COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainability Management

Smart Agriculture for a Changing Climate (in-person)
Every Thursday 6 - 8:00pm
Course Credits (Elective):

Instructor: Henry Gordon-Smith, Founder & CEO AGRITECTURE, hag2118@columbia.edu, 347-575-4335

Office Hours: One hour before class for in-person or by appointment for remote meetings. Location TBD.

Response Policy: I am online 9 am - 9 pm EST Monday-Thursday During the term, the easiest way to reach me is via email. You will usually get a response within 48 hours. If you have a question about an assignment, you are advised to email me several days before it is due; if your email arrives within 24 hours of the due date, you may not receive a timely response.

Course Overview: Smart Agriculture for a Changing Climate

Agriculture is at a pivotal point in addressing climate change, facing the dual challenge of being both a victim and a contributor to it. As other sectors reduce their carbon footprints, agriculture's emissions could rise without intervention. This sector must now embrace transformative actions, including regenerative practices and smart technologies, to adapt and mitigate climate impacts. This urgency was highlighted in global discussions, like at the COP28 meetings in the UAE, focusing on Climate Smart Agriculture (CSA) - an approach integrating cropland, livestock, forests, and fisheries to tackle food security and climate change.

This course is tailored for future sustainability leaders, offering a deep dive into the intersection of climate change and agriculture. With climate change threatening to reduce global crop yields significantly, understanding and addressing these challenges is critical. The course explores CSA solutions, from AI and IOT to hydroponics and urban agriculture, emphasizing adaptive strategies for diverse environments. Students will analyze key agricultural regions and crops, assess real-world challenges, and discuss successful adaptation strategies.

The course demands analytical thinking and practical application of climate-smart solutions in assignments reflecting real-world challenges. Through this, students will enhance their ability to convert theory into actionable strategies, preparing them for roles in the $1+ trillion US agriculture sector or the global sustainable agriculture industry.

Learning Objectives

Upon successful completion of this course, students should be able to:

- L1 - Analyze the current threat posed to the global food system by climate change and formulate informed recommendations.
- L2 - Articulate a strong understanding of food security, including its nuances, and effectively address the challenges arising from the escalating global demand for food through well-reasoned recommendations.
- L3 - Evaluate a diverse array of Climate Smart Agriculture solutions that are actively being implemented, demonstrating the ability to assess their efficacy and applicability across various contexts.
- L4 - Critique the roles played by both high-tech and low-tech solutions in distinct geographic areas, considering the varied climate conditions, and formulating recommendations for optimizing their impact.
- L5 - Identify and recommend climate-smart agriculture solutions tailored to specific crops and regions facing imminent threats, showcasing the capacity to align interventions with the unique challenges of different agricultural landscapes and socio-economic contexts.

Readings

Required[1]

- Acevedo, M., Pixley, K., Zinyengere, N., Meng, S., Tufan, H., Cichy, K., Bizikova, L., Isaacs, K., Ghezzi-Kopel, K., & Porciello, J. (2020). **A scoping review of the adoption of climate-resilient crops by small-scale producers in low- and middle-income countries.** *Nature Plants*, *6*(10), 1231–1241. https://doi.org/10.1038/s41477-020-00783-z, Pages: 1231-1241, Total: 11 pages.

- Ahmed, L., & Nabi, F. (2021). **Machine learning (ML) driven agriculture**. *Agriculture 5.0: Artificial Intelligence, IoT, and Machine Learning*, 135–155. https://doi.org/10.1201/9781003125433-6, Pages: 135-155, Total: 21 pages.

- Anggraeni, E. W., Handayati, Y., & Novani, S. (2022). **Improving local food systems through the coordination of Agriculture Supply Chain Actors**. *Sustainability*, *14*(6), 3281.

[1] Page numbers and ranges are estimated but may be updated once the classes begin as the instructor reviews readings and finalizes course content.
Adapted from: **The Course Syllabus: A Learning-Centered Approach, 2nd Edition,** Judith Grunert O'Brien, Barbara J. Millis, Margaret W. Cohen. ISBN: 978-0-470-60549-3. Available as an E-Book from Wiley at:
https://www.wiley.com/en-us/The+Course+Syllabus%3A+A+Learning+Centered+Approach%2C+2nd+Edition-p-9780470605493

https://doi.org/10.3390/su14063281, Pages: 1-17, Total: 17 pages.

