**EAS 639 Global Environmental Change and Sustainable Food Systems - Winter 2019 -**

**3 credit hours**

**Instructor:** Meha Jain (mehajain@umich.edu)

**Class Meeting Times:** W 10:00-1:00 PM; 1006 Dana

**Office Hours:** W 1:00 PM-2:00 PM; 3540 Dana

**Textbook(s):**

No required textbook. All readings will be from the primary literature and will be distributed through the Canvas website.

**Overview**: Global environmental change, including climate change, natural resource degradation, and burgeoning populations, will challenge global food security over the coming decades. In this class, we will read recent primary literature to understand the extent to which our current food system can sustain growing food demand in the face of global environmental change. We will discuss potential solutions for increasing food security more sustainably, reducing pressures on the limited resources that remain on the planet. There are no pre-requisites for the course.

**Class Structure:** Lecture (1st hour); Reading discussion (2nd hour); Group project (3rd hour)

**Learning Mechanisms**: (1) lectures, (2) readings, (3) in-class and online paper discussions, and (4) working towards a group project.

**Evaluation:** The final grade will be based on completing readings and posting online discussion pieces (25%), class attendance and in-class discussions (50%), and working on the group project (25%).

**Note 1:** If you need accommodations for a disability, please contact the Services for Students with Disabilities (SSD) office at 734-763-3000 or email ssdoffice@umich.edu. You are also welcome to email the instructor or drop by during office hours to discuss your academic needs.

**Note 2**: Students are expected to take personal responsibility for understanding and observing the Rackham Academic and Professional Integrity Policy. Zero credit will be given for any assignments involving acts of dishonesty, and additional acts can result in failing the class.

Please see the following link for more details: <http://www.rackham.umich.edu/current-students/policies/academic-policies/section11>

**Grading:** Grades will be as follows:

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| --- | --- |
| **Grade** | **Percentage Points** |
| A | 93-100 |
| A- | 90-92.9 |
| B+ | 87-89.9 |
| B | 83-86.9 |
| B- | 80-82.9 |
| C+ | 77-79.9 |
| C | 73-76.9 |
| C- | 70-72.9 |
| D+ | 67-69.9 |
| D | 63-66.9 |
| D- | 60-62.9 |
| F | Below 60 |

Total grades are determined based on components 1-3 detailed below:

**(1) Readings and Online Blog Posts (25%):** All readings are required. To facilitate in-class discussions, all students will be required to complete one task weekly on Piazza, the online class blog. Each student will write a paragraph to initiate class discussion (at least one question/comment should be included about each paper). This paragraph can include questions that you have about the readings, insights you may have about how the readings for the week are linked, etc. These posts will be used by student discussion leaders to initiate class discussions each week. If you fail to post in a given week, you will earn 0 for that week. If you fail to discuss all of the papers you will only earn 50% that week. You must post even if you are leading the discussion.

**(2) Class attendance, participation, and leading discussions (50% of total grade):** Class attendance is mandatory and will contribute to your grade (40%). If a class must be missed due to some conflict (e.g., important conference, etc) please discuss this with the instructor in advance. If you miss a class regardless of the reason, you will earn 0% for class attendance that day. Two students will be in charge of leading the discussion for each week, and all students are expected to contribute to in class discussion. Leading at least one discussion section throughout the year and this will contribute to 10% of the student’s grade.

**(3) Group Project (25%):** All students will work together towards a group project on some topic of the group’s choosing related to global environmental change and agricultural production. Students are expected to work on this project during 33% of class time every week and a few hours outside of class each week. If a student does not complete the group project task for a given week, they will earn 0 for that week.

(4) **Extra Credit (up to 15% extra credit):** If students missed a class or assignment and would like to do extra credit to boost their grade, please email Meha. She will come up with a task related to the literature review that will count for extra credit.

