July 2002.

- Dillon, C.R., T. Mueller and S.A. Shearer. 2002. The value of innovative seed coatings to delay germination under field average and variable rate technology. Forthcoming Proceedings of the 6th International Conference on Precision Agriculture. Minneapolis, Minnesota. July 14-17, 2002. 1814-1827.
- Dillon, C.R., T.G. Mueller and S.A. Shearer. 2001. An assessment of the profitability and risk management potential of variable rate seeding and planting date. Paper presented at the Southern Agricultural Economics Association meeting. Fort Worth, Texas. January 28-31, 2001. Abstract in *Journal of Agricultural and Applied Economics*. 33,3 (2001):622.
- Fleming, R. 2003. The economic and environmental implications of precision resources management Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Fleming, R., T.G. Mueller, T.S. Stombaugh, S.A. Shearer, and J.L. Taraba. 2001. Optimization of animal nutrient application for reduced environmental loading using GIS. ASAE Paper No. 01-1014. Annual International Meeting, Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Fulton, J. P. 2003. Variable-rate application of fertilizer and lime. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Fulton, J.P., L.G. Wells, S.A. Shearer and R.I. Barnhisel. 1996. Spatial variation of soil physical properties: A precursor to precision tillage. ASAE Paper No. 961002. International Meeting, Phoenix, Arizona. July 14-18.
- Fulton, J.P., S.A. Shearer, G. Chabra and S.G. Higgins. 1999. Field evaluation of a spinner disc variable-rate fertilizer applicator. ASAE Paper No. 991101. Annual International Meeting, Sheraton Centre, Toronto, Canada, July 18-21.
- Fulton, J.P., S.A. Shearer, M.E. Anderson, T.F. Burks and S.G. Higgins. 2000. Simulated application errors for granular materials for fixed and variable-rate application. ASAE Paper No. 001153. Annual International Meeting, Midwest Express Center, Milwaukee, Wisconsin, July 9-12.
- Fulton, J.P., S.A. Shearer, T.S. Stombaugh, and S.G. Higgins. 2002. Simulation of variable-rate application of granular materials. ASAE Paper No. 02-1168. Annual International Meeting, Hyatt Regency Chicago, Chicago, Illinois, July 28-31, 2002.
- Fulton, J.P., S.A. Shearer, T.S. Stombaugh, and S.G. Higgins. 2001. Pattern assessment of a spinner disc variable-rate fertilizer applicator. ASAE Paper No. 01-1116. Annual International Meeting, Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Fulton, J. P., S. A. Shearer, T. S. Stombaugh, S. F. Higgins. 2003. Comparison of variable-rate granular application equipment. ASAE Paper No. 031125, St. Joseph, MI:ASAE.
- Fulton, J.P., S.A. Shearer, T.S. Stombaugh, S.G. Higgins and C.R. Dillon. 2002. 'As-Applied' model validation for variable-rate application of granular materials. In P.C. Robert et al. (ed.) Proc. 6th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.

- Gandonou, J., T. S. Stombaugh, C. Dillon, and S.A. Shearer. 2001. Precision agriculture: A break-even acreage analysis. Paper presented at the ASAE Annual International Meeting, Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Gandonou, JM. C.R. Dillon, S.G. Isaacs and S.A. Shearer. 2001. Precision agriculture: A breakeven acreage analysis. Paper presented at the Southern Agricultural Economics Association meeting. Fort Worth, Texas. January 28-31. Abstract in Journal of Agricultural and Applied Economics. 33,3 (2001):626.
- Gandonou, JM., C.R. Dillon and M. Kanakasabai. 2002. Custom hiring versus equipment ownership in precision agriculture. Poster presented at the American Agricultural Economics Association meeting. Long Beach, California. July 28-31, 2002.
- Gandonou, JM., C.R. Dillon, S.G. Isaacs, S.A. Shearer and T. Stombaugh. 2000. Economically efficient GIS adoption in precision agriculture. Poster presented at University of Kentucky GIS Day 2000. Lexington, KY. November 15, 2000.
- Grove, J.H. 2003. Site-specific methods in nutrient management. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Grove, J.H., and E.M. Pena-Yewtukhiw. 2000. Fertilizer recommendations based upon nutrient removal or soil testing: A spatial analysis. In J. Gerwing (ed.). Proc. 30<sup>th</sup> North Central Extension-Industry Soil Fertility Conf., 15-16 Nov., St. Louis, MO. Potash and Phosphate Institute. V16: 123-131.
- Grove, J.H., and E.M. Pena-Yewtukhiw. 2002. Spatial analysis of soil nitrate or grain n removal for phytoremediation of post-harvest soil nitrate. Proc. 6<sup>th</sup> Int. Conf. On Precision Agriculture. 14-17 July. Minneapolis, MN.
- Grove, J.H., and E.M. Pena-Yewtukhiw. 2001. Continuous manure application without adverse environmental impact: Spatial analysis of crop phosphorus removal to improve the kentucky phosphorus index. p. 59. Proc. Kentucky Water Resources Annual Symposium. 23 Feb. Lexington, KY.
- Grove, J.H., and E.M. Pena-Yewtukhiw. 2001. The site-specific approach and environmental quality: Phytoremediation of post-harvest soil nitrate following corn production in central Kentucky, USA. 3<sup>rd</sup> European Conference on Precision Agriculture, Montpellier, France. pp. 30.
- Grove, J.H., E.M. Pena-Yewtukhiw, and C.E. Kiger. 2000. Spatial variation in corn grain nutrient composition: An issue for nutrient removal (yield map) based fertilizer recommendations. Agron. Abstr. 92:363.
- Grove, J.H., E.M. Pena-Yewtukhiw, and G. Hupman. 2001. A field-scale evaluation of nitrogen fertilizer rate recommendations for corn. Agronomy Abstracts 93: (on CD-ROM)
- Grove, J.H., E.M. Pena-Yewtukhiw, and J.A. Thompson. 2000. Site-specific management of starter fertilizer application. Agron. Abstr. 92:362.