- BAGLEY, J.E., MILLER, J. and BERNACCHI, C.J. (2015), **Biophysical impacts of climate-smart agriculture**. Plant Cell Environ, 38: 1913-1930. https://doi.org/10.1111/pce.12485 (Total pages TBD)

- Barasa PM, Botai CM, Botai JO, Mabhaudhi T. **A Review of Climate-Smart Agriculture Research and Applications in Africa**. Agronomy. 2021; 11(6):1255. https://doi.org/10.3390/agronomy11061255 (Total pages TBD)

- Benkeblia, N. (Ed.). (2018). **Climate Change and Crop Production: Foundations for Agroecosystem Resilience** (1st ed.). CRC Press. https://doi.org/10.1201/9781315391861 (Total pages TBD)

- Baumont de Oliveira, F. J., Ferson, S., Dyer, R. A., Thomas, J. M., Myers, P. D., & Gray, N. G. (2022). **How high is high enough? assessing financial risk for vertical farms using imprecise probability.** *Sustainability*, *14*(9), 5676. https://doi.org/10.3390/su14095676, Pages: 1-9, Total 9 pages.

- Carolyn Steel, March 7 2013, ISBN: 9780099584476, **Hungry City: How Food Shapes Our Lives** (Total pages TBD)

- Clements, D. R., & Jones, V. L. (2021). **Ten ways that weed evolution defies human management efforts amidst a changing climate**. *Agronomy*, *11*(2), 284. https://doi.org/10.3390/agronomy11020284, Pages: 2-15, (Total 14 pages).

- Gabriel McNunn, Douglas L. Karlen, William Salas, Charles W. Rice, Steffen Mueller, David Muth, Jeffrey W. Seale, **Climate smart agriculture opportunities for mitigating soil greenhouse gas emissions across the U.S**. Corn-Belt, Journal of Cleaner Production, Volume 268, 2020, 122240, ISSN 0959-6526 https://doi.org/10.1016/j.jclepro.2020.122240. (Total pages TBD)

- Gebeyehu, M. N. (2019). **Remote Sensing and GIS application in agriculture and Natural Resource Management**. *International Journal of Environmental Sciences & Natural Resources*, *19*(2).

https://doi.org/10.19080/ijesnr.2019.19.556009, Pages: 2-4, (Total 3 pages).

- Govind A, Wery J, Dessalegn B, Elmahdi A, Bishaw Z, Nangia V, Biradar C, Nisa ZU, Abay K, Amarnath G, et al. **A Holistic Framework towards Developing a Climate-Smart Agri-Food System in the Middle East and North Africa**: A Regional Dialogue and Synthesis. Agronomy. 2021; 11(11):2351. (Total pages TBD) https://doi.org/10.3390/agronomy11112351

- He, W., Liu, Y., Sun, H., & Taghizadeh-Hesary, F. (2020). **How does climate change affect rice yield in China?** Agriculture, 10(10), 441. https://doi.org/10.3390/agriculture10100441, Pages:5-13, (Total 14 pages).

- Henry Jonathan, Hesham Magd, Aatadal Al Salhi, 2022, **Climate Smart Agriculture and Mitigation Techniques for Sustainable Resilient Farming in Middle East Region,** http://www.gbmrjournal.com/pdf/v14n2s/V14N2s-2.pdf (Total pages TBD)

- Koul, S. (2021). **Machine learning and deep learning in agriculture**. *Smart Agriculture*, 1–19. https://doi.org/10.1201/b22627-1 (18 pages)

- Lewis J and Rudnick J (2019) **The Policy Enabling Environment for Climate Smart Agriculture: A Case Study of California**. Front. Sustain. Food Syst. 3:31. https://doi.org/10.3389/fsufs.2019.00031 (Total pages TBD)

- Mahto, R., Sharma, D., John, R., & Putcha, C. (2021). Agrivoltaics: A climate-smart agriculture approach for Indian Farmers. Land, 10(11), 1277. https://doi.org/10.3390/land10111277, Pages:1-18, (Total 18 pages).

- McCarthy, N. (2014). **Climate-smart agriculture in Latin America: drawing on research to incorporate technologies to adapt to climate change**. (Total pages TBD)

- Misra, N. N., Dixit, Y., Al-Mallahi, A., Bhullar, M. S., Upadhyay, R., & Martynenko, A. (2022). **IOT, Big Data, and artificial intelligence in agriculture and Food Industry**. *IEEE Internet of Things Journal*, *9*(9), 6305–

6324. https://doi.org/10.1109/jiot.2020.2998584, Pages: 6305-6320, (Total 16 pages).

