Course Title	**Food Production System Sustainability**
Instructor	Michel A. Wattiaux
Semester	Spring (*2018*)
Meeting times	Tuesdays and Thursdays 4:00 – 5:15 pm
Office hours	After class or by appointment

Expected Learning Outcomes

The expected learning outcomes of this class falls in two themes, each associated with distinct class structure and organization.

Theme 1: (ten weeks) Reading and discussion of core research in food systems and sustainability

- Students will learn to integrate knowledge from crop science, livestock science, environmental science, and social science about distinct production systems, including urban and rural, local and global, and small to industrial scale.
- Students will learn about distinct food production systems and their distinct contribution to sustainable development. For example, students will discuss:
    - Renewable and non-renewable resource use (land, water, fossil energy, etc.);
    - Farm nutrient balance (Nitrogen, Phosphorus) and associated risk of air and water impairment;
    - Contribution to climate change (carbon footprint), potential mitigations strategies (carbon sequestration, carbon credit, etc.) as well as resilience and potential for adaptation to climate change due to expected changes in weather patterns.
- Students will learn how social structures profoundly affect not only people, but also biology, ecology, and our very climate (contribution to/mitigation of climate change). And the complement: how people's race / class / gender / occupation / nation status within the global social structure, as well as the nature of the global social structure itself, profoundly impacts their ability to cope with changing climate (adaptation to climate change).

Theme 2: (five weeks) Student Group Projects and Field Visits

- Students will develop the capacity to critically assess the sustainability of distinct food production and distribution systems, including:
    - contributing personal efforts as a member of a goal-oriented learning community;
    - identifying a researchable question;
    - searching for sources of information and evaluation methods and tools relevant to your project; and
    - developing analytic and problem-solving skills as you use the information and evaluation tools.

- Students will develop their ability to communicate information to multiple audiences through multiple media, including: co-authoring a peer-review style article (for grad students); and audio-visual presentation of findings.

Additional Learning Objectives for Graduate Students

- Students will develop skills working with mixed teams including undergraduate students.
- Students will hone their research and writing skills in drafting academically rigorous literature reviews.
- Students will learn to assess the broader impacts of research beyond the academic setting.

Anticipated Course Materials and Schedule

Pd	Wk	Date	Topic	Reading/Viewing
			MODULE I: INTRODUCTION / SETTING THE STAGE	
1	1	1/23	Introduction: Food and Population	Erisman et al. 2008
2	1	1/25	Sustainability: A wicked problem	Peterson
			MODULE 2: FOOD / ENVIRONMENT H /EALTH	
3	2	1/30	Greenhouse Gas Emission Estimates of U.S. Dietary Choices and Food Loss	Heller et al., 2015
4	2	2/1	Land, irrigation water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States	Eshel et al.
5	3	2/6	Role of livestock in human nutrition and health for poverty reduction in developing countries	Randolph et al., 2007
6	3	2/8	Global diets link environmental sustainability and human health	Tilman et al., 2014
			MODULE 3: SOCIO-ECONOMIC ASPECTS	
7	4	2/13	Production Treadmill	Bell, 2012
8	4	2/15	Revisiting the commons: Local Lesson, Global Challenges	Ostrom et al, 1999
9	5	2/20	Achieving social sustainability of animal agriculture (ecosystem service)	Niles, 2013
10	5	2/22	Food sustainability: problems, perspectives and solutions	Garnett, 2013
11	6	2/27	Social Perception of Dairy Farming (European Perspective)	Boogaard et al., 2011
			MODULE 4: METHODS	
12	6	3/1	Panorama of Methods to assess food sustainability	Aubin et al, 2013
13	7	3/6	Life cycle assessment (LCA)	Beauchemin and McGeough, 2013
			MODULE 5: SUSTAINABILITY OF DAIRY SYSTEMS / BIOLOGICAL ASPECTS	
14	7	3/8	A cradle to farm gate assessment of the American Dairy Industry	Thoma et al., 2013

