Sustainable Agriculture

in theory and practice

Fall 2023

Dr. Oren Hoffman
Weekly 1.5 hours lecture, 1.5 hours hands-on, 3 credits, undergraduate credit

Course description

The course offers an overview of approaches to sustainable agriculture. In this course, farming methods and the agronomic and environmental consequences are explored through lectures and gardening. Subjects include crop diversity, ancient crops, organic vs. conventional management, water- saving techniques, soil ecology, and co-cropping. The students will have the opportunity to visit and help in the experimental fields while exploring various approaches towards agricultural sustainability. As they learn, they will document and share something they learned on social media (or present in class). The social media assignment offers the opportunity to engage with a wider audience, including friends and family, on the important topic of sustainable development. Aside from being an important skill, posting to social media enables access to more information and knowledge sources.

The students will be exposed to various research questions currently being studied in the Center for Sustainable Agriculture, revolving around resource conservation in desert agriculture. They will take part in setting up and running experiments in the student garden and/or the experimental fields of the CSA in Ketura. Their assignments will include hands on tasks and writing a report about the experiments. They will write and hand in parts of the report throughout the semester. The first part will be a short introduction/literature review (based on max 5 papers), the second part will include the students' methodology and the final report will include the results and some discussion.

In a nutshell

- We will learn about the environmental consequences of factory farming
- We will learn the theories and science behind approaches to sustainable farming
- We will get our hands dirty: prepping, planting, maintaining and harvesting out garden
- We will run our own experiment in the best practices for desert agriculture
- The students will write a report on the experiment as the final assignment

Grade components:

- Literature review 20%
- Methodology section 20%
- Final report of the hands-on experiment 30%
- Social media assignment 15%
- Attendance and punctuality 15%

Recommended book:
Agroecology: The ecology of sustainable food systems, SR Gliessman, 2014

Course schedule:

Week 1
Introduction to course structure and grading.
Crop production basics: water-soil-plant-atmosphere.
The evolution of agriculture: irrigation systems, tillage, fertilizers.

Hands- on in student garden: getting to know the local conditions and challenges in the desert; Planting the experimental plots.

Week 2
The agroecosystem concept: ecology of plants in managed systems.
Managing agriculture for ecosystem services.

Reading: Agroecology Ch2 - Agroecology and the Agroecosystem Concept

Week 3
Sustainability science: How can agriculture be sustainable?
Agricultural inputs and their environmental outcomes: fertilizers and pesticides.

Reading: Agroecology Ch 23 – Indicators of Sustainability

Week 4
Introducing the structure of the written assignments and providing tips on writing and research.
Studying one example paper together: learning about paper structure, important aspects in reading and writing scientific literature.

Hands-on: soil management, soil amendments, and soil cover; marking experimental units, more experimental setup as needed, planning the data structure and sampling methods.

Reading: How to conduct research on your farm, p 6-8.

Agomoh et al. 2019. Increasing crop diversity in wheat roations increases yields but decreases soil health. *Soil Science Society of America Journal* 84: 170-181.

Week 5
Soil fertility, soil health, and soil ecosystem services.

Hands on: Planting more crops. Crop diversity: varieties, species, families.

Reading: Tamburini, G., De Simone, S., Sigura, M., Boscutti, F., Marini, L., 2016. Soil management shapes ecosystem service provision and trade-offs in agricultural landscapes. Proceedings of the Royal Society B: Biological Sciences 283, 20161369. https://doi.org/10.1098/rspb.2016.1369

Week 6
Part 1 of the written assignment is due.

Week 7
The value of wild plants and crop-plant ancestors. Crop diversity to support sustainability: co-cropping, complementarity, facilitation.

Hands on in the garden: methods of weed management. Finding use in weeds.
Reading: Kremen, C., 2020. Ecological intensification and diversification approaches to maintain biodiversity, ecosystem services and food production in a changing world. Emerging Topics in Life Sciences 4, 229–240.

Week 8
Biodiversity in the garden, and the ecosystem services it supports.
Social media assignment.

Hands on: visiting gardens around kibbutz Ketura; discussing diversity and ES on Kibbutz.

Reading: Zhang, W., Ricketts, T.H., Kremen, C., Carney, K., Swinton, S.M., 2007. Ecosystem services and dis-services to agriculture. Ecological Economics, Special Section – Ecosystem Services and Agriculture 64, 253–260. https://doi.org/10.1016/j.ecolecon.2007.02.024

Week 9
Learning from indigenous agriculture. Models for production within the natural limitations. Runoff farming in the desert as a case study.
Hands on: monitoring experiments and garden maintenance.

Reading: Altieri, M. and Toledo, V. (2005) 'Natural Resource Management among Small-scale Farmers in Semi-arid Lands: Building on Traditional Knowledge and Agroecology'

Week 10

Agricultural pests. What is a pest? How can we sustainably manage pest populations? Integrated pest management. (Dr. Jessica Schaeckermann guest lecture)

Hands on in the garden: searching for pest damage, pests, and natural enemies. Building insect hotels for beneficials.

Reading:
Dara, S.K., (2019). The new integrated pest management paradigm for the modern age. Journal of Integrated Pest Management, 10(1), p.12.

Schäckermann, J., Morris, E. J., Alberdi, A., Razgour, O., & Korine, C. (2022). The Contribution of Desert-Dwelling Bats to Pest Control in Hyper-Arid Date Agriculture. Diversity,14(12), 1034. https://doi.org/10.3390/d14121034

Week 11
Water management for sustainable desert agriculture.
Instructions on final report.