- Richard Perkins, RP 59°N / Richard Perkins, 2019, ISBN 9151910519, 9789151910512, **Regenerative Agriculture: A Practical Whole Systems Guide to Making Small Farms Work** (Total pages TBD)

- Salazar, A., & Rios, I. (2010). **Sustainable agriculture: Technology, planning and management**. Nova Science Publishers. (Total pages TBD)

- Tanure, T. M., Miyajima, D. N., Magalhães, A. S., Domingues, E. P., & Carvalho, T. S. (2020). **The impacts of climate change on agricultural production, land use and economy of the legal Amazon region between 2030 and 2049**. EconomiA, 21(1), 73–90. https://doi.org/10.1016/j.econ.2020.04.001, Pages:74-83, (Total 10 pages).

- Thomas B. Long, Vincent Blok, Ingrid Coninx, **Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy**, Journal of Cleaner Production, Volume 112, Part 1, 2016, Pages 9-21, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2015.06.044. (12 pages)

- Vågsholm, I., Arzoomand, N. S., & Boqvist, S. (2020). **Food security, safety, and sustainability—getting the trade-offs right**. *Frontiers in Sustainable Food Systems*, *4*. https://doi.org/10.3389/fsufs.2020.00016, Pages:2-12, (Total 11 pages).

- Verschuuren J. **Towards an EU Regulatory Framework for Climate-Smart Agriculture**: The Example of Soil Carbon Sequestration. Transnational Environmental Law. 2018;7(2): 301-322. (21 pages) https://doi.org/10.1017/S2047102517000395

- Zhou, Z.-Y. (2019). **Global Food Security: What Matters?** (1st ed.). Routledge. https://doi.org/10.4324/9781315406947 (Total pages TBD)

Optional Readings

Regenerative Agriculture

- Giller, K. E., Hijbeek, R., Andersson, J. A., & Sumberg, J. (2021). Regenerative Agriculture: An agronomic perspective. Outlook on Agriculture, 50(1), 13-25. https://doi.org/10.1177/0030727021998063
- L. Schreefel, R.P.O. Schulte, I.J.M. de Boer, A. Pas Schrijver, H.H.E. van Zanten, Regenerative agriculture – the soil is the base, Global Food Security, Volume 26, 2020, 100404, ISSN 2211-9124, https://doi.org/10.1016/j.gfs.2020.100404.
- Newton P, Civita N, Frankel-Goldwater L, Bartel K and Johns C (2020) What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. Front. Sustain. Food Syst. 4:577723. https://doi.org/10.3389/fsufs.2020.577723
- O'Donoghue T, Minasny B, McBratney A. Regenerative Agriculture and Its Potential to Improve Farmscape Function. Sustainability. 2022; 14(10):5815. https://doi.org/10.3390/su14105815

Urban Agriculture

- Diekmann, L. O., Gray, L. C., & Thai, C. L. (2020). More than food: The social benefits of localized urban food systems. Frontiers in Sustainable Food Systems, 4. https://doi.org/10.3389/fsufs.2020.534219, Pages: 3-13, (Total 11 pages).
- Grebitus, C., Chenarides, L., Muenich, R., & Mahalov, A. (2020). Consumers' perception of urban farming—an exploratory study. *Frontiers in Sustainable Food Systems*, *4*. https://doi.org/10.3389/fsufs.2020.00079, Pages:5-11, (Total 7 pages).
- Harada, Y., & Whitlow, T. H. (2020). Urban Rooftop Agriculture: Challenges to science and Practice. *Frontiers in Sustainable Food Systems*, *4*. https://doi.org/10.3389/fsufs.2020.00076, Pages:2-5, (Total 4 pages).
- Hardman, M., Clark, A., & Sherriff, G. (2022). Mainstreaming urban agriculture: Opportunities and barriers to upscaling city farming. *Agronomy*, *12*(3), 601. https://doi.org/10.3390/agronomy12030601, Pages 2-4, 7-13 (Total 10 pages).
- Ilieva, R. T., Cohen, N., Israel, M., Specht, K., Fox-Kämper, R., Fargue-Lelièvre, A., Poniży, L., Schoen, V., Caputo, S., Kirby, C. K., Goldstein, B., Newell, J. P., & Blythe, C. (2022). The socio-cultural benefits of urban agriculture: A review of the literature. *Land*, *11*(5), 622. https://doi.org/10.3390/land11050622, Pages:5-15, (Total 11 pages).
- Nicholls, E., Ely, A., Birkin, L., Basu, P., & Goulson, D. (2020). The contribution of small-scale food production in urban areas to the Sustainable Development Goals: A Review and Case Study. *Sustainability Science*, *15*(6), 1585–1599. https://doi.org/10.1007/s11625-020-00792-z, Pages:1585-1596, (Total 12 pages).
- Wadumestrige Dona, C. G., Mohan, G., & Fukushi, K. (2021). Promoting urban agriculture and its opportunities and challenges—a global review. *Sustainability*, *13*(17), 9609. https://doi.org/10.3390/su13179609, Pages:15-19, (Total 5 pages).
- Yan, D., Liu, L., Liu, X., & Zhang, M. (2022). Global trends in Urban Agriculture Research: A pathway toward urban resilience and sustainability. *Land*, *11*(1), 117. https://doi.org/10.3390/land11010117, Pages:12-14, (Total 3 pages).