15	8	3/13	Milk carbon footprint (conventional vs. pasture vs organic)	Wattiaux et al. 2017
16	8	3/15	Land use: Producing crops for human vs animal feed	Davis and D'Odorico 2015
			MODULE 6: STUDENT PROJECTS PART I	
17	9	3/20	Prelim. presentations and discusion Teams A-B-C-D	tba
18	9	3/22	Prelim. presentations and discusion Teams E-F-G-H	tba
--	10	--	Spring break (3/27 and 3/29)	
			MODULE 7: RESPONSE TO CHALLENGES OF LIVESTOCK SYSTEMS / GLOBAL PERSPECTIVES	
19	11	4/3	Responses to Environmental Issues	Steinfeld et al., 2010
20	11	4/5	Responses to Human Nutrition issues	Opio and Steinfeld, 2010
21	12	4/10	Responses to Social Issues	Dijkman and Steinfeld, 2010
			MODULE 8: COUNTRY SPECIFIC CASE STUDIES	
22	12	4/12	Recorded video of French & Canadian scientists	J. Peigne (France) & D. Pellerin (Canada)
23	13	4/17	Recorded video of Peruvian & Mexican scientists	Gomez (Peru) and C. Arriaga (Mexico)
			MODULE 9: STUDENT PROJECTS	
24	13	4/19	Final Presentations and Discussion Teams A-B	tba
27	14	4/24	Final Presentations and Discussion Teams C-D	tba
28	14	4/26	Final Presentations and Discussion Teams E-F	tba
29	15	5/1	Final Presentations and Discussion Teams G-H	tba

Course Reading (Bibliography)

Arriaga, C. 2015. Small-scale dairy production system and poverty alleviation in Mexico. https://www.youtube.com/watch?v=3mEFSOrg5hw

Aubin J., C. Donnars, M. Supkova, and B. Dorin. 2013. A critical panorama of methods used to assess food sustainability. Chapter 10 pp 198-246 IN: Food System Sustainability, Insights from duALIne. C. Esnouf, M. Russel and N. Bricas Eds; Cambridge University Press, Cambridge, UK.

Bauchemin, K. and E. J. McGeough. 2013. Life cycle assessment in ruminant production; pp 212-237 In: Sustainable Animal Agriculture; Ed. E. Kebreab. CABI International, Boston, MA.

Bell, M. 2012. Money and Machine. Ch 3, p 58-67 in: An invitation to Environmental Sociology. 4th Ed. Thousand Oaks, Calif. Pine Foarge Press.

Boogaard, B.K., S.J. Oosting, B.B. Bock and J.S.C. Wiskerke. 2011. The sociocultural sustainability of livestock farming: an inquiry into social perceptions of dairy farming.

Animal 5: 1458-1466.

Davis, K.F. and P. D'Odorico. 2015. Livestock intensification and the influence of dietary change: A calorie-based assessment of competition for crop production. Science of The Total Environment 538: 817-823. doi:http://dx.doi.org/10.1016/j.scitotenv.2015.08.126.

Dijkman, J. and H. Steinfeld. 2010. Responses to Social Issues; pp 363-372 In: Livestock in a Changing Landscape: Drivers, Consequences, and Responses; Vol. 1. H. Steinfeld, H. A. Mooney, F. Schneider, and L.E. Neville Eds. Island Press, Washington D.C.

Erisman, J.W., M.A. Sutton, J. Galloway, Z. Klimont and W. Winiwarter. 2008. How a century of ammonia synthesis changed the world. Nature Geosci 1: 636-639.

Eshel, G., A. Shepon, T. Makov and R. Milo. 2014. Land, irrigation water, greenhouse gas, and reactive nitrogen burdens of meat, eggs, and dairy production in the United States. Proceedings of the National Academy of Sciences. doi:10.1073/pnas.1402183111.

Garnett, T. 2013. Food Sustainability: Problems, perspectives and solutions. Proceedings of the Nutrition Society 72:29-39.

Gomez, C. Food Production Systems in Peru. 2015. https://www.youtube.com/watch?v=39L5N8d7jpE

Heller, M.C. and G.A. Keoleian. 2015. Greenhouse Gas Emission Estimates of U.S. Dietary Choices and Food Loss. Journal of Industrial Ecology 19: 391-401. doi:10.1111/jiec.12174.