- Grove, J.H., E.M. Pena-Yewtukhiw, and J.A. Thompson. 2000. Spatially probabilistic evaluation of the benefit of starter fertilizer to no-till corn. Proc. 5<sup>th</sup> Int. Conf. On Precision Agriculture. 16-19 July. Minneapolis, MN. 12 pp.
- Grove, J.H., E.M. Pena-Yewtukhiw, J.A. Thompson and C.E. Kiger. 2001. Using a spatial analysis of the kentucky phosphorus index to permit continuous manure applications without adverse environmental impact. Proc. Soil Water Conserv. Soc. 4-8 Aug., Myrtle Beach, SC.
- Grusy, R. 2003. Public and private sector influence on precision agriculture adoption decision. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Hancock, D.W., and T.S. Stombaugh. 2003. Choosing a GPS receiver. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Hancock, D.W., S.A. Shearer, T.G. Mueller, C.R. Dillon. 2003. Precision agriculture: More specific analysis and management using new tools. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Hancock, D.W., T.S. Stombaugh, S.A. Shearer, T.G. Mueller, and C.R. Dillon. 2003. Extension outreach in precision agriculture for Kentucky. ASAE Paper No. 031098, St. Joseph, MI:ASAE.
- Hart, W.E., J.B. Wilkerson, T.F. Morrow, and T.S. Stombaugh. 2002. Evaluating operator feedback accuracy of row-guidance systems with GPS. Paper presented at the 6th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.
- Hartsock, N.J., T.G. Mueller, S.A. Shearer, G.W. Thomas, R.I. Barnhisel, and K.L. Wells. 2000. Soil electrical conductivity variability. Paper presented at the 5th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.
- Hartsock, N.J., T.G. Mueller, A.D. Karathanasis, and P.L. Cornelius. 2001. the potential for enhancing soil surveys with digital terrain models and electrical conductivity in Kentucky. Proceedings for the 2nd European Conference on Precision Agriculture. (In Press)
- Hartsock, N.J., T.G. Mueller, S.A. Shearer, G.W. Thomas, R.L. Barnhisel, and K.L. Wells. 2000. Soil electrical conductivity variability: A research approach. Agronomy Meetings Abstracts.
- Kooststra, B.K. and T.S. Stombaugh. 2003. Development and evaluation of a sensor to continuously measure air permeability of soil. ASAE Paper No. 031072, St. Joseph, MI:ASAE.
- McNeill, S.G. 2003. Spatial variability of oil, protein, and starch in yellow corn. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- McNeill, S.G., Montross, M.D., and S.A. Shearer. 2002. Spatial variation of protein, oil and starch in yellow corn. ASAE Paper No. 02-1011. Annual International Meeting, Hyatt Regency Chicago, Chicago, Illinois, July 28-31, 2002.

