Agroecology

Applied Research and the Use of Ecosystem Services in Agriculture

Lecturer Dr. Jessica Schackermann
3 hour lectures once a week, 3 credits, Undergraduate

Course description
This course introduces the concept of agroecology, how ecological processes can be applied to agricultural systems and how this can lead to new management approaches. The students will discover the differences between agribusiness and agroecology and how the principles of agroecology can be applied to small scale and big scale farms. We will learn that agroecology is not associated with organic agriculture but that it can support its principles. We will learn which ecosystem functions and connected ecosystem services are important and can help agriculture and how a functioning agroecosystem can support nature and its conservation. The course includes 2 field trips and 2 hands on sessions in which the students will use the learned information to improve habitat for service agents.

Course Requirements and Class Structure
Each week consists of 3 hours, split in 1.5 hour sessions. 1.5 hour sessions consist of lectures, student's oral presentations, discussions, short projects in teamwork, presentation of teamwork. The course furthermore includes two field trips and two hands on lessons. Due to the interactive layout of the course participation and knowledge of the readings is a vital aspect of the class. For each lesson specific articles or book chapters will be chosen for the next lesson, literature presented in the list below is not all mandatory but can help with preparation for lessons and the exam. Students will be asked to submit a short report for each of the field trips, do teamwork assignments that will be presented to the class and answer a few questions regarding chosen publications. It is mandatory that specific chosen publications will be read as preparation for the lesson. The oral presentation will be on a topic of student's choice made in consultation with the lecturer based on a topic and the literature list. It will be presented in power point or other media and will be embedded in the course schedule, starting from week 3. The contents of the student's presentations will also be included in the final exam.

Grading components

Participation, attendance and punctuality	10%
Teamwork assignments and presentation of outcomes	15%
Assignment and oral presentation	30%
Field trip reports	15%
Final exam	30%

Recommended books for course preparation:
Agroecology: the science of sustainable agriculture, MA Altieri, 2018
Agroecology: the ecology of sustainable food systems, SR Gliessman, 2014
Essentials of Ecology, 4th Edition, Michael Begon, Robert W. Howarth, Colin R. Townsend ISBN: 978-0-470-90913-3, 2014

Week 1
Lesson 1: Agroecology, food systems, and interdiciplinarity. The Agroecosystem concept.
Readings: Agroecology: the ecology of sustainable food systems, Chapter 2; Agroecology: the science of sustainable agriculture, Chapter 3; (Dalgaard, Hutchings and Porter, 2003),
Lesson 2: Differences between industrial and sustainable agriculture. Eecosystem functions relevant to agriculture.
Readings: (Francis *et al.*, 2003), (Gliessman, 2016), (M. Altieri and Nicholls 2005), (Thomas and Kevan, 1993), (Zhang, Ricketts and Kremen, 2007)

Week 2
Lesson 3: The crop plant and abiotic factors of the environment, resources and destructors: sun, soil, water, minerals, wind, fire. Biotic factors of the environment.
Readings: Essentials of Ecology, Chapters 3.3 and 3.4; Agroecology: the ecology of sustainable food systems, Chapters 3 to 11,
Lesson 4: Conventional and alternative cropping systems. An overview concerning different cropping systems, their advantages and disadvantages.
Readings: Agroecology: the science of sustainable agriculture, Chapters 6 to 12

Week 3
Lesson 5: Chemicals in agriculture, advantages, disadvantages and limitations. The alternatives to chemical control in agriculture, and the importance of healthy soil.
Readings: Agroecology: the science of sustainable agriculture, Chapters 13 to 15, (Savci, 2012), (Sánchez-Bayo *et al.*, 2016), (Johansen, 1977), (Goulson *et al.*, 2015),
Lesson 6: Ecosystem Services to agriculture in an overview: Soil fertility and formation, nutrient cycling and retention, Water provision and purification, Genetic diversity and Climate regulation, pollination and biological pest control. Ecosystem dis-services to agriculture in an overview: pests damage, competition for water, competition for pollination

Readings: (Zhang, Ricketts and Kremen, 2007), (Spangenberg, von Haaren and Settele, 2014), (Dunn, 2010), (Vaz *et al.*, 2017), (Power, 2010)