IOT, A.I. Big Data

- Dengel, A. (2013). Special issue on artificial intelligence in agriculture. *KI - Künstliche Intelligenz*, *27*(4), 309–311. https://doi.org/10.1007/s13218-013-0275-y, Pages:309-311, (Total 3 pages).
- Mani, P. K., Mandal, A., Biswas, S., Sarkar, B., Mitran, T., & Meena, R. S. (2020). Remote Sensing and geographic information system: A tool for precision farming. *Geospatial Technologies for Crops and Soils*, 49–111. https://doi.org/10.1007/978-981-15-6864-0_2
- Subeesh, A., & Mehta, C. R. (2021). Automation and digitization of agriculture using Artificial Intelligence and internet of things. *Artificial Intelligence in Agriculture*, *5*, 278–291. https://doi.org/10.1016/j.aiia.2021.11.004, Pages:278-289, (Total 12 pages).
- Talaviya, T., Shah, D., Patel, N., Yagnik, H., & Shah, M. (2020). Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides. *Artificial Intelligence in Agriculture*, *4*, 58–73. https://doi.org/10.1016/j.aiia.2020.04.002, Pages:60-70, (Total 11 pages).
- Xu, J., Gu, B., & Tian, G. (2022). Review of Agricultural IOT Technology. *Artificial Intelligence in Agriculture*, *6*, 10–22. https://doi.org/10.1016/j.aiia.2022.01.001, Pages:15-20, (Total 6 pages).

Climate-smart Agriculture

- Petersen, L. (2019). Impact of climate change on twenty-first century crop yields in the U.S. *Climate*, *7*(3), 40. https://doi.org/10.3390/cli7030040, Pages:6-15, (Total 10 pages).
- Raza, A., Razzaq, A., Mehmood, S., Zou, X., Zhang, X., Lv, Y., & Xu, J. (2019). Impact of climate change on crops adaptation and strategies to tackle its outcome: A Review. Plants (Basel, Switzerland), 8(2), 34. https://doi.org/10.3390/plants8020034, Pages:3-17, (Total 15 pages).
- Schmitt Olabisi, L., Ugochukwu Onyeneke, R., Prince Choko, O., Nwawulu Chiemela, S., Liverpool-Tasie, L. S., Ifeyinwa Achike, A., & Ayo Aiyeloja, A. (2020). Scenario planning for climate adaptation in Agricultural Systems. *Agriculture*, *10*(7), 274. https://doi.org/10.3390/agriculture10070274, Pages:6-8, (Total 3 pages).
- Shayanmehr, S., Rastegari Henneberry, S., Sabouhi Sabouni, M., & Shahnoushi Foroushani, N. (2020). Climate change and sustainability of crop yield in dry regions food insecurity. *Sustainability*, *12*(23), 9890. https://doi.org/10.3390/su12239890, Pages:1-6, 16-20, (Total 11 pages).
- Snowdon, R. J., Wittkop, B., Chen, T.-W., & Stahl, A. (2020). Crop adaptation to climate change as a consequence of long-term breeding. *Theoretical and Applied Genetics*. https://doi.org/10.1007/s00122-020-03729-3, Pages:1614-1619, (Total 6 pages).