- Mueller, T.G. 2002. Soil electrical conductivity, terrain attributes, and hyperspectral imagery: Variability between and within soil map phases. Lecture to ASPRS (American Society for Photogrammetry & Remote Sensing) Mid-South Regional Fall 2002 MEETING on "Imaging and Geospatial Information in the 21st Century" on October 24-25, 2002, Murray State University, Murray, KY.
- Montross, M.D., R.Prewitt, S.A. Shearer, T.S. Stombaugh, S.G. McNeill, S. Sokhansanj. 2003. Economics of collection and transportation of corn stover. ASAE Paper No. 036081, St. Joseph, MI:ASAE.
- Mueller, T.G. 2003. Soil sampling, soil surveys, and sensors for precision agriculture. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Mueller, T.G. and F.J. Pierce. 2000. Optimizing spatial estimates of soil carbon with terrain attributes. Agronomy Meetings Abstracts.
- Mueller, T.G. R.I. Barnhisel, and S.A. Shearer. 2001. Geostatistical decisions and impact on map quality. Agronomy Meetings Abstract.
- Mueller, T.G., A.D. Karathanasis, P.L. Cornelius, H. Cetin. 2002. Hyperspectral imagery: Variability within and between soil map phases. Paper presented at the 6th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.
- Mueller, T.G., F.J. Pierce, O. Schabenberger, D.D. Warncke. 1999. Assessing map accuracy for site-specific fertility management. Agronomy Meetings Abstracts.
- Mueller, T.G., F.J. Pierce, S.A. Shearer, and R.I. Barnhisel. 2001. Map quality for site-specific fertility management: An analysis of methods. Agronomy Meetings Abstract.
- Mueller, T.G., S.A. Shearer, K.L. Wells, G.W. Thomas, R.I. Barnhisel, N.J. Hartsock, S.A. Shearer, A. Kumar, C.R. Dillon. 2000. Soil fertility map quality: Case studies in Kentucky. Paper presented at the 5th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.
- Mueller, T.G., S.A. Shearer, R.I. Barnhisel, G.W. Thomas, K.L. Wells, and A. Kumar. 2000. Map quality for site-specific fertility management in Kentucky. Agronomy Meetings Abstracts.
- Mueller., T.G. 2000. Assessing spatial uncertainty for site-specific fertility management. North American Council on Geostatistics. 2000 Annual Meetings. Ann Arbor, MI.
- Murdock, L.W. 2002. Variable rate nitrogen for corn in Kentucky. North Central Soil Fertility Conference. Des Moines, IA. Nov. 2002.
- Murdock, L.W. 2003. Correlation of corn and/or soybean yield variability with the variability of soil characteristics within fields. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.

- Murdock, L.W. and P Howe. 1997. Profitability of variable rate fertilization on a Kentucky soil (A theoretical analysis). Soil Science News & Views. VOL. 18, NO 10. Univ. of Kentucky, College of Agriculture, Agronomy Department.
- Murdock, L.W., 2001. Variable rate nitrogen. Southern Soil Fertility Conference Proceedings. Memphis, TN. Oct.10 2001.
- Pena-Yewtukhiw, E.M., and J. H. Grove. 2002. The site-specific approach and environmental quality: Phytoremediation of post-harvest soil nitrate following corn production. Proc. Kentucky Water Resources Ann. Sym. 20 Feb. Lexington, KY. p. 3-4.
- Pena-Yewtukhiw, E.M., and J. H. Grove. 2001. Phytoremediation of post-harvest soil nitrate: Spatial analysis of soil nitrate or grain N removal. Agronomy Abstracts 93: (on CD-ROM)
- Pena-Yewtukhiw, E.M., and J.H. Grove. 2001. Some considerations and examples regarding research on precision agriculture in the United States Of America (in Spanish). XV Latin American Soil Science Congress. 11-16 Nov. Varadero, Cuba. 18 pp.
- Pena-Yewtukhiw, E.M., and J.H. Grove. 2002. A stochastic analysis of profile soil moisture change within a meso-landscape. Agron. Abstr. 94: CDR0M s06-grove133220-O.
- Pena-Yewtukhiw, E.M., J.H. Grove and J.A. Thompson. 2000. Soil and landscape variability effects on no-till corn population and yield: A precision agriculture analysis. Agron. Abstr. 92:324.
- Pena-Yewtukhiw, E.M., J.H. Grove and J.A. Thompson. 2001. Using site-specific management of starter fertilizer application. 3<sup>rd</sup> European Conference on Precision Agriculture, Montpellier, France. pp. 58.
- Pena-Yewtukhiw, E.M., J.H. Grove, and J.A. Thompson. 2002. Probability of response of no-till corn to in-row fertilization: Role of topography in a karst landscape. Proc. 6<sup>th</sup> Int. Conf. On Precision Agriculture. 14-17 July. Minneapolis, MN.
- Pena-Yewtukhiw, E.M., J.H. Grove, and J.A. Thompson. 2002. Topographic interaction with nutrient mitigation of crop stress: Eight site-years on early planted corn response to starter in Kentucky's pennyroyal landscape. Agron. Abstr. 94: CDR0M s04-grove112306-P.
- Pena-Yewtukhiw, E.M., J.H. Grove, and J.A. Thompson . 2001. A site-specific approach to improving the Kentucky Phosphorus Index. Agronomy Abstracts 93: (on CD-ROM)
- Pena-Yewtukhiw, E.M., J.H. Grove, J.A. Thompson, and C.E. Kiger. 2001. New technologies and analytical tools for fertilizer recommendations. Better Crops. 85(1): 18-22.
- Powers, L. A. 2003. Risk management tools in precision agriculture. Paper presented at Southern Agricultural Economics Association annual meeting. Mobile, Alabama. February 2003.
- Powers, L.A., S.G. Isaacs, C.R. Dillon and S.A. Shearer. Development of a decision-making advisory framework for users of precision agriculture: A production/nonproduction decision example. Paper presented at the Southern Agricultural Economics Association

