Sus Ag 530
Ecologically Based Pest Management Strategies
SYLLABUS

Instructors

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Course Description

SUSAG 530 is a three-credit course designed to introduce graduate students to the principles and practices of ecologically based pest management. The course will emphasize the management of weeds, insects, mites, fungi, bacteria, viruses, and nematodes interfering with crop production, although some attention will be directed toward pests interfering with livestock production. Students will gain familiarity with basic concepts of population and community ecology relevant to pest management. They will also gain experience with systemic thinking using a user-friendly modeling program called STELLA. Case studies will address the ecology and management of weeds, arthropods, and pathogens in a range of agricultural systems. Students will design and examine the feasibility of systems for managing multiple pests. The course is co-listed as Agron 530, Ent 530, and Pl P 530.

Background

In its 1996 publication titled *Ecologically Based Pest Management: New Solutions for a New Century*, the National Research Council (NRC) stated that the goals of ecologically based pest management (EBPM) are profitability, safety, and durability. Achieving these goals requires improved understanding of how ecosystem processes, such as predation, parasitism, herbivory, competition, and mutualism, can be manipulated effectively. The NRC report noted that the theoretical base of EBPM is similar to that of integrated pest management (IPM), but that the actual practice of IPM often has differed significantly from the intended approach. Specifically, the NRC report noted that IPM practice has focused more on insect pests than on weeds, pathogens, and vertebrate pests, and has, in many cases, emphasized improved use of pesticides rather than better management of fundamental ecosystem processes. For these and

other reasons, the NRC recommended the development of ecologically based pest management systems that take a broader view of all pests within an agroecosystem context.

In the spirit of the NRC report, Sus Ag 530 will emphasize ecological principles and their applications in pest management strategies. The course is designed to provide graduate students with a broad overview of pest management in the context of whole farming systems. Thus, it differs from existing courses in weed science, entomology, and plant pathology that focus more on specific control tactics. Sus Ag 530 is intended to complement ISU graduate courses and research work in specific pest management disciplines and the interdepartmental undergraduate program in integrated pest management.

Graded Activities

Grades will be based on several homework assignments (25% of total points), a project report (25% of the total), and two take-home exams (50% of the total). Project reports will be developed in sections that will be handed in for review by class participants. Final drafts will be evaluated by the course instructors.

Text Materials and Software

You are required to buy two things for this course:

(1) The student version of a modeling program called STELLA. This software is available at the campus bookstore. After signing a licensing agreement and paying a fee, you will have access to a CD-ROM with which you can install the program.

(2) Cavigelli, M.A., S.R. Deming, L.K. Probyn, and D.R. Mutch (eds.). 2000. *Michigan Field Crop Pest Ecology and Management*. Extension Bulletin E-2704. Michigan State University, East Lansing, MI. This book is available at the campus bookstore. It provides an excellent overview of the subject matter of the course.

Additional reading assignments will be drawn from a diverse set of sources and will include journal articles and books chapters. These can be viewed as PDFs on the Parks Library Reserve web site (http://www.lib.iastate.edu/class/ers/course.html). There is no cost for the electronic text materials.

Reading materials will be used as the basis of in-class discussions in which all students are expected to participate. The STELLA program will be introduced in class, but the major part of learning how to use this program will be the outside-class responsibility of each student.

Projects

Students will work in groups to develop a pest management program for a cropping system that is of interest to the group and acceptable to the instructors. The cropping system can be one that already exists or one that could exist in the future if certain (specified) constraints were removed. Each group will identify key pests in its study system, gather research-based information concerning the ecology of these pests, develop an integrated management strategy, and examine the strategy's ecological and economic feasibility. The project will include a modeling component. If a student prefers to work alone rather than in a group, s/he can do so. Grades for all students will be based on overall project quality and individual contributions.

Each project report will contain four sections:

Section 1: Introduction and definition of the problem, statement of objectives. 3-4 pages. 20% of project grade. This section should provide a description of the farming system, including temporal and spatial patterns affecting pest dynamics. Key pests and their impacts on crops should be identified. Critical ecological information should be given.