Other

- Carreño-Ortega, A., do Paço, T. A., Díaz-Pérez, M., & Gómez-Galán, M. (2021). Lettuce production under Mini-PV modules arranged in patterned designs. *Agronomy*, *11*(12), 2554. https://doi.org/10.3390/agronomy11122554, Pages 3-4, (Total 2 pages).
- Cho, J., Park, S. M., Park, A. R., Lee, O. C., Nam, G., & Ra, I.-H. (2020). Application of photovoltaic systems for agriculture: A study on the relationship between power generation and farming for the improvement of photovoltaic applications in agriculture. *Energies*, *13*(18), 4815. https://doi.org/10.3390/en13184815, Pages: 1-16, (Total 16 pages)
- Garg, A. (2014). Recent trends in agriculture: Vertical Farming and organic farming. *Advances in Plants & Agriculture Research*, *1*(4). https://doi.org/10.15406/apar.2014.01.00023, Pages:142-144, (Total 3 pages).

- Gibson, M. (2012). Food security—a commentary: What is it and why is it so complicated? Foods, 1(1), 18–27. https://doi.org/10.3390/foods1010018, Pages: 18-25, (Total 8 pages).

Assignments and Assessments

The assignments of this course are intended to train students in the approaches to Climate Smart Agriculture and develop critical skills for leading in the sustainable agriculture industry professionally with knowledge and methods.

Assignment 1: (Individual, 10%)

First reaction paper on the readings related to climate-smart agriculture

A short essay (approximately 5 pages) demonstrating that the students have completed initial readings and can formulate a critical lens on climate change as it relates to agriculture. This will be the easiest of the course assignments and relates to L1. The essay will be evaluated based on how clearly they understood the readings and how they demonstrated critical thinking about the complexity of the food security and climate change adaptation challenges. This is also a first opportunity for students to share what interests them the most regarding climate-smart agriculture. Feedback will be provided with 2-3 paragraphs about the students' essay and a grade for the assignment on the document which will be returned to students.

Deliverables: Short essay (approximately 5 pages)

Evaluation criteria: Understanding of Readings, Critical Thinking, Developing their Perspective on CSA

Assignment 2: (Team, 20%)

Food Security Assessment Tool

Students will develop a unique tool for assessing food security within teams of 2-3. They will need to choose a stakeholder (public, private, nation, region, or community) and develop a simple and demonstrable tool that quantifies food security. Students will have 5 minutes to demonstrate the key features and considerations of their tool and how it balances complex quantitative and qualitative factors for food security. They will also need to submit a 1-page description of the tool and its strengths/limitations. This assignment relates to L2. Students will be graded 1/3rd on their tool, 1/3rd on their presentation, and 1/3rd on their 1-page description. Teams will receive one grade for their submission. This assignment will help students move from analysis of food security to real considerations of the challenge in a specific context.

Deliverables: Tool for assessing food security, 1-page description, 5 minutes on-site presentation.

Evaluation criteria: Tool Design, Presentation, and 1-page description Clarity and Conciseness.

Assignment 3: (Individual, 15%)

Climate Smart Agriculture Matrix

Students will develop a matrix of 3-5 Climate Smart Agriculture (CSA) solutions for one specific agriculture region of their choosing. What are the benefits of the solutions? How advanced are they? Are they low-tech or high-tech? What regions and scales do they work at? Do they benefit smallholder farmers or larger farmers? How might they affect food access and equity? Again, thinking about the end user (government, corporation, non-profit, nation, or region), students will research and analyze all possible climate-smart agriculture solutions for that end user and build a matrix of data about them providing the audience with a means to critically assess them. This relates to L3 and will force students to compare and contrast each CSA solution. Students will be graded based on the comprehensiveness of their matrix and how well they weigh the different dimensions of their impact on the end user. Students will be graded ½ on their matrix overall and ½ on their 1-page description with justifications. Feedback will be provided with a grade and 1 paragraph from the instructor.

Deliverables: Matrix of Climate Smart Agriculture (CSA) solutions, 1-page description, and justification

Evaluation criteria: Matrix development, Identification of Benefits, Impact assessment End-User

Assignment 4: (Team, 20%)

Debate about low-tech VS high-tech solutions agriculture solutions to adapt to climate change

This interactive assignment will involve teams of two students that will play the role of a group representing either high or low tech smart agriculture solutions. Regions for context and solutions to debate will be submitted by students and then assigned by the instructor. Each debate will have a different region and two teams debating which is the best approach for the region. Students will learn to both understand the role of low and high-tech solutions and be asked to defend a position that they may not personally agree with. This will encourage them to dig deeper into new perspectives and strengthen their ability to understand the complexity and trade-offs of solutions for various regions and stakeholders as they consider investment, incentives, and policies for climate-smart agriculture. Teams will get a single grade together as a team for this assignment. Each grade will be provided with a short paragraph assessment from the instructor and this assignment relates to L4.