- meeting. Orlando, Florida. February 2-6, 2002. Abstract in Journal of Agricultural and Applied Economics. 34,2 (2002):372.
- Powers, L.A. 2003. An economic assessment of precision agriculture and decision aids Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Priddy, T. 2003. Precision agriculture weather forecasting. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Ramalingam, N., T. S. Stombaugh, and J. Mirgeaux. 2000. DGPS-based automatic vehicle guidance. ASAE Paper No. 001068. Annual International Meeting, Midwest Express Center, Milwaukee, Wisconsin, July 9-12.
- Shearer, S.A. 2003. Collecting quality yield data. InfoAg 2003. July 31-August 1. Indianapolis, IN.
- Shearer, S.A. 2003. Research, extension, and education efforts at the Univ. of Kentucky. InfoAg 2003. July 31-August 1. Indianapolis, IN.
- Shearer, S.A., R.L. Hoskinson, R.K. Fink, T.G. Mueller, A. Thomasson, J.P. Fulton, and M. Ellis. 2000. Use of the Decision Support System for Agriculture (DSS4Ag) for corn fertilization in Kentucky. In. P.C. Robert et al. (ed.) Proc. 5th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.
- Shearer, S.A., S.G. Higgins, S.G. McNeill, G.A. Watkins, R.I. Barnhisel, J.C. Doyle, J.H. Leach, and J.P. Fulton. 1997. Data filtering and correction techniques for generating yield maps from multiple combine systems. Paper presented at the ASAE Annual International Meeting, Minneapolis Minnesota, August 10-14.
- Shearer, S.A., T.F. Burks, J.A. Thomasson, T.G. Mueller, J.P. Fulton, S.F. Higgins, and S. Samson. 1999. Yield prediction using a neural network classifier trained using soil landscape features and soil fertility data. ASAE Paper No. 993042. Annual International Meeting, Sheraton Centre, Toronto, Canada, July 18-21.
- Shearer, S. A., J. P. Fulton, T. S. Stombaugh, and D.W. Hancock. 2003. Extraction of machine performance data from GPS and yield monitor data. ASAE Paper No. 031085, St. Joseph, MI:ASAE.
- Shearer, S. A., M. D. Montross, T. S. Stombaugh, R. Prewitt, J. P. Fulton, S. Sokhansanj. Use of spatial technologies for tracking the efficiency of biomass harvesting. 2003. ASAE Paper No. 036087, St. Joseph, MI:ASAE.
- Shearer, S.A., T.G. Mueller, C.R. Dillon, J.P. Fulton, N. Hartsock and J. Stull. 2000. A GIS-based simulation model for estimating the potential benefits of variable-rate fertilizer application. Paper presented at the ASAE Annual International Meeting, Milwaukee, July 9-12.
- Shearer, S.A., T.G. Mueller, J.P. Fulton, C.R. Dillon, N.J. Hartsock. Assessing variable rate fertilizer application: An interdisciplinary approach. 2000. Agronomy Meetings Abstracts.

- Shearer, S.A., T.S. Stombaugh, J.P. Fulton, and T.G. Mueller. 2002. Considerations for development of variable-rate controller test standard. ASAE Paper No. 02-1191 Paper presented at the ASAE Annual International Meeting, Hyatt Regency Chicago, Chicago, Illinois, July 28-31, 2002.
- Shearer, S.A.. 2003. Assessment of grain yield monitoring and mapping accuracy precision agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Shearer, S.A.. 2003. Precision agriculture research in Kentucky. precision agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Simpson, A., T. S. Stombaugh, L. G. Wells, and J. Walker. A low-cost unmanned aerial vehicle for remote sensing. ASAE Paper No. 0210839, St. Joseph, MI:ASAE. 2002.
- Simpson, A., T.S. Stombaugh, L.G. Wells, J.D. Jacob. 2003. Imaging techniques and applications for UAVs in Agriculture. ASAE Paper No. 031105, St. Joseph, MI:ASAE.
- Stangeland, D.L., M.D. Montross, T.S. Stombaugh, S.A. Shearer. 2003. Use of near-infrared reflectance for soil pH and buffer pH measurement. ASAE Paper No. 031045, St. Joseph, MI:ASAE.
- Stombaugh, T. S. and S. A. Shearer. 2001. DGPS-based guidance of high-speed application equipment. ASAE Paper No. 01-1190. Annual International Meeting, Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Stombaugh, T. S., A. Simpson, J. D. Jacobs, T. G. Mueller. 2003. A low cost platform for obtaining remote sensed imagery. In Proc. of the Fourth European Conference on Precision Agriculture, pp. 665 - 670. Berlin, Germany, 16-19 June.
- Stombaugh, T. S. and S. A. Shearer. 2002. Automatic pilot. Resource, 9(2):7-8.
- Stombaugh, T.S. 2003. Low cost GPS-based sensors. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Stombaugh, T.S., B.K. Kooststra, S.A. Shearer. 2003. Using low cost GPS Receivers for boundary mapping. ASAE Paper No. 031010, St. Joseph, MI:ASAE.
- Stombaugh, T.S., S.A. Shearer, and J.P. Fulton. 2002. Elements of a dynamic GPS test standard. ASAE Paper No. 02-1150. Paper presented at the ASAE Annual International Meeting, Hyatt Regency Chicago, Chicago, Illinois, July 28-31, 2002.
- Stombaugh, T.S., S.A. Shearer, and J.P. Fulton. 2002. Standards for comparison of GPS receiver performance. Paper presented at the 6th International Conference on Precision Agriculture. ASA Misc. Publ., ASA, CSSA, and SSSA, Madison, WI.
- Stull, J, C. Dillon, S. Isaacs, and S.A. Shearer. 2000. Using GPS data to optimally allocate land in production to CRP buffer strips. Paper presented at the Southern Agricultural Economics Association meeting. Lexington, KY. Jan. 29 - Feb. 2, 2000. Abstract in Journal of Agricultural and Applied Economics. 32,2 (2000): 405.