Niles, M.T. 2013. Achieving social sustainability of animal agriculture: Challenges and opportunities to reconcile multiple sustainability goals; pp 193-211 In: Sustainable Animal Agriculture; Ed. E. Kebreab. CABI International, Boston, MA.

Opio, C and H. Steinfeld. 2010. Responses to Human Nutrition Issues; pp 323-344 In: Livestock in a Changing Landscape: Drivers, Consequences, and Responses; Vol. 1. H. Steinfeld, H. A. Mooney, F. Schneider, and L.E. Neville Eds. Island Press, Washington D.C.

Ostrum E., J. Burger, C. B. Field, R. B. Norgaard, and D. Policansky. 1999. Revisitng the Commons: Local Lessons, Global Challenges. Science:"284 (5412; April 9, 1999):278-282.

Peigne, J. Grain Production in France. 2015. https://www.youtube.com/watch?v=8gyeBwrpWds&spfreload=5

Pellerin, D. The Economic Sustainability of Farms. 2015. https://www.youtube.com/watch?v=wz3J0QCZCxw

Peterson. 2013. Sustainability: A wicked Problem; pp 1-10 In: Sustainable Animal Agriculture; Ed. E. Kebreab. CABI International, Boston, MA.

Randolph, T.F., E. Schelling, D. Grace, C.F. Nicholson, J.L. Leroy, D.C. Cole, et al. 2007. Invited Review: Role of livestock in human nutrition and health for poverty reduction in developing countries1,2,3. Journal of Animal Science 85: 2788-2800.

Steinfeld, H. P. Gerber, and C. Opio. 2010. Responses to Environmental Issues; pp 311-322 In: Livestock in a Changing Landscape: Drivers, Consequences, and Responses; Vol. 1. H. Steinfeld, H. A. Mooney, F. Schneider, and L.E. Neville Eds. Island Press, Washington D.C.

Tilman, D. and M. Clark. 2014. Global diets link environmental sustainability and human health. Nature 515: 518-522. doi:10.1038/nature13959.

Thoma, G., J. Popp, D. Shonnard, D. Nutter, M. Matlock, R. Ulrich, et al. 2013. Regional analysis of greenhouse gas emissions from USA dairy farms: A cradle to farm-gate assessment of the American dairy industry circa 2008. International Dairy Journal 31, Supplement 1: S29-S40. doi:http://dx.doi.org/10.1016/j.idairyj.2012.09.010.

Wattiaux , M. A., E. Silva, A. Morales and K. Anderson. 2017: Comparing carbon footprint of conventiona vs. organic milk production systems. Retrieved from: https://kb.wisc.edu/dairynutrient/375fsc/page.php?id=49930

Additional (Optional) readings

LCA and Assessment of Environmental Impacts

de Vries, M. and I.J.M. de Boer. 2010. Comparing environmental impacts for livestock products: A review of life cycle assessments. Livestock Science 128: 1-11. doi:http://dx.doi.org/10.1016/j.livsci.2009.11.007.

Hou, Y., G.L. Velthof and O. Oenema. 2015. Mitigation of ammonia, nitrous oxide and methane emissions from manure management chains: a meta-analysis and integrated assessment. Global Change Biology 21: 1293-1312. doi:10.1111/gcb.12767.

Knapp, J.R., G.L. Laur, P.A. Vadas, W.P. Weiss and J.M. Tricarico. 2014. Invited review: Enteric methane in dairy cattle production: Quantifying the opportunities and impact of reducing emissions. J. Dairy Sci. 97: 3231–3261. doi:http://dx.doi.org/ 10.3168/jds.2013-7234.

Montes, F., R. Meinen, C. Dell, A. Rotz, A.N. Hristov, J. Oh, et al. 2013. SPECIAL TOPICS — Mitigation of methane and nitrous oxide emissions from animal operations: II. A review

of manure management mitigation options1. J. Anim. Sci. 91: 5070-5094. doi:10.2527/jas.2013-6584.

