2014

Farming: It's Not Just for Farmers Anymore

Jennifer Schmidt
Pomona College

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Bringing Agricultural Education to the Liberal Arts at the Pomona College Organic Farm

Jennifer Schmidt

Pomona College, Environmental Analysis

October 18, 2013

"A campus farm is where students can put their hands to the plow, figuratively and sometimes literally: a place where abstract intellectual discussions about sustainability are put to the test, where ideals yield to action. It is in that transition from theory to practice, that physical testing, that the most radical and compelling forms of learning take place."

–Laura Sayre, *Fields of Learning*, p. 12.

Acknowledgements

Many thanks to Rick Hazlett and Adam Long for your invaluable comments, support, and advice during the writing of this thesis. You pushed me to think critically and refine my arguments, and the quality of this thesis would have been much poorer without your help. Thank you also to the six students who signed up for the Introduction to Organic Farming independent study this semester, especially for your patience and willingness to try an untested curriculum. Your enthusiasm kept me motivated this semester. And finally, thank you to everyone who has helped make the Pomona College Organic Farm such an incredible part of my college experience.

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Introduction

Agricultural education in the United States is changing rapidly and for the better. Once taught only to future farmers at the land-grant institutions, agriculture has entered the liberal arts curriculum in recent years, driven largely by an explosion of student farms.[1,2,3] The content of the land-grant curriculum has been revitalized as well, moving beyond industrial-scale production and specialized skills to incorporate growing environmental awareness and interdisciplinary breadth.[4] The student-farm movement that began in the 1990s is providing liberal arts colleges with an invaluable opportunity to explore sustainable agriculture firsthand and is raising important questions. How significant of a change does this represent for agricultural education? How should agriculture be taught in the liberal arts context? And what could agricultural education look like at the Pomona College Organic Farm?

Understanding the history of agricultural education shows that this student-farm movement is a revitalization of themes present a hundred years ago. Traditional agricultural education was rooted in the natural sciences, experiential, broad, and available to non-farmers as well as farmers. Originating in 1862 with the Morrill Act, which established the land-grant institutions, and extended by the introduction of vocational agriculture in secondary schools, the first movement of formal agricultural education was shaped by Progressive-era educational theorists. Members of the "nature-study" movement such as John Dewey and Liberty Hyde Bailey advocated for a natural-science-based, hands-on approach to agricultural education.[5] Rufus W. Stimson formalized the concept of teaching farms, laying the foundation for present-day extension stations as well as student-run campus farms.[6] By emphasizing the importance of

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[1] Sayre, Laura. "Introduction: The Student Farm Movement in Context." In *Fields of Learning : The Student Farm Movement in North America.*, 1–28. University Press of Kentucky, 2011.

[2] Harris, Sarah. "Farmers Under 40: Liberal Arts Students Try Their Hand at Farming." Accessed October 8, 2013. http://www.northcountrypublicradio.org/news/story/18013/20110714/farmers-under-40-liberal-arts-students-try-their-hand-at-farming.

[3] "Cultivating Responsibility: Liberal Arts Schools' Contribution to Sustainable Agriculture." *Wildlife Promise*. Accessed October 8, 2013. http://blog.nwf.org/2009/02/cultivating-responsibility-liberal-arts-schools-contribution-to-sustainable-agriculture/.

[4] Parr, Damian M., Cary J. Trexler, Navina R. Khanna, and Bryce T. Battisti. "Designing Sustainable Agriculture Education: Academics' Suggestions for an Undergraduate Curriculum at a Land Grant University." *Agriculture and Human Values* 24, no. 4 (December 1, 2007): 523–533. doi:10.1007/s10460-007-9084-y.

[5] Sayre, 2011.