- Stull, J., C. Dillon, S. Isaacs, and S.A. Shearer. 2001. Use of geographically referenced grain yield data for location and enrollment of vegetative buffer strips in the conservation reserve program. ASAE Paper No. 01-1028. Paper presented at the ASAE Annual International Meeting, Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Thomas, G.W., M.V. Fernandez-Canigia, T.G. Mueller, and M.S. Coyne. 1999. Microbial diversity as affected by landscape position in two Kentucky physiographic regions. Agronomy Meetings Abstracts.
- Thomasson, J.A., S.A. Shearer, R.L. Hoskinson, J.R. Wooten, R.K. Fink, J.P. Fulton, S.F. Higgins, T.G. Mueller. 2001. Decision Support System for Agriculture (DSS4Ag) applied to fertilization of corn and cotton. ASAE Paper No. 01-1018. St. Joseph, Mich.: ASAE.
- Thompson, J.A., E.M. Pena-Yewtukhiw, and J.H. Grove. 2002. Soil-landscape modeling across a physiographic region: Topographic patterns and scales of soil variability. Agron. Abstr. 94: CDROM s05-thompson110348-O.
- Thompson, J.A., J.H. Grove, E.M. Pena-Yewtukhiw, and C.E. Kiger. 2002. Soil-landscape modeling for defining landform management segments transferable across a physiographic region. Proc. 6<sup>th</sup> Int. Conf. On Precision Agriculture. 14-17 July. Minneapolis, MN.
- Thompson, J.A., J.H. Grove, E.M. Pena-Yewtukhiw, and C.E. Kiger. 2001. Soil-landscape modeling for defining management zones transferable across a physiographic region. Agronomy Abstracts 93: (on CD-ROM)
- Wells, K.L. and J.E. Dollarhide. 1998. Precision agriculture: A field study of soil test variability and its effect on accuracy of fertilizer recommendations. Soil Science News & Views. VOL. 19, NO 5. Univ. of Kentucky, College of Agriculture, Agronomy Department.
- Wells, L.G., T.S. Stombaugh, and S.A. Shearer. 2001. Application and assessment of precision deep tillage. ASAE Paper No. 01-1032. Paper presented at the ASAE Annual International Meeting, Sacramento Convention Center, Sacramento, California, July 29 through August 1, 2001.
- Wells, L.G. 2003. Potential of precision tillage to improve cropland productivity. Precision Agriculture in Kentucky: 1st Annual Conference. February 13, 2003. Louisville, KY.
- Wells, L.G., S.A. Shearer and L.W. Murdock. 2000. Assessment of remote sensing for implementation of precision tillage. ASAE paper no. 00-1097. Paper presented at the ASAE Annual International Meeting, Midwest Express Center, Milwaukee, Wisconsin, July 9-12. St. Joseph, MI.
- Wells, L.G., T.S. Stombaugh and S.A. Shearer. 2001. Application and assessment of precision deep tillage. . ASAE paper no. 011032, St. Joseph, MI.
- Wells, L.G., S.A. Shearer, J.P. Fulton and L.W. Murdock. 2000. Assessment of remote sensing for implementation of precision tillage. ASAE Paper No. 00-1084. Annual International Meeting, Midwest Express Center, Milwaukee, Wisconsin, July 9-12.

- Wells, L.G., T.S. Stombaugh and S.A. Shearer. 2003. Crop yield response to precision deep tillage. Paper presented at the 2003 International Meeting of ASAE, Las Vegas, Nevada, July 27-31, 2003.
- Wilkerson, J. B., W. E. Hart, F. H. Moody, T. S. Stombaugh, T. F. Morrow. 2003. Evaluating operator feedback accuracy of row-guidance systems with GPS. ASAE Paper No. 031012, St. Joseph, MI:ASAE.
- Witt, W.W. 2000. Precision agriculture and sustainable agriculture: Are they compatible? Proc. Southern Weed Science Society.