Week 4

Lesson 7: Ecosystem services provided by birds – international and local examples (guest lecture by Noam Weiss)
Readings: (Mols and Visser, 2007; Barbaro and Battisti, 2011; Karp *et al.*, 2013), (Whelan, Şekercioğlu and Wenny, 2015)
Lesson 8: Ecosystem services provided by bats – international and local examples
Readings: (Maas, Clough and Tscharntke, 2013), (Maas *et al.*, 2018), (Puig-Montserrat *et al.*, 2015), (Kunz *et al.*, 2011), (Cleveland *et al.*, 2006), (Boyles *et al.*, 2011)

Week 5 (field trip 3 hours)

Lesson 9: Field trip to Samar date plantation – organic date farming and its challenges (explained in the plantation)
Lesson 10: Science in commercial agricultural plantations and fields – opportunities and challenges (explained in the plantation of Samar dates)
Readings: (Hole *et al.*, 2005), (Rigby and Cáceres, 2001), (Fuller *et al.*, 2005),

Week 6

Lesson 11: Biological pest control: predators and parasitoids in the insect kingdom, understanding and helping beneficial insects
Readings:,
www.goodhousekeeping.com/home/gardening/a20705937/beneficial-insects/, www.amentsoc.org/insects/insects-and-man/gardening-for-insects.html (Hewlett, Szczepaniec and Eubanks, 2019), (Rana *et al.*, 2017),
Lesson 12: Integrated pest management (IPM). AND Commercializing Beneficial's – the business with ecosystem services.
Readings: www.biobee.com, www.biobestgroup.com/en/biobest/products/biological-pest-control-4463/, www.defenders.co.uk/, www.dragonfli.co.uk/, https://greenmethods.com/, www.planetnatural.com/product-category/natural-pest-control/beneficial-insects/, www.arbico-organics.com/category/beneficial-insects-organisms,

Week 7

Lesson 13: Pollination, honeybees and wild pollinators, the use of flowering strips for pollinators and natural enemies.
Readings: https://www.beyondpesticides.org/programs/bee-protective-pollinators-and-pesticides/what-can-you-do/pollinator-friendly-seed-directory, (Hatt *et al.*, 2017), (Tschumi *et al.*, 2016), (Walton and Isaacs, 2011), (Kopta, Pokluda and Psota, 2012), (Haaland, Naisbit and Bersier, 2011), (Long *et al.*, 1998), (Uyttenbroeck *et al.*, 2015), (Westphal *et al.*, 2015)
Lesson 14: Insect composition as a key component for pest control and pollination services. – Diversity can be key!
Readings: (Alhadidi, Griffin and Fowler, 2018), (Brødsgaard and Enkegaard, 1995), (Rocca and Messelink, 2017)

Week 8
Lesson 15: The importance of the landscape, the habitat and their elements in agro-ecosystems and sustainable agriculture.
Readings: (Gosme and Alomar, 2016), (Schäckermann *et al.*, 2014), (Karp *et al.*, 2018), (Schäckermann, Mandelik, *et al.*, 2015), (Schäckermann, Pufal, *et al.*, 2015)
Lesson 16: Planning of the hands on part of the course, what can we do to enhance ecosystem services to agriculture and gardening?
Readings: (Flaquer, Torre and Ruiz-Jarillo, 2006), collection of building instructions will be handed out

Week 9 (field trip)
Lessons 17 and 18: Field trip to the agricultural R&D farm – Science in small scale experimental farms – opportunities and challenges AND eco/ agricultural tourism
Readings: (Gössling, 1999), (Jolly and Reynolds, 2005), (Veeck, Che and Veeck, 2006; Veeck *et al.*, 2016), (Jouzi *et al.*, 2017)

Week 10
Lessons 19 and 20: Improving the habitat: We build bat boxes, bird nesting boxes and insect hotels, according to the ecosystem that we find in the area and to the needs of the beneficial's.

Week 11
Lessons 21 and 22: Improving the habitat: We finalize building bat boxes, bird nesting boxes and insect hotels, and install them in relevant places. Students will explain the choice of location based on the ecological knowledge gained in the course so far.