[6] Moore, Gary E. "The Forgotten Leader in Agricultural Education: Rufus W. Stimson." *Journal of Agricultural Education* (Fall 1988): 50–58.

quality teachers, Garland A. Bricker helped agriculture gain acceptance as an academic discipline and improved the quality of existing programs.[7]

Despite their efforts, agriculture receded from the general education curriculum, due in part to changes in the structure of American higher education in the early 1900s. It became a narrow, career-oriented discipline focused on increasing production to feed a growing population.[8] Attention to the underlying natural processes and connections to other disciplines diminished. As a result of these changes and the growing environmental movement, traditional agricultural education was roundly criticized in the second half of the twentieth century,[9,10,11] leading to attempts to revitalize the curriculum. As change began to occur *within* the land-grant institutions, a strong student movement to establish on-campus farms started to expand agricultural education *beyond* the land-grants. This second movement brought agriculture into liberal arts colleges for the first time, a development with positive implications for the future of the American food system.

Given that fewer people are actively involved in growing food today than in the past,[12] and that only a small percentage of students at liberal arts colleges will go on to be farmers, why should agriculture be included in the liberal arts curriculum? And *how* should agriculture be taught in this context?

Including agriculture in the liberal arts curriculum has the potential to improve the sustainability of the American food system by creating informed consumers. Even though few liberal arts graduates may pursue farming as a career, all students without exception will go on to purchase, prepare, and consume food, and some may even eventually enter careers with influence over food policy. Including agriculture in the liberal arts curriculum will help prepare

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[7] Bricker, Garland Armor. *Agricultural Education for Teachers*. American Book Company, 1914.
[8] *Agriculture and the Undergraduate*. Washington, DC: Board on Agriculture, National Research Council, 1992. http://www.nap.edu/catalog/1986.html.
[9] Orr, David W. *Earth in Mind: On Education, Environment, and the Human Prospect*. Washington, DC: Island Press, 1994.
[10] Mayer, André, and Jean Mayer. “Agriculture, the Island Empire.” *Daedalus* 103, no. 3 (July 1, 1974): 83–95. doi:10.2307/20024221.
[11] MacRae, Rod J., Stuart B. Hill, John Henning, and Guy R. Mehuys. “Agricultural Science and Sustainable Agriculture: a Review of the Existing Scientific Barriers to Sustainable Food Production and Potential Solutions.” *Biological Agriculture & Horticulture* 6, no. 3 (1989): 173–219. doi:10.1080/01448765.1989.9754518.
[12] Grasgreen, Allie. “Farming Attracts Academically Diverse Students.” *USATODAY.COM*, August 2, 2011. http://www.usatoday.com/news/education/2011-08-02-college-student-farms_n.htm.

students to create positive change in the food system, since educated consumers and those with gardening experience are more likely to purchase organic and local foods.[13]

Making agriculture a part of the liberal arts curriculum is a crucial first step, but choosing the right educational approach is just as important. Drawing on the theories of those who pioneered agricultural education in the United States as well as more recent literature, three significant themes can be identified. To achieve the maximum positive impact, agricultural education should be *science-based*, *experiential*, and *locally specific*. Preparing students to reform our food system requires interdisciplinary critical thinking about what sustainability in agriculture truly means, and understanding the natural systems that support food production is indispensable to this analysis. Focusing on the environmental science underlying agriculture will help students better appreciate the resources that go into the food we eat and inspire them to support ways of growing crops which do less harm to the balance of ecological systems. Second, agricultural education should be experiential, as it has been since the establishment of the land grant institutions, in the liberal arts context as well.[14] Hands-on exploration offers incomparable opportunities for firsthand learning, increasing students' connection to nature and giving them a reason to care about preserving the environmental systems they study.[15] A hands-on approach also allows students to reap the beneficial effects of gardening on physical and mental health.[16] Finally, agricultural education should be place-based, emphasizing local climate, soil, and ecosystems as well as the cultures they sustain. Understanding that sustainable agriculture is fundamentally based in the unique characteristics of a given location can help students develop a sense of connection to their surroundings, giving them further motivation to preserve the environment around them.[17,18]

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[13] Zepada, Lydia, and Jinghan Li. "Who Buys Local Food?" *Journal of Food Distribution Research* 37, no. 3 (November 2, 2006).