### **III. Degrees Conferred and Topics Studied**

- Brommer, Chad Ph.D. 2002.
- Hartsock, Than. Agronomy, M.S., 2002.
- Powers, Laura. Agricultural Economics, M.S.. 2002.
- Richard, Ashley. Agronomy, M.S. 2003.
- Stull, Jeremy. Agricultural Economics, M.S.. 2000.
- Sobolik, Christopher. Biosystems and Agricultural Engineering, M.S. 2003.
- Subramaniam, Vijayaratnam. Agricultural Economics, M.S.. 2001.

### **IV. Current Graduate Students**

- Cole, John. Biosystems and Agricultural Engineering, M.S.
- Darr, Matt. Biosystems and Agricultural Engineering, M.S.
- Fulton, John. Biosystems and Agricultural Engineering, Ph.D.
- Foley, Megan. Agronomy, M.S.
- Gandonou, Jean-Marc. Agricultural Economics, Ph.D.
- Hancock, Dennis. Agronomy, Ph.D.
- Higgins, Steve. Agronomy, Ph.D.

Hudson, Jeremy. Biosystems and Agricultural Engineering, M.S.

Logsdon, Tommy. Agricultural Economics, M.S.

Mijatovic, Blazan. Agronomy, M.S.

Moberly, Amy. Agronomy, M.S.

Pierce, Chris. Agricultural Economics, M.S.

Sears, Brandon. Agronomy, M.S.

Simpson, Andrew. Biosystems and Agricultural Engineering, M.S.

Stangeland, Dan. Biosystems and Agricultural Engineering, M.S.

Ward, Jason. Biosystems and Agricultural Engineering, M.S.

## **V. Refereed Publications**

### **a. In Print**

Atherton, B.C., M.T. Morgan, S.A. Shearer, T.S. Stombaugh, A.D. Ward. 1999. Site-specific farming: A perspective on information needs, benefits, and limitations. *Journal of Soil and Water Conservation* Soil and Water Conservation Society, Ankeny, Iowa. 54(2):455-461.

Burks, T.F., S.A. Shearer, and F.A. Payne. 2000. Classification of weed species color texture features and discriminant analysis. *Transactions of ASAE*. St. Joseph, Michigan. 43(2): 441-448.

Burks, T.F., S.A. Shearer, J.D. Green, and J.R. Heath. 2002. Influence of weed maturity levels on species classification using machine vision. *Journal of Weed Science*. Vol. 50(6), pp. 802-811.

Burks, T.F., S.A. Shearer, R.S. Gates and K.D. Donohue. 2000. Backpropagation neural network design and evaluation for classifying weed species using color image texture features. *Transactions of ASAE*. St. Joseph, Michigan. 43(4):1029-1037.

Dillon, C.R., T. Mueller and S.A. Shearer. An economic optimization model for management zone configuration. In *Proc. of the Fourth European Conference on Precision Agriculture*, (J. Stafford and A. Werner, ed.) pp. 165-169. Berlin, Germany, 16-19 June.

Dillon, C.R., S.A. Shearer, J. Fulton and M. Kanakasabai. Optimal path nutrient application using variable rate technology. In *Proc. of the Fourth European Conference on Precision Agriculture*, (J. Stafford and A. Werner, ed.) pp. 171-176. Berlin, Germany, 16-19 June.

Fulton, J.P., S.A. Shearer, G. Chabra and S.F. Higgins. 2001. Field evaluation of a spinner disc variable-rate fertilizer applicator. *Transactions of the ASAE*. Vol. 44(5): 1071-1081.

- Hartsock, N.J., T.G. Mueller, A.D. Karathanasis, P.L. Cornelius. 2001. The potential for enhancing soil surveys with digital terrain models and electrical conductivity in Kentucky. *In. S. Blackmore and G. Grenier (ed.) Proceedings for the 2<sup>nd</sup> European Conference on Precision Agriculture.* p. 389 – 393.
- Mueller, T.G., N.J. Hartsock, T.S. Stombaugh, S.A. Shearer, P.L. Cornelius, and R.I. Barnhisel. 2003. Soil electrical conductivity map variability in limestone soils overlain by loess. *Agron. J.* 95:496-507.
- Mueller, T.G., and F.J. Pierce. 2003 Enhancing spatial estimates of soil carbon with terrain attributes. *Soil Sci. Soc. Am. J.* 2003 67: 258-267.
- Mueller, T.G., F.J. Pierce, O. Schabenberger, and D.D. Warncke. 2001. Map quality for site-specific management. *Soil Sci. Soc. Am. J.* 65: 1547-1558.
- Stombaugh, T. S. and S. A. Shearer. 2001. DGPS-based automatic guidance of agricultural vehicles. *In Proc. of the Third European Conference on Precision Agriculture, (S. Blackmore and G. Grenier, ed.)* 1:121-126. Montpellier, France, 18-20 June.
- Stombaugh, T.S., and S.A. Shearer. 2000. Equipment technologies for precision agriculture. *Journal of Soil and Water Conservation.* 55(1): 6-11.
- Stombaugh, T. S., A. Simpson, J. D. Jacobs, T. G. Mueller. 2003. A low cost platform for obtaining remote sensed imagery. *In Proc. of the Fourth European Conference on Precision Agriculture, (J. Stafford and A. Werner, ed.)* pp. 665 - 670. Berlin, Germany, 16-19 June.
- Workman, S.R., S.F. Higgins, and S.A. Shearer. 2002. Monitoring subsurface drainage flow at remote locations. *Applied Engineering in Agriculture.* Vol. 17(6): 783–786.