Section 2: Pest ecosystem model. 5-10 pages. 30% of project grade. This section should identify components of the system and explain their relationships with one another. Controllable and monitored factors affecting each component should be described. Focal points for the development of pest management strategies and implementation of pest management tactics should be identified.

Section 3: Design for implementation. 5-10 pages. 30% of project grade. Using their pest ecosystem models as guides, students should design management strategies that are effective, safe, durable, and profitable. The roles of modeling and environmental and biological monitoring should be discussed.

Section 4: Expected impacts and feasibility analysis. 3-4 pages. 20% of project grade. Students should consider the short- and long-term impacts of their pest management programs on crop production and quality, pest populations, and financial returns.

Examinations

There will be two take-home examinations, which will cover reading materials, lectures, and in-class discussions. A short essay format will be used.

Schedule

Week 1

27 Aug: Overview of the course and course procedures, examples of ecologically based pest management systems (Liebman)

Reading:
Lewis, W.J., J.C. van Lenteren, S.C. Phatak, and J.H Tumlinson III. 1997. A total system approach to sustainable pest management. Proceedings of the National Academy of Sciences, USA 94: 12243-12248.

29 Aug: Principles of field crop pest ecology (Menalled)

Reading:
Michigan Field Crop Pest Ecology and Management, pp. 1-34.
Anonymous. 2000. *A Whole-Farm Approach to Managing Pests.* Sustainable Agriculture Network, USDA Sustainable Agriculture Research and Education Program, Beltsville, MD. Available on-line at: http://www.sare.org/farmpest/farmpest.pdf.

Week 2

3 Sept: Introduction to STELLA (Liebman).

Reading:
Work through the "Getting Started Guide," including the Tutorial section, and look at the contents of the folder named "Building Blocks" in the STELLA software package.

5 Sept: Sampling and monitoring pest and natural enemy populations (Obrycki).

Reading:
Flint, M.L. and P. Gouveia. 2001. *IPM in Practice: Principles and Methods of Integrated Pest Management*, pp. 149-195 (Monitoring and decision-making guidelines). Publication 3418, University of California, Division of Agriculture and Natural Resources, Oakland, CA.

Week 3

10 Sept: Predator/prey, parasitoid/host interactions (Menalled).

Reading:
Michigan Field Crop Pest Ecology and Management, pp. 35-50.

Mackenzie, A., A.S. Ball, and S.R. Virdee. 1998. *Instant Notes in Ecology*, pp. 71-83 (population ecology), 107-110 (predation). Springer-Verlag, New York, NY.

12 Sept: Insect biocontrol model–first homework (Obrycki).

Week 4

17 Sept: Impact of landscape structure on insect pest and natural enemy dynamics (Menalled).

Reading:

Landis, D., S. Wratten, and G. Gurr. 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology* 45: 175-201.

Menalled, F, P. Marino, S. Gage, and D. Landis. 1999. Does agricultural landscape structure affect parasitism and parasitoid diversity? *Ecological Applications* 9: 634-641.

Ostman, O., B. Ekbom, J. Bengtsson, and A. Weibull. 2001. Landscape complexity and farming practice influence the condition of polyphagous carabid beetle. *Ecological Applications* 11: 480-488.

19 Sept: Introduce projects. Hand in and review first homework assignment: key findings, ways to improve models (Obrycki)

Week 5

24 Sept: Monitoring environmental conditions and disease incidence and severity (Gleason).

Reading:

Campbell, C. L. and L. V. Madden. 1990. *Introduction to Plant Disease Epidemiology*, pp. 129–138 (modeling and data analysis); 161-175 and 192-194 (disease progression curves). John Wiley and Sons, New York, NY.

26 Sept: Host/pathogen interactions above- and belowground (Gleason).

Reading:

Michigan Field Crop Pest Ecology and Management, pp. 69-94.

Week 6

1 Oct: Model of pathogen population dynamics in response to weather conditions and management tactics–second homework (Gleason).