**Detailed Syllabus and Reading List** (tentative and subject to change).

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| --- | --- | --- | --- | --- |
| **Week** | **Date** | **General Topic** | **Specific Topic** | **Readings** |
| Week 1 | Wed 1/9 | Setting up the food security challenge  Possible solutions to ensure food security | Overview: The challenge of feeding 9 billion people | Godfray et al. 2010; Foley et al 2011 |
| Week 2 | Wed 1/16 | Overview: Current global agricultural production patterns and trade | Bedow et al. 2010; Khoury et al. 2016; D’Odorico et al. 2014; Feeding the world story map |
| Week 3 | Wed 1/23 | Challenge 1: Growing demand & changing diets | FAO, Bruisma et al. 2003, |
| Week 4 | Wed 1/30 | Challenge 2: Climate change | Schmidhuber and Tubiello 2007; Lobell et al. 2011 |
| Week 5 | Wed 2/6 | Challenge 3: Sustainability and environmental impacts of irrigation | Dalin et al. 2017; Rosegrant et al. 2009 |
| Week 6 | Wed 2/13 | Challenge 4: Sustainability and environmental impacts of fertilizer use | Cassman et al. 2003; Townsend and Porder 2012; Liu et al. 2010 |
| Week 7 | Wed 2/20 | Challenge 5: Crop pests & diseases | TBD |
| Week 8 | Wed 2/27 | Possible solutions to ensure food security | Solution 1: Arable land expansion and increased cropping intensity | Tilman et al. 2011; Rudel et al. 2009; Bruinsma 2003 (Sections 4.1-4.3) |
| - | Wed 3/6 |  | NO CLASS – SPRING BREAK |  |
| Week 9 | Wed 3/13 | Possible solutions to ensure food security | Solution 2: Closing yield gaps | Lobell et al. 2009; Mueller et al. 2012; Ittersum et al. 2013 |
| Week 10 | Wed 3/20 | Solution 3: Sustainable intensification | Loos et al. 2014; Pretty and Bharucha 2014; |
| Week 11 | Wed 3/27 | Solution 4: Adaptation to environmental change | Howden et al. 2007; Anwar et al. 2013; Challinor et al. 2014 |
| Week 12 | Wed 4/3 | Solution 5: Reducing food waste and changing diets | Lipinski et al. 2013; Gustavsson et al. 2011 |
| Week 13 | Wed 4/10 | Solution 6: Improving food distribution | TBD |
| Week 14 | Wed 4/17 | Solution 7: Using a systems approach to identify solutions | Ingram 2011; Erickson 2008; Francis et al. 2003 |

**Detailed Reading List**

Week 1

* Godfray et al. (2010). [Food Security: The Challenge of Feeding 9 Billion People](http://science.sciencemag.org/content/327/5967/812.full). Science. 327 (5967): 812-818.
* Foley et al. (2011). [Solutions for a cultivated planet.](http://science.sciencemag.org/content/327/5967/812.full) Nature. 478: 337-342.

Week 2

* Bedow et al. (2010). [The Changing Landscape of Global Agriculture](https://www.card.iastate.edu/products/books/shifting_patterns/pdfs/chapter2.pdf) in *The Shifting Patterns of Agricultural Production and Productivity Worldwide*.
* D’Odorico et al. 2014. [Feeding humanity through global food trade](http://onlinelibrary.wiley.com/doi/10.1002/2014EF000250/epdf). Earth’s Future. 2: 458-469.
* Khoury et al. 2016. [Origins of food crops connect countries worldwide](http://rspb.royalsocietypublishing.org/content/royprsb/283/1832/20160792.full.pdf). Proceedings of the Royal Society B. 283:20160792.
* <http://storymaps.esri.com/stories/feedingtheworld/>

Week 3

* FAO. How to feed the world in 2050. Executive summary, Section 1, & Section 2.

<<http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf>>

* Bruinsma 2003. World agriculture: towards 2015/2030. An FAO Perspective. Summary Report. Long-term Perspectives. P 11-20.

<http://www.fao.org/tempref/docrep/fao/004/y3557e/y3557e.pdf>

Week 4

* Schumidhuber and Tubiello. [Global food security under climate change](http://www.pnas.org/content/104/50/19703.full). PNAS. 104(50): 19703-19708.
* Lobell et al. 2011. [Climate Trends and Global Crop Production Since 1980](http://science.sciencemag.org/content/333/6042/616). Science. 333(6042): 616-620.
* *Optional:* Lobell et al. 2008. Prioritizing Climate Adaptation Needs for Food Security in 2030. Science. 319(5863):607-610.

Week 5

* Rosegrant et al. 2009. [Water for Agriculture: Maintaining Food Security under Growing Water Scarcity](http://www.annualreviews.org/doi/full/10.1146/annurev.environ.030308.090351). Annual Review of Environment and Resources. 34:205-222.
* Dalin et al. 2017. [Groundwater depletion embedded in global food trade](https://www.nature.com/articles/nature21403). Nature. 543:700-704.