#### **b. In Press**

- Fulton, J.P., S.A. Shearer, T.S. Stombaugh, M.E. Anderson, T.F. Burks and S.F. Higgins. 2003. Simulation of Fixed and Variable-Rate Application of Granular Materials. Accepted for publication in *Trans. of ASAE.*
- Stull, J.D., C.R. Dillon, S.G. Isaacs and S.A. Shearer. 2003. Using precision agriculture technology for economically optimal strategic decisions: The case of CRP filter strip enrollment. *Journal of Sustainable Agriculture.*
- Zhang, J., J.C. Yingling, and S.A. Shearer. Analysis of precision agriculture decision parameters using geostatistics and conditional simulation. Part I. Structural analysis of soil fertility in the geostatistics framework. *Transactions of the ASAE.* St. Joseph, Michigan.

#### **c. In Review**

- Burks, T.F., S.A. Shearer, J.P. Fulton, and C.J. Sobolik. Influence of dynamically varying inflow rates on clean grain elevator yield monitor accuracy. *Applied Engineering in Agriculture.* ASAE, St. Joseph, Michigan.

- Gandonou, J.M., C.R. Dillon, S.A. Shearer, and T.S. Stombaugh. Precision agriculture: A break-even analysis. *Applied Engineering in Agriculture*.
- Higgins, S.F., S.A. Shearer, M.S. Coyne, and J.P. Fulton. Relationship of total nitrogen and total phosphorus concentration to solids content in animal waste slurries. *Applied Engineering in Agriculture*.
- McNeill, S.G., M.D. Montross, S.A. Shearer. Spatial variation of protein and oil in yellow corn. *Applied Engineering in Agriculture*
- Mueller, T.G., N.J. Hartsock, A.D. Karathanasis, and P.L. Cornelius. Soil electrical conductivity and terrain attributes: relationships soil survey map phases. *Precision Agriculture Journal*.
- Mueller, T.G., K.K. Mathias, P.L. Cornelius, and R.I. Barnhisel. Site specific fertility management: Predicting map quality. Submitted to *Soil Science Society of America Journal*.
- Mueller, T.G., K.K. Mathias, P.L. Cornelius, R.I. Barnhisel, and S.A. Shearer. Site-specific fertility management: Predicting the performance of inverse distance weighted interpolation. Submitted to *Soil Science Society of America Journal*.
- Powers, L.A., C.R. Dillon, S.G. Isaacs, S.A. Shearer. Risk management tools in precision agriculture. Submitted to *Precision Agriculture Journal*.
- Powers, L.A., C.R. Dillon, S.G. Isaacs, S.A. Shearer. Development of a decision-making framework for users of precision agriculture: A production/nonproduction decision example. Submitted July 2003 to *The Southern Business and Economic Journal*.
- Stull, J.D., C.R. Dillon, S.G. Isaacs, S.A. Shearer and S. Riggins. Using GPS data for risk reducing CRP filter strip enrollment under alternative land tenure arrangements. Being revised for second submission to *Journal of Precision Agriculture*.
- Wells, L.G., T.S. Stombaugh and S.A. Shearer. 2003. Crop yield response to precision deep tillage. Submitted to *Applied Engineering in Agriculture*.
- Zhang, J., J.C. Yingling, S.A. Shearer, and R. Ganguli. Analysis of precision agriculture decision parameters using geostatistics and conditional simulation. Part II. Optimization of soil sampling density and management of block size for precision agriculture. *Transactions of the ASAE*. St. Joseph, Michigan.

## **VI. Other**

- Brommer, C. L. and W. W. Witt. Environmental and Ecological Factors of Perennial Weed Establishment in Kentucky No-Tillage Fields. 2002 Agronomy Research Report.
- Cetin, H., T.G Mueller, and G. A. Carter (2002). Comparison of IKONOS and RDACS Imagery for Detection of Nitrogen Deficiency in Corn. The 2002 High Spatial Resolution Commercial Imagery Workshop, the USGS Headquarters in Reston, Virginia 25 - 27 March 2002.