3 Oct: Arthropod pests and livestock production (Ken Holscher).

Week 7

8 Oct: Biological control of plant diseases (Gleason).

10 Oct: Hand in and review second homework assignment: key findings, ways to improve models (Gleason).

Week 8

15 Oct: Basic aspects of weed ecology. Relationships between crop yield loss, weed density, weed emergence date, and planting date (Liebman).

Reading:

Michigan Field Crop Pest Ecology and Management, pp. 51-68.

17 Oct: Building a simple bioeconomic model of weed management in corn–third homework (Liebman).

Week 9

22 Oct: Weed life histories and vulnerabilities to management tactics at different life history stages (Liebman).

Reading:

Liebman, M. and E.R. Gallandt. 1997. Many little hammers: Ecological approaches for managing weed-crop interactions. Pp. 291-343 in L.E. Jackson (ed.), *Ecology in Agriculture*. Academic Press, San Diego, CA.

Mohler, C.L. 2001. Weed life histories: Identifying vulnerabilities. Pp. 40-98 in: M. Liebman, C.L. Mohler, and C.P. Staver, *Ecological Management of Agricultural Weeds*. Cambridge University Press, Cambridge, UK.

24 Oct: Hand in and review third homework assignment: key findings, ways to improve models (Liebman). First exam handed out.

Week 10

29 Oct: Case study 1–Tomato production in California

Reading:

Clark, M.S., H. Ferris, K. Klonsky, W.T. Lanini, A.H.C. van Bruggen, and F.G. Zalom. 1998. Agronomic, economic, and environmental comparison of pest management in conventional and alternative tomato and corn systems in northern California. *Agriculture, Ecosystems, and Environment* 68: 51-71.

Clark, M.S., W.R. Horwath, C. Shennan, K.M. Scow, W.T. Lanini, and H. Ferris. 1999. Nitrogen, weeds and water as yield-limiting factors in conventional, low-input, and organic tomatoes. *Agriculture, Ecosystems, and Environment* 73: 257-270.

Drinkwater, L.E., D.K. Letourneau, F. Workneh, A.H.C. van Bruggen, and C. Shennan. 1995. Fundamental differences between conventional and organic tomato agroecosystems in California. *Ecological Applications* 5: 1098-1112.

31 Oct: First exam due. Section 1 of project due. Student group work: feedback on Section 1 of project.

Week 11

5 Nov: Case study 2–Rice production in Asia

Reading:

Andow, D.A. and K. Hidaka. 1989. Experimental natural history of sustainable agriculture: Syndromes of production. *Agriculture, Ecosystems, and Environment* 27: 447-462.

Matteson, P.C. 2000. Insect pest management in tropical Asian irrigated rice. *Annual Review of Entomology* 45: 549-574.

Settle, W.H., H. Ariawan, E.T. Astuti, W. Cahyana, A.L. Hakim, D. Hindayana, A.S. Lestari, and Pajarningsih [sic]. 1996. Managing tropical rice pests through conservation of generalist natural enemies and alternative prey. *Ecology* 77: 1975-1988.

Zhu, Y., H. Chen, J. Fan, Y. Wang, Y. Li, J. Chen, J. Fan, S. Yang, L. Hu, H. Leung, T.W. Mew, P.S. Teng, Z. Wang, and C.C. Mundt. 2000. Genetic diversity and disease control in rice. *Nature* 406: 718-722.

7 Nov: Section 2 of project due. Student group work: feedback on Section 2 of project.

Week 12

12 Nov: Case study 3–IPM in the midwestern USA

Reading:

Michigan Field Crop Pest Ecology and Management, pp. 95-100.

Gray, M.E. 2001. Prescriptive use of transgenic hybrids for corn rootworms: an ominous cloud on the horizon? Department of Crop Sciences, University of Illinois, Urbana-Champaign, IL. Available on-line at: http://www.cropsci.uiuc.edu/faculty/mgray/icpt00.htm

U.S. General Accounting Office. 2001. *Agricultural Pesticides: Management Improvements Needed to Further Promote Integrated Pest Management*. Report GAO-01-815. USGAO, Washington, DC. Available on-line at: http://www.gao.gov/new.items/d01815.pdf

14 Nov: Section 3 of project due. Student group work: feedback on Section 3 of project.

Week 13

19 Nov: Case study 4–Apple production in the northeastern USA

Reading:

Merwin, I.A., S.K. Brown, D.A. Rosenberger, D.R. Cooley, and L.P. Berkett. 1994. Scab-resistant apples for the northeastern United States: New prospects and old problems. *Plant Disease* 78: 4-10.