Hands on: Harvesting the garden for experimental data.

Reading: TBA
Part 2 of assignment is due

Week 12
Tour of CSA projects: preserving species diversity in our shelter garden, exploring sustainable farming practices in our experimental fields.

Hands on: setting up a scientific experiment on a field scale.
Reading: Sollowey, E. Seeds of Abundance (pages x-y)

Week 13
Agricultural sustainability beyond the farm: climate footprint of food systems and searching for ways to improve them. What can we do as consumers?

Hands on: workshop on data analysis and reporting

Reading: Ritchie, H. (2020). Less meat is nearly always better than sustainable meat, to reduce your carbon footprint - Our World in Data. Available at: https://ourworldindata.org/less-meat-or-sustainable-meat.

Week 14
Science on the farm: what can we learn from our own garden?
What other questions can we try and answer?

Hands on: monitoring the experimental field, harvesting, and reflection on our experience.

Week 15

Bees and other pollinators. The importance of pollination for global crop production.
How to support pollinators in agriculture and gardens.
Threats to pollinators.
Q&A on final report. Open discussion on the course materials.

Reading:

Aizen, M.A., Garibaldi, L.A., Cunningham, S.A. and Klein, A.M., (2009). How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. Annals of botany, 103(9), pp.1579-1588.

Klein, A.M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C. and Tscharntke, T., (2007). Importance of pollinators in changing landscapes for world crops. Proceedings of the royal society B: biological sciences, 274(1608), pp.303-313.

Nicholson, C.C. and Egan, P.A., (2020). Natural hazard threats to pollinators and pollination. Global Change Biology, 26(2), pp.380-391.

Submit final report

Reading materials

Aizen, M.A., Garibaldi, L.A., Cunningham, S.A. and Klein, A.M., (2009). How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. Annals of botany, 103(9), pp.1579-1588.

Altieri, M. and Toledo, V. (2005) 'Natural Resource Management among Small-scale Farmers in Semi-arid Lands: Building on Traditional Knowledge and Agroecology', in. Available at: https://www.semanticscholar.org/paper/Natural-Resource-

Avni, Y., Avni, G. and Porat, N. (2019) 'A review of the rise and fall of ancient desert runoff agriculture in the Negev Highlands - A model for the southern Levant deserts', Journal of Arid Environments, 163, pp. 127–137. doi:10.1016/j.jaridenv.2019.01.010.

Dara, S.K., (2019). The new integrated pest management paradigm for the modern age. Journal of Integrated Pest Management, 10(1), p.12.

Hatt, S. et al. (2017) 'Pest regulation and support of natural enemies in agriculture: Experimental evidence of within field wildflower strips', Ecological Engineering. Elsevier B.V., 98, pp. 240–245. doi: 10.1016/j.ecoleng.2016.10.080.

Klein, A.M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C. and Tscharntke, T., (2007). Importance of pollinators in changing landscapes for world crops. Proceedings of the royal society B: biological sciences, 274(1608), pp.303-313.

Long, R. F. et al. (1998) 'Beneficial insects move from flowering plants to nearby crops', California Agriculture, 52(5), pp. 23–26. doi: 10.3733/ca.v052n05p23.

Nicholson, C.C. and Egan, P.A., (2020). Natural hazard threats to pollinators and pollination. Global Change Biology, 26(2), pp.380-391.

Nyfeler, D., Huguenin-Elie, O., Suter, M., Frossard, E., Lüscher, A., 2011. Grass-legume mixtures can yield more nitrogen than legume pure stands due to mutual stimulation of nitrogen uptake from symbiotic and non-symbiotic sources. Agriculture, Ecosystems and Environment 140, 155–163. https://doi.org/10.1016/j.agee.2010.11.022

Savci, S. (2012) 'An Agricultural Pollutant: Chemical Fertilizer', International Journal of Environmental Science and Development, 3(1), pp. 73–80. doi:10.7763/ijesd.2012.v3.191.

Schäckermann, J., Morris, E. J., Alberdi, A., Razgour, O., & Korine, C. (2022). The Contribution of Desert-Dwelling Bats to Pest Control in Hyper-Arid Date Agriculture. Diversity,14(12), 1034. https://doi.org/10.3390/d14121034

Tim Searchinger, Richard Waite, Craig Hanson, Janet Ranganathan and Emily Matthews (2019). Creating a Sustainable Food Future. World Resources Institute Report. https://www.wri.org/research/creating-sustainable-food-future

Tamburini, G., Bommarco, R., Wanger, T.C., Kremen, C., van der Heijden, M.G.A., Liebman, M., Hallin, S., 2020. Agricultural diversification promotes multiple ecosystem services without compromising yield. Science Advances 6. doi: 10.1126/SCIADV.ABA1715

Tamburini G, De Simone S,Sigura M, Boscutti F, Marini L. 2016 Soil management shapes ecosystem service provision and trade-offs in agricultural landscapes. Proc. R. Soc. B283: 20161369.http://dx.doi.org/10.1098/rspb.2016.1369t

Thomas, V. G. and Kevan, P. G. (1993) 'Basic principles of agroecology and sustainable agriculture', Journal of Agricultural and Environmental Ethics, 6(1), pp. 1–19. Doi : 10.1007/BF01965612.

Zhang, W., Ricketts, T. and Kremen, C. (2007) 'Ecosystem services and dis-services to agriculture', Ecological Economics, 64, pp. 253–260. doi: 10.1016/j.ecolecon.2007.02.024.