Week 12
Lesson 23: Connecting agriculture and farmers to nature conservation (guest lecture by Noam Weiss)
Lesson 24: How can we take scientific results out of the bubble and into the world of agriculture? How applicable is applied research? Involving the farmers in research and its design, towards sustainable agriculture.
Readings: Agroecology: the science of sustainable agriculture, Chapters 4 to 5., (Maas *et al.*, 2018)

Week 13
Lesson 25: Student's presentation
Lesson 26: Final exam

Literature for course preparation and oral presentations
Alhadidi, S. N., Griffin, J. N. and Fowler, M. S. (2018) 'Natural enemy composition rather than richness determines pest suppression', *BioControl*. Springer Netherlands, 63(4), pp. 575–584. doi: 10.1007/s10526-018-9870-z.
Barbaro, L. and Battisti, A. (2011) 'Birds as predators of the pine processionary moth (Lepidoptera: Notodontidae)', *Biological Control*. Elsevier Inc., 56(2), pp. 107–114. doi: 10.1016/j.biocontrol.2010.10.009.

Boyles, J. G. *et al.* (2011) 'Economic importance of bats in agriculture', *Science*, 332(6025), pp. 41–42. doi: 10.1126/science.1201366.
Brødsgaard, H. F. and Enkegaard, A. (1995) 'Interactions among polyphagous anthocorid bugs used for thrips control and other beneficials in multi-species biological pest management systems', *Mededelingen Faculteit Landbouwkundige en Toegepaste Biologische Wetenschappen Universiteit Gent*, 60, pp. 893–900.
Cleveland, C. J. *et al.* (2006) 'Economic Value of the Pest Control Service Provided by the Brazilian Free-tailed Bat in South-Central Texas', *Frontiers in Ecology and the Environment*, 4(5), pp. 238–243. doi: 10.1007/s13398-014-0173-7.2.
Dalgaard, T., Hutchings, N. J. and Porter, J. R. (2003) 'Agroecology, scaling and interdisciplinarity', *Agriculture, Ecosystems and Environment*, 100(1–3), pp. 39–51. doi: 10.1016/S0167-8809(03)00152-X.
Dunn, R. (2010) 'Global mapping of ecosystem disservices: The unspoken reality that nature sometimes kills us', *Biotropica*, 42(5), pp. 555–557. doi: 10.1098/rspb.2010.0340.F.
Flaquer, C., Torre, I. and Ruiz-Jarillo, R. (2006) 'The value of bat-boxes in the conservation of Pipistrellus pygmaeus in wetland rice paddies', *Biological Conservation*, 128(2), pp. 223–230. doi: 10.1016/j.biocon.2005.09.030.
Francis, C. *et al.* (2003) 'Agroecology: The ecology of food systems', *Journal of Sustainable Agriculture*. Taylor & Francis Group, 22(3), pp. 99–118. doi: 10.1300/J064v22n03_10.
Fuller, R. J. *et al.* (2005) 'Benefits of organic farming to biodiversity vary among taxa', *Biology Letters*. Royal Society, 1(4), pp. 431–434. doi: 10.1098/rsbl.2005.0357.
Gliessman, S. (2016) 'Transforming food systems with agroecology', *Agroecology and Sustainable Food Systems*. Taylor and Francis Inc., 40(3), pp. 187–189. doi: 10.1080/21683565.2015.1130765.
Gosme, M. and Alomar, O. (2016) *Landscape Features to Improve Pest Control in Agriculture*. Available at: www.thesolutionsjournal.org (Accessed: 3 May 2020).
Gössling, S. (1999) 'Ecotourism: A means to safeguard biodiversity and ecosystem functions?', *Ecological Economics*, 29(2), pp. 303–320. doi: 10.1016/S0921-8009(99)00012-9.
Goulson, D. *et al.* (2015) 'Bee declines driven by combined Stress from parasites, pesticides, and lack of flowers', *Science*. American Association for the Advancement of Science, pp. 1255957–1255957. doi: 10.1126/science.1255957.
Haaland, C., Naisbit, R. E. and Bersier, L. F. (2011) 'Sown wildflower strips for insect conservation: A review', *Insect Conservation and Diversity*. John Wiley & Sons, Ltd, 4(1), pp. 60–80. doi: 10.1111/j.1752-4598.2010.00098.x.
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.
Hewlett, J. A., Szczepaniec, A. and Eubanks, M. D. (2019) 'The effects of sugarcane aphid density in sorghum on predation by lady beetles and lacewings', *Biological Control*. Academic Press Inc., 129, pp. 171–177. doi: 10.1016/j.biocontrol.2018.10.015.
Hole, D. G. *et al.* (2005) 'Does organic farming benefit biodiversity?', *Biological Conservation*, 122(1), pp. 113–130. doi: 10.1016/j.biocon.2004.07.018.
Johansen, C. A. (1977) 'Pesticides and Pollinators', *Annual Review of Entomology*, 22(1), pp. 177–192. doi: 10.1146/annurev.en.22.010177.001141.