O'Brien, D., J.L. Capper, P.C. Garnsworthy, C. Grainger and L. Shalloo. 2014. A case study of the carbon footprint of milk from high-performing confinement and grass-based dairy farms. Journal of Dairy Science 97: 1835-1851. doi:http://dx.doi.org/10.3168/jds.2013-7174.

Food choice and Sustainability

Aiking, H. 2011. Future protein supply. Trends in Food Science & Technology 22: 112-120. doi:http://dx.doi.org/10.1016/j.tifs.2010.04.005.

Heller, M.C. and G.A. Keoleian. 2011. Life Cycle Energy and Greenhouse Gas Analysis of a Large-Scale Vertically Integrated Organic Dairy in the United States. Environmental Science & Technology 45: 1903-1910. doi:10.1021/es102794m.

Leip, A., F. Weiss, J.P. Lesschen and H. Westhoek. 2014. The nitrogen footprint of food products in the European Union. The Journal of Agricultural Science 152: 20-33.

Scarborough, P., P. Appleby, A. Mizdrak, A.M. Briggs, R. Travis, K. Bradbury, et al. 2014. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. Climatic Change 125: 179-192. doi:10.1007/s10584-014-1169-1.

Westhoek, H., J.P. Lesschen, T. Rood, S. Wagner, A. De Marco, D. Murphy-Bokern, et al. 2014. Food choices, health and environment: Effects of cutting Europe's meat and dairy intake. Global Environmental Change 26: 196-205. doi:http://dx.doi.org/10.1016/j.gloenvcha.2014.02.004.

Land Use Human food versus Animal Feed Production

Patel, M., U. Sonesson and A. Hessle. 2016. Upgrading plant amino acids through cattle to improve the nutritional value for humans: effects of different production systems. animal 11: 519-528. doi:10.1017/S1751731116001610.

Expectations: What am I expected to do to get good grades?

1. Class Participation: Journal Entries, Blog Entries and Post Class Quizzes

As a student, you are expected to take an active role in your own learning. Please review the lecture material or complete the reading assignment before class. The ways you can be proactive and gain credit in this class include:

- Be prepared for class and team work: Allocate enough time to read the papers carefully before class. Think of the reading and homework assignments as a way of helping yourself find out what you know and what you don't know or don't fully understand. For making sense of the course material, you have to continually question yourself, your teammates, your

classmates and your instructor. To reward you for doing the "right" things, there will be pre-class on-line quizzes to complete. These are meant to make sure that you are well-prepared for class discussion or other activities.

- Another important aspect of being prepared for class is synthesizing the material from the readings through your own summaries and notes before the class. In addition, you should be taking notes during class to be able to study and have a record of your thinking (and how it changes) through the course of the class. To facilitate both the pre-class and in-class learning and synthesizing, we will require that each student keep a weekly journal summarizing and reacting to the pre-class assignments and in which each student will add his/her in-class notes. This journal will be one Word document to which students add information every week as the semester progresses. Please see the Journal Entry Template.docx. In addition to this, students will be expected to submit a 70-80 word post-class blog post which offers a highlight of the student's journal entry for that week for everyone else in the class to read.
- Be an active participant in class: Active participation in class means listening, thinking, taking notes and asking questions. There are (almost) no stupid questions in this class. As long as you have a genuine interest in learning the subject matter, all questions will be valid questions! Be honest with yourself and you will find out what your current level of knowledge really is, and what your misunderstandings might be.

Depending on the schedule, here is what you are expected to do for this class:
Before class:

- Use your NetID to log onto the "restricted" (internal) Schedule and Materials page of the website
- Read the posted paper(s) and/or view posted videos
- Take the pre-class quiz, if there is one appointed for that day. The quiz will test your knowledge and understanding of the pre-class assignments (readings, videos, etc.)
- Students are allowed two attempts at each quiz, however the quiz grade will be assessed by averaging the scores of every attempt, rather than taking the high score and then final points will be assigned for the quizzes based on the following scale: 80-100% = 10/10; 70-79% = 9/10; 60-69% = 8/10; 50-59% = 7/10; 40-49% = 6/10; 30-39% = 5/10; 20-29% = 4/10; 10-19% = 3/10; 1-9% = 2/10. Deadline to complete the pre-class quiz is 1:00 PM the day of class.