- Coomer, Kyle. Farm Size and Break-even MPP Required for Precision Agriculture Profitability. Senior Seminar Paper of the Department of Agricultural Economics. University of Kentucky. Fall 2001.
- Coyne, M.S., T.G. Mueller, and J. Cobb. 2000. Applying GIS technology to preserve and document a historic cemetery in Lexington, KY. UK GIS Day 2000
- Cromer, Joshua. How Many Acres of Farmland Should a Farmer Have Before He/She Can Justify Buying and Owning Precision Agriculture Equipment. Senior Seminar Paper of the Department of Agricultural Economics. University of Kentucky. Fall 1999.
- Gleason, Ryan. Encouraging Investment in Precision Agriculture for Environmental Benefit: A Cost Share Analysis Policy. Senior Seminar Paper of the Department of Agricultural Economics. University of Kentucky. Fall 2001.
- Gregory, Curtis and Jeremy Satterwhite. The Cost Analysis of Full Season Soybean and Corn in Precision Agriculture and Traditional Agriculture for Kentucky 2000. Senior Seminar Paper of the Department of Agricultural Economics. University of Kentucky. Fall 2000.
- Grove, J.H. In-row starter fertilization for early planted corn. Kentuckiana Crop Production Seminar. 9-10 Dec. 2002, Evansville, IN.
- Hancock, D.W. 2003. PA at UK: Research at the Cutting Edge. Agronomy Days. 25 Feb. 2003. Hardin Co. Extension Office.
- Harris, Warren. Precision Agriculture as a Tool for On-Farm Research and An Economic Analysis of the Effects Zinc has on Corn Production. Senior Seminar Paper of the Department of Agricultural Economics. University of Kentucky. Fall 2002.
- Hartsock, N.J., T.G. Mueller, S.A. Shearer, G.W. Thomas, K.L. Wells, and R.I. Barnhisel. 2000. Department of Agronomy Research Report. Univ. of Kentucky. Lexington, KY.
- Isukapalli, K.V. and B.G. Sears. 2002. Boundary Line Analyst for Precision Agriculture. ASPRS, Murray State.
- Mueller, T.G. and T.S. Stombaugh. 2003. Using EC for management decisions. Conservation Tillage and Technology Conference, Ada, OH. March 4
- Mueller, T.G. 2002. Soil electrical conductivity, terrain attributes, and hyperspectral imagery: variability between and within soil map phases. Lecture at the American Society for Photogrammetry & Remote Sensing Mid-South Regional Fall 2002 Meeting on Imaging and Geospatial Information in the 21st Century on October 24-25, Murray State University, Murray, KY 42071
- Mueller, T.G. 1999. Issues of Scale and secondary map information: A precision agriculture example from Michigan. For the mini-symposium: Issues of scale and spatial variability as related to solute transport. Presented to S-257 (Soil Physics Regional Project). Lexington, KY 26 April 1999.

- Mueller, T.G., R.I. Barnhisel, and S.A. Shearer. 2000. Precision Agriculture Opportunities for Kentucky: Agronomic Research at UK. Department of Agronomy Research Report. Univ. of Kentucky. Lexington, KY.
- Mueller, T.G., S.A. Shearer, K.L. Wells, D.S. Adams, and A. Kumar. 2000. Assessing Soil fertility map quality in Kentucky. Department of Agronomy Research Report. Univ. of Kentucky. Lexington, KY.
- Mueller, T.G. and F.J. Pierce. 2000. Enhancing spatial estimates of soil properties with terrain attributes. UK GIS Day 2000.
- Mueller, T.G., K.L. Wells, S.A. Shearer, and D.S. Adams. 1999. Data Quality for Geographic Information Systems: A Precision Agriculture Example. UK GIS Day 1999.
- Murdock, L.W., 2001. Soil Properties. Kentucky CCA Seminar. Princeton, KY. Nov. 27, 2001.
- Murdock, L.W., 2002. UK Agriculture Agent Update Training. Princeton, KY. Nov. 19, 2002
- Murdock, L.W., 2002. UK All Commodity Field Day. Princeton, KY. July 18, 2002
- Murdock, L.W., and P.L. Howe. 2000. Correlation of Corn Yield Variability as Affected by Soil Characteristics. University of Kentucky 2000 Agronomy Research Report. PR-432.
- Murdock, L.W., and P.L. Howe. 2002. Applying Variable Rate Nitrogen Using Yield Maps. University of Kentucky 2002 Agronomy Research Report. PR-464.
- Robey, Adam. Analyzing GPS Data to Maximize Profits Using CRP. Senior Seminar Paper of the Department of Agricultural Economics. University of Kentucky. Fall 2001.
- Shearer, S.A., R.I. Barnhisel, J.L. Taraba, and S.F. Higgins. 1999. Swine and Dairy Waste Management Using Precision Agriculture. A Progress Report for Year I. Senate Bill 271 "An Act Relating to Agricultural Chemical Usage". February, 1999.
- Stombaugh, T.S., D.W. Hancock, and B. Koostra. 2002. Basics of GPS. October 16, and 23, 2002. Extension Agent In-Service training. Lexington and Princeton, KY.
- Stombaugh, T.S., D.W. Hancock, and B. Koostra. 2002. Using GPS for Sampling and Scouting October 24, 2002. Extension Agent In-Service training. Princeton, KY.

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