Week 6

* Cassman et al. 2003. [Meeting Cereal Demands While Protecting Natural Resources and Improving Environmental Quality](http://www.annualreviews.org/doi/abs/10.1146/annurev.energy.28.040202.122858). Annual Review of Environment and Resources. 28: 315-358.
* Townsend and Porder. 2012. [Agricultural legacies, food production and its environmental consequences](http://www.pnas.org/content/109/16/5917.full.pdf). PNAS. 109(16): 5917-5918.
* Liu et al. 2010. [A high-resolution assessment on global nitrogen flows in croplands](http://www.pnas.org/content/107/17/8035.short). PNAS. 107(17):8035-8040.

Week 7

* TBD

Week 8

* Rudel et al. 2009. [Agricultural intensification and changes in cultivated areas, 1970-2005](http://www.pnas.org.proxy.lib.umich.edu/content/106/49/20675.full.pdf). PNAS. 106(49):20675-20680.
* Bruinsma 2003. World agriculture: towards 2015/2030. An FAO Perspective. FAO, Earthscan Publications. Sections 4.1-4.3

< <http://www.fao.org/tempref/docrep/fao/005/y4252E/y4252e.pdf>>

* Tilman et al. 2011. [Global food demand and the sustainable intensification of agriculture](http://www.pnas.org/content/108/50/20260.full.pdf). PNAS. 108(50):20260-20264.

Week 9

* Lobell et al. 2009. [Crop Yield Gaps: Their Importance, Magnitudes, and Causes](http://www.annualreviews.org/doi/pdf/10.1146/annurev.environ.041008.093740). Annual Review of Environment and Resources. 34:179-204.
* Mueller et al. 2012. [Closing yield gaps through nutrient and water management](https://www.nature.com/articles/nature11420.pdf). Nature. 490:254-257.
* Ittersum et al. 2013. [Yield gap analysis with local to global relevance – A review](https://ac.els-cdn.com/S037842901200295X/1-s2.0-S037842901200295X-main.pdf?_tid=415e552a-e4ea-11e7-9408-00000aab0f01&acdnat=1513708223_015f4b1347d5189273d6eabeae4141af). Field Crops Research. 143:4-17.

Week 10

* Pretty and Bharucha. 2014. [Sustainable intensification in agricultural systems](https://academic.oup.com/aob/article/114/8/1571/210078). Annals of Botany. 114(8): 1571-1596.
* Loos et al. 2014. [Putting meaning back into “sustainable intensification.”](http://onlinelibrary.wiley.com/doi/10.1890/130157/epdf) Frontiers in Ecology and the Environment. 12(6): 356-361.

Week 11

* Howden et al. 2007. [Adapting agriculture to climate change](http://www.pnas.org/content/104/50/19691.full.pdf). PNAS. 104(50):19691-19696.
* Anwar et al. 2013. [Adapting agriculture to climate change: a review](https://link.springer.com/article/10.1007/s00704-012-0780-1). Theoretical and Applied Climatology. 113 (1-2): 225-245.
* Challinor et al. 2014. [A meta-analysis of crop yield under climate change and adaptation](https://www.nature.com/articles/nclimate2153.pdf). Nature Climate Change. 4:287-291.

Week 12

* Gustavsson et al. 2011. Global food losses and food waste – Extent, causes, and prevention. FAO. Rome < <http://www.fao.org/3/a-i2697e.pdf>>
* Lipinski et al. 2013. [Reducing food loss and waste](http://staging.unep.org/wed/2013/docs/WRI-UNEP-Reducing-Food-Loss-and-Waste.pdf). World Resources Institute.

Week 13

* TBD

Week 14

* Ingram 2011. [A food systems approach to researching food security and its interactions with global environmental change](https://link.springer.com/content/pdf/10.1007%2Fs12571-011-0149-9.pdf). Food Security. 3:417-431.
* Erickson 2008. [Conceptualizing food systems for global environmental change research](https://www.sciencedirect.com/science/article/pii/S0959378007000659/pdfft?md5=60dc131afa3a161680f6b6a96767d02f&pid=1-s2.0-S0959378007000659-main.pdf). Global Environmental Change. 18: 234-245.
* Francis et al. 2003. [Agroecology: the ecology of food systems](http://www.tandfonline.com/doi/pdf/10.1300/J064v22n03_10?needAccess=true). Journal of Sustainable Agriculture. 22(3): 99-118.