During class we may engage in any of the following class activities:

- Group discussion of the readings
- Introduction of the topic with a mini-lecture (if needed)
- Small group activities
- Discuss a case study

After class:

- After having read and/or watched videos and participated in the class activities, now you can synthesize what you've learned by completing a journal entry and posting its highlight as a post-class blog.
- Deadline to complete the journal and the post-class blog is 4:00 PM the day after class (i.e. 24 hours after class)

If necessary, make an appointment with a member of the Instruction team for help

Note that the blog entries and the quizzes should be completed as your own effort reflecting your understanding of the topic. If you have access to materials from previous offerings of the course, the act of copying/pasting answers or partially editing answers from others is an instance of academic misconduct, the definition of which includes "any act aimed at making false representation of one's academic performance." The University has strict rules and provides for disciplinary action on this issue. Please see the UW academic misconduct page for more details.

2. Team Research Project

The group research project is, in some ways, the heart of the course. Through your efforts, with guidance and feedback from the instructors, you will learn how to make evidence-based assessments and recommendations. You will most likely learn to assess the greenhouse gas emissions from different food system configurations, although some projects will focus more on adaptation, mitigation, and social implications. Groups will form early in the semester to begin the important process of team-building and topic identification. Intermediate components of the final project will be due periodically throughout the semester.

For more information on the intermediate deliverables and instructions, a list of recommended projects, a timeline, and helpful resources, see the Team Projects: Instructions and Timeline page (2017 version can be found at: https://kb.wisc.edu/dairynutrient/375fsc/page.php?id=59168 .

2(a): Annotated Bibliography (Team-based)

This will be the first team deliverable in which all members of each team must participate, no matter their student standing as graduate or undergraduate. The annotated bibliography should contain citations of credible sources that directly inform the research question of the group. Several sentences or a small paragraph of a team member's own writing should then summarize the important points of each of these sources and connect it to their research question. For an example, see these annotated bibliography entries from Purdue OWL. ***Using their annotated bibliography, teams will present their preliminary project ideas to the class in two sessions before spring break.***

2(b): Peer-Review Style Article (Graduate)

Graduate students' final written deliverable will be a peer-review style article summarizing your project, modeled after a respected peer-reviewed journal. We

expect graduate students to take the leadership, but surely undergraduate could and should contribute to this effort. Publishing in peer-reviewed journals allows researchers to contribute to our collective knowledge and to take an active role in their respective field. Publications contribute to your reputation and to your ability to fund your research projects and find engaging employment. Peer-reviewed publications are needed to establish the credibility of your work. The relatively high turn-around for journals allows you to communicate your research results and impact your field quickly.

2(c): Audio-visual Presentation (Team-based)

Effective presentation skills are vital for getting a job, getting your project funded, and communicating information so people understand it, remember it, and use it. ***At the end of the semester, your team will deliver an effective and engaging audio-visual presentation of your project and findings to the class.***

At the end of the semester, students will complete a grading rubric to rate the effort and involvement of their other team members in the final project. This will adjust the student's final grade for the sum of all the team project deliverables by up to 5 points.

Grading scheme

Grades will be assigned as indicated in the Table below.

	Due Date	Undergraduate	Graduate
Individually Grades			
Pre-class quizzes	On-going	20	15
Post-class blog entries[1]	On-going	15	10
Journal Entries[2]	End of each module	10	15
Team Project Grades[3]			
Annotated bibliography	3/20	20	10
Preliminary presentation	3/20 and 3/22	15	10
Peer-reviewed style article		--	20
Final class presentation	4/19 to 5/01	20	20
Total		100	100

[1] To be shared with entire class

[2] To be reviewed by instructional team

[3] At the end of the semester, students will complete a grading rubric to rate the effort and involvement of their other team members in the final project. This will adjust the student's final grade for the sum of all the team project deliverables by up to 5 points.

Final grades will be assigned according to the following scale:

- A: 90-100%
- AB: 87-89%
- B: 80-86%
- BC: 77-79%

- C: 70-76%
- D: 60-69%
- F: 0-59%