Deliverables: Live ~15-minute debate (in person or virtual)

Evaluation criteria: Teamwork and Collaboration, Understanding of High and Low Tech Solutions, Logical Argumentation,

Assignment 5: (Individual, 25%)

Proposal for accelerating a Climate Smart Agriculture solution

In their final assignment, students will share a 6-page proposal to a stakeholder (government body, farming organization, or corporate entity) recommending specific actions to develop and accelerate a climate-smart agriculture solution in a specific region. Students will need to share research contextualized to a region or specific climate change & food security challenge. They will need to outline the why, how, what, and when of their plan for this approach for the stakeholder. They will need to include economic, social, and environmental research to demonstrate they understand the triple-bottom-line impacts and consider relevant stakeholders. Students will present their final recommendations in a 5-minute final presentation along with the proposal. Students will be graded 30% on their presentation and 70% on their proposal. The presentation will be made in person to the class.

Deliverables: 6-page CSA proposal for one region, 5-minute onsite presentation.

Evaluation criteria: Contextualized Research, Clarity of Proposal Structure, Triple-Bottom-Line Impacts, Stakeholder Considerations, Feasibility and Practicality, Presentation Structure, Effective Communication

Assignment 6: (Individual, 10%)

Online and In-Class Interaction

Throughout the course and every week, students will need to share 1 article or news on agriculture and share critical analysis in the form of 3-5 sentences on the course's online forum. Students will also be assessed on their attendance to classes which will be recorded and their active participation in classes. This relates to all of the learning objectives. Students will be graded based on their participation in this weekly assignment and the quality of their analysis. Grades for this assignment will be provided at the end of the course.

Deliverables: 1 post weekly with a news article and analysis related to sustainability & agriculture

Evaluation criteria: Weekly Contribution, Analytical Thinking & Communication

Grading

The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage	
A+	98–100 %	
A	93–97.9 %	
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	60–69.9 %	
F	59.9% and below	

Assignment/Assessment	% Weight	Individual or Group/Team Grade
Assignment 1: Reaction paper on literature	10%	Individual
Assignment 2: Food Security Assessment Tool	20%	Team
Assignment 3: CSA Matrix	15%	Individual
Assignment 4: Debate on low-tech VS high-tech CSA	20%	Team
Assignment 5: Proposal for accelerating CSA	25%	Individual
Assignment 6: Online and In-class Interaction	10%	Individual

Course Schedule/Course Calendar

Week	Date	Topics and Activities	Readings (due on this day)	Assignments (due on this date)