Prokopy, R.J., J.L. Mason, M. Christie, and S.E. Wright. 1996. Arthropod pest and natural enemy abundance under second-level versus first-level integrated pest management practices in apple orchards: A 4-year study. *Agriculture, Ecosystems, and Environment* 57: 35-47.

21 Nov: Section 4 of project due. Student group work: feedback on Section 4 of project.

Week 14

26, 28 Nov: Thanksgiving break.

Week 15

3 Dec: Discussion.

5 Dec: Student group work: review Sections 1-4 of project.

Week 16

10 Dec: Presentations of student projects.

12 Dec: Second exam handed out. Presentations of student projects.

Additional reference materials (not required, but potentially useful):

Altieri, M.A. 1994. *Biodiversity and Pest Management in Agroecosystems*. Haworth Press, Binghamton, NY.

Andow, D.A., D.W. Ragsdale, and R.F. Nyvall (eds.). 1997. *Ecological Interactions and Biological Control*. Westview Press, Boulder, CO.

Barbosa, P. (ed.). 1998. *Conservation Biological Control*. Academic Press, San Diego, CA.

Benbrook, C.M. 1996. *Pest Management at the Crossroads*. Consumers Union, Yonkers, NY.

Burdon, J.J. 1987. *Diseases and Plant Population Biology*. Cambridge University Press, Cambridge, UK.

Campbell, R. 1989. *Biological Control of Microbial Plant Pathogens*. Cambridge University Press, Cambridge, UK.

Cook, R.J. and K.F. Baker. 1983. *The Nature and Practice of Biological Control of Plant Pathogens*. American Phytopathological Society, St. Paul, MN.

Cousens, R. and M. Mortimer. 1995. *Dynamics of Weed Populations*. Cambridge University Press, Cambridge, UK.

Horn, D.J. 1988. *Ecological Approach to Pest Management*. Guilford Press, New York, NY.

Jackson, L.E. (ed.). 1997. *Ecology in Agriculture*. Academic Press, San Diego, CA.

Kogan, M. (ed.). 1986. *Ecological Theory and Integrated Pest Management*. John Wiley & Sons, New York, NY.

Liebman, M. C.L. Mohler, and C.P. Staver. 2001. *Ecological Management of Agricultural Weeds*. Cambridge University Press, Cambridge, UK.

Mayerfeld, D.B., G.R. Hallberg, G.A. Miller, W.K. Wintersteen, R.G. Hartzler, S.B. Brown, M.D. Duffy, and J.R. DeWitt. 1996. *Planning for the Future: Pest Management in Iowa*. Publication IFM 17. Iowa State University Extension, Ames, IA.

National Research Council. 1996. *Ecologically Based Pest Management: New Solutions for a New Century*. National Academy Press, Washington, DC.

Padgitt, M., D. Newton, R. Penn, and C. Sandretto. 2000. *Production Practices for Major Crops in U.S. Agriculture, 1990-97*. Statistical Bulletin 969. Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Schneider, R.W. (ed.). 1984. *Suppressive Soils and Plant Disease*. American Phytopathological Society, St. Paul, MN.

Thurston, H.D. 1992. *Sustainable Practices for Plant Disease Management in Traditional Farming Systems*. Westview Press, Boulder, CO.

Van Bruggen, A.H.C. 1995. Plant disease severity in high-input compared to reduced-input and organic farming systems. *Plant Disease* 79: 976-984.

Vorley, W. and D. Keeney (eds.). 1998. *Bugs in the System: Redesigning the Pesticide Industry for Sustainable Agriculture*. Earthscan Publications Ltd., London, UK.