Jolly, D. A. and Reynolds, K. A. (2005) 'Consumer Demand for Agricultural and On-Farm Nature Tourism Interest in Agricultural and Nature Tourism Motivations for Agritourism Visits'.
Jouzi, Z. *et al.* (2017) 'Organic Farming and Small-Scale Farmers: Main Opportunities and Challenges', *Ecological Economics*, 132, pp. 144–154. doi: 10.1016/j.ecolecon.2016.10.016.
Karp, D. S. *et al.* (2013) 'Forest bolsters bird abundance, pest control and coffee yield.', *Ecology Letters*, 16(11), pp. 1339–1347. doi: 10.1111/ele.12173.
Karp, D. S. *et al.* (2018) 'Crop pests and predators exhibit inconsistent responses to surrounding landscape composition', *Proceedings of the National Academy of Sciences of the United States of America (PNAS)*. National Academy of Sciences, 115(33), pp. E7863–E7870. doi: 10.1073/pnas.1800042115.
Kopta, T., Pokluda, R. and Psota, V. (2012) 'Attractiveness of flowering plants for natural enemies', *Horticultural Science*, 39(2), pp. 89–96. doi: 10.17221/26/2011-HORTSCI.
Kunz, T. H. *et al.* (2011) 'Ecosystem services provided by bats', *Annals of the New York Academy of Sciences*, pp. 1–38. doi: 10.1111/j.1749-6632.2011.06004.x.
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.
Maas, B. *et al.* (2018) *Effects of Ecosystem Services Provided by Birds and Bats in Smallholder Cacao Plantations of Central Sulawesi*, *Effects of Ecosystem Services Provided by Birds and Bats in Smallholder Cacao Plantations of Central Sulawesi*. Göttingen: Göttingen University Press. doi: 10.17875/gup2018-1085.
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Power, A. (2010) 'Ecosystem services and agriculture: tradeoffs and synergies', *Phil. Trans. R. Soc. B*, 365, pp. 2959–2971. doi: 10.1098/rstb.2010.0143.
Puig-Montserrat, X. *et al.* (2015) 'Pest control service provided by bats in Mediterranean rice paddies: Linking agroecosystems structure to ecological functions', *Mammalian Biology*, 80(3), pp. 237–245. doi: 10.1016/j.mambio.2015.03.008.
Rana, L. B. *et al.* (2017) 'Feeding Efficiency of Green Lacewing, Chrysoperla carnea (Stephens) against Different Species of Aphid in Laboratory Conditions', *International Journal of Applied Sciences and Biotechnology*. Nepal Journals Online (JOL), 5(1), pp. 37–41. doi: 10.3126/ijasbt.v5i1.16983.
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Rocca, M. and Messelink, G. J. (2017) 'Combining lacewings and parasitoids for biological control of foxglove aphids in sweet pepper', *Journal of Applied Entomology*. Blackwell Publishing Ltd, 141(5), pp. 402–410. doi: 10.1111/jen.12355.
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Schäckermann, J., Mandelik, Y., *et al.* (2015) 'Natural habitat does not mediate vertebrate seed predation as an ecosystem dis-service to agriculture', *Journal of Applied Ecology*, p. doi: 10.1111/1365-2664.12402. doi: 10.1111/1365-2664.12402.
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Walton, N. J. and Isaacs, R. (2011) 'Influence of Native Flowering Plant Strips on Natural Enemies and Herbivores in Adjacent Blueberry Fields', *Environmental Entomology*, 40(3), pp. 697–705. doi: 10.1603/en10288.
Westphal, C. *et al.* (2015) 'Promoting multiple ecosystem services with flower strips and participatory approaches in rice production landscapes', *Basic and Applied Ecology*. Elsevier GmbH, 16(8), pp. 681–689. doi: 10.1016/j.baae.2015.10.004.
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