1	1/18/2024	Course introductions Foundations of Food Security	Steel, C. (2013). ***Hungry City: How Food Shapes Our Lives***. Vintage Books. Vågsholm, I., Arzoomand, N. S., & Boqvist, S. (2020). **Food security, safety, and sustainability—getting the trade-offs right**. *Frontiers in Sustainable Food Systems*, *4*. https://doi.org/10.3389/fsufs.2020.00016 Zhou, Z.-Y. (2019). Global Food Security: What Matters? (1st ed.). Routledge. https://doi.org/10.4324/9781315406947	Start of Interaction Assignment (weekly submission required)
2	1/25/2024	What is Climate Smart Agriculture?	Clements, D. R., & Jones, V. L. (2021). **Ten ways that weed evolution defies human management efforts amidst a changing climate**. *Agronomy*, *11*(2), 284. https://doi.org/10.3390/agronomy11020284 Anggraeni, E. W., Handayati, Y., & Novani, S. (2022). **Improving local food systems through the coordination of Agriculture Supply Chain Actors**. *Sustainability*, *14*(6), 3281. https://doi.org/10.3390/su14063281 Zhou, Z.-Y. (2019). Global Food Security: What Matters? (1st ed.). Routledge. https://doi.org/10.4324/9781315406947	
3	2/1/2024	Intro to Urban Agriculture	Baumont de Oliveira, F. J., Ferson, S., Dyer, R. A., Thomas, J. M., Myers, P. D., & Gray, N. G. (2022). **How high is high enough? assessing financial risk for vertical farms using imprecise probability.** *Sustainability*, *14*(9), 5676. https://doi.org/10.3390/su14095676 Diekmann, L. O., Gray, L. C., & Thai, C. L. (2020). **More than food: The social benefits of localized urban food systems**. *Frontiers in Sustainable Food Systems*, *4*. https://doi.org/10.3389/fsufs.2020.534219	
4	2/8/2024	Intro to Regenerative Agriculture	Perkins, R. (2019). ***Regenerative agriculture: A practical whole systems guide to making small farms work***. RP 59°N / Richard Perkins. Salazar, A., & Rios, I. (2010). ***Sustainable Agriculture Technology, planning and management***. Nova Science Publishers.	Reaction Paper Due
5	2/15/2024	Intro to IOT, AI, and Big Data for Agriculture	Gebeyehu, M. N. (2019). **Remote Sensing and GIS application in agriculture and Natural Resource Management**. *International Journal of Environmental Sciences & Natural Resources*, *19*(2). https://doi.org/10.19080/ijesnr.2019.19.556009 Misra, N. N., Dixit, Y., Al-Mallahi, A., Bhullar, M. S., Upadhyay, R., & Martynenko, A. (2022). **IOT, Big Data, and artificial intelligence in agriculture and Food Industry**. *IEEE Internet of Things Journal*, *9*(9), 6305–6324. https://doi.org/10.1109/jiot.2020.2998584 Koul, S. (2021). **Machine learning and deep learning in agriculture**. *Smart Agriculture*, 1–19. https://doi.org/10.1201/b22627-1 Ahmed, L., & Nabi, F. (2021). **Machine learning (ML) driven agriculture. *Agriculture 5.0: Artificial Intelligence, IoT, and Machine Learning***, 135–155. https://doi.org/10.1201/9781003125433-6	
6	2/22/2024	CSA in NA	BAGLEY, J.E., MILLER, J. and BERNACCHI, C.J. (2015), Biophysical impacts of climate-smart agriculture. Plant Cell Environ, 38: 1913-1930. https://doi.org/10.1111/pce.12485 Gabriel McNunn, Douglas L. Karlen, William Salas, Charles W. Rice, Steffen Mueller, David Muth, Jeffrey W. Seale, **Climate smart agriculture opportunities for mitigating soil greenhouse gas emissions across the U.S**. Corn-Belt, Journal of Cleaner Production, Volume 268, 2020, 122240, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2020.122240. Lewis J and Rudnick J (2019) **The Policy Enabling Environment for Climate Smart Agriculture: A Case Study of California**. Front. Sustain. Food Syst. 3:31. https://doi.org/10.3389/fsufs.2019.00031	Food Security Tool Due
7	2/29/2024	CSA in Europe	Verschuuren J. **Towards an EU Regulatory Framework for Climate-Smart Agriculture: The Example of Soil Carbon Sequestration.** Transnational Environmental Law. 2018;7(2):301-322. https://doi.org/10.1017/S2047102517000395 Thomas B. Long, Vincent Blok, Ingrid Coninx,	

			Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: evidence from the Netherlands, France, Switzerland and Italy, Journal of Cleaner Production, Volume 112, Part 1, 2016,Pages 9-21, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2015.06.044.	
8	3/7/2024	Debate on CSA	Benkeblia, N. (Ed.). (2018). **Climate Change and Crop Production: Foundations for Agroecosystem Resilience** (1st ed.). CRC Press. https://doi.org/10.1201/9781315391861 Acevedo, M., Pixley, K., Zinyengere, N., Meng, S., Tufan, H., Cichy, K., Bizikova, L., Isaacs, K., Ghezzi-Kopel, K., & Porciello, J. (2020). **A scoping review of adoption of climate-resilient crops by small-scale producers in low- and middle-income countries.** *Nature Plants*, *6*(10), 1231–1241. https://doi.org/10.1038/s41477-020-00783-z	Debate Assignment
9	3/11-3/15	SPRING BREAK NO CLASS		
10	3/21/2024	CSA in the Middle East	Govind A, Wery J, Dessalegn B, Elmahdi A, Bishaw Z, Nangia V, Biradar C, Nisa ZU, Abay K, Amarnath G, et al. **A Holistic Framework towards Developing a Climate-Smart Agri-Food System in the Middle East and North Africa: A Regional Dialogue and Synthesis**. Agronomy. 2021; 11(11):2351. https://doi.org/10.3390/agronomy11112351 Henry Jonathan, Hesham Magd, Aatadal Al Salhi, 2022, **Climate Smart Agriculture and Mitigation Techniques for Sustainable Resilient Farming in Middle East Region,** http://www.gbmrjournal.com/pdf/v14n2s/V14N2s-2.pdf	
11	3/28/2024	CSA in Asia	He, W., Liu, Y., Sun, H., & Taghizadeh-Hesary, F. (2020). **How does climate change affect rice yield in China?** Agriculture, 10(10), 441. https://doi.org/10.3390/agriculture10100441, Pages:5-13, (Total 14 pages). Mahto, R., Sharma, D., John, R., & Putcha, C. (2021). **Agrivoltaics: A climate-smart agriculture approach for Indian Farmers. Land,** 10(11), 1277. https://doi.org/10.3390/land10111277, Pages:1-18, (Total 18 pages).	CSA Matrix Due
12	4/4/2024	CSA in Africa	Barasa PM, Botai CM, Botai JO, Mabhaudhi T. A Review of **Climate-Smart Agriculture Research and Applications in Africa.** Agronomy. 2021; 11(6):1255. https://doi.org/10.3390/agronomy11061255 Govind A, Wery J, Dessalegn B, Elmahdi A, Bishaw Z, Nangia V, Biradar C, Nisa ZU, Abay K, Amarnath G, et al. **A Holistic Framework towards Developing a Climate-Smart Agri-Food System in the Middle East and North Africa: A Regional Dialogue and Synthesis.** Agronomy. 2021; 11(11):2351. https://doi.org/10.3390/agronomy11112351	
13	4/11/2024	CSA in South America	McCarthy, N. (2014). **Climate-smart agriculture in Latin America: drawing on research to incorporate technologies to adapt to climate change.** Tanure, T. M., Miyajima, D. N., Magalhães, A. S., Domingues, E. P., & Carvalho, T. S. (2020). **The impacts of climate change on agricultural production, land use and economy of the legal Amazon region between 2030 and 2049**. EconomiA, 21(1), 73–90. https://doi.org/10.1016/j.econ.2020.04.001, Pages:74-83, (Total 10 pages).	
14	4/18/2024	Final Presentations Day	No Readings	Final Proposals Due

Course Policies

You are expected to complete all assigned readings, attend all class sessions, and engage with others in online discussions. Your participation will require that you answer questions, defend your point of view, and challenge the point of view of others. If you need to miss a class for any reason, please discuss the absence with me in advance.

Late work

There will be no credit granted to any written assignment that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor.

Citation & Submission
All written assignments must use standard citation format (e.g., MLA, APA, Chicago), cite sources, and be submitted to the course website (not via email).

School and University Policies and Resources

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

> The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at https://sps.columbia.edu/students/student-support/academic-integrity-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Diversity Statement
It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

Accessibility
Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: https://health.columbia.edu/content/disability-services.

Class Recordings
All or portions of the class may be recorded at the discretion of the Instructor to support your learning. At any point, the Instructor has the right to discontinue the recording if it is deemed to be obstructive to the learning process.

If the recording is posted, it is confidential and it is prohibited to share the recording outside of the class.

SPS Academic Resources
The Division of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: https://sps.columbia.edu/students/student-support/student-support-resources.

Columbia University Information Technology
Columbia University Information Technology (CUIT) provides Columbia University students, faculty and staff with central computing and communications services. Students, faculty and staff may access University-provided and discounted software downloads.

Columbia University Library
Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online.

The Writing Center
The Writing Center provides writing support to undergraduate and graduate students through one-on-one consultations and workshops. They provide support at every stage of your writing, from brainstorming to final drafts. If you would like writing support, please visit the following site to learn about services offered and steps for scheduling an appointment. This resource is open to Columbia graduate students at no additional charge. Visit http://www.college.columbia.edu/core/uwp/writing-center.

Career Design Lab
The Career Design Lab supports current students and alumni with individualized career coaching including career assessment, resume & cover letter writing, agile internship job search strategy, personal branding, interview skills, career transitions, salary negotiations, and much more. Wherever you are in your career journey, the Career Design Lab team is here to support you. Link to https://careerdesignlab.sps.columbia.edu/