[14] Parr *et al.*, 2007.

[15] Louv, Richard. *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books, 2005.

[16] Hansen-Ketchum, Patricia, Patricia Marck, and Linda Reutter. "Engaging with Nature to Promote Health: New Directions for Nursing Research." *Journal of Advanced Nursing* 65, no. 7 (July 2009): 1527–1538. doi:10.1111/j.1365-2648.2009.04989.x.

[17] Gruenewald, David A., and Gregory A. Smith, eds. *Place-Based Education in the Global Age*. New York: Lawrence Erlbaum Associates, 2008.

[18] Noddings, Nel. "Place-Based Education to Preserve the Earth and Its People." In *Educating Citizens for Global Awareness*. New York: Teachers College Press, 2005.

But what good would it do to theorize about agricultural education without putting it into practice? The Pomona College Organic Farm provides an ideal opportunity to integrate agriculture into the liberal arts curriculum, but academic offerings at Pomona have not used the full potential of this educational resource. Demand by students for hands-on courses at the Farm far exceeds enrollment capacity in the single course that is regularly taught there. Furthermore, a recent survey showed strong student interest in other forms of academic study at the Farm, including fall-semester and independent study options. To meet this demand, I designed a scientific, experiential, and place-based independent study curriculum for the Pomona College Organic Farm. During fall 2013, a group of six students participated in the course, providing the opportunity to reflect on this educational approach and on the value of student farms at liberal arts colleges. The resulting independent study curriculum will be available to help future students at the Claremont Colleges become informed consumers and policy-makers who can create positive change in the American food system.

Chapter 1. Traditional Agricultural Education

The first agricultural education movement in the United States, beginning in the mid-nineteenth century, established the land-grant institutions and brought vocational agriculture into secondary schools to educate future farmers. Agriculture has been an essential component of the United States' economy since the earliest colonists, but formalized agricultural education arose only relatively late. Growing public demand for government-funded instruction in agriculture led to the establishment of the land-grant institutions in 1862, supported by further measures in the late nineteenth and early twentieth centuries that established vocational agriculture programs in high schools. Educational reformers within the Progressive movement made this early agricultural education science-based, experiential, interdisciplinary, and accessible to all. Changes to the structure of American higher education over the course of the twentieth century altered the agricultural curriculum and target audience, however, making it less scientific and interdisciplinary and restricting it to future farmers. Criticism of traditional agricultural education on these grounds, in combination with the nascent environmental movement, the farm crisis of the 1980s, and declining enrollments in agricultural institutions, led to growing awareness of the need to reform.

Origins of Agricultural Education in the United States

Early agricultural education was informal and decentralized. Parents taught their children how to prepare land for planting and cultivate crops, but instruction beyond the level of the immediate family was rare.[19] As farmers began to identify common problems, though, they created growing demand for research to optimize agricultural methods. Since individual farmers lacked the resources to conduct such research on their own, they exerted political pressure, especially in the Northern states, to establish government-funded agricultural institutions for research and education. The Grange movement, a populist political group composed mainly of farmers, advocated particularly strongly for federal support of agriculture.[20] This proposed extension of the government's role in agriculture met with opposition from Southern farmers, who perceived it as undesirable bureaucratic overreach, an attempt to interfere in decisions best

[19] *Understanding Agriculture: New Directions for Education*. Committee on Agricultural Education in Secondary Schools, Board on Agriculture, National Research Council, 1988, 54.
[20] Ibid.

left to individual landowners. The political stalemate continued to prevent any federal involvement in agricultural education until the outbreak of the Civil War, when the secession of the Southern states removed the voices who had opposed a broader government role.[21]

As a significant number of Americans in the late nineteenth century were small-scale farmers and agriculture played a large role in American economic vitality, the government moved quickly to support this important constituency. The establishment of a new Department of Agriculture in May 1862 was followed in July by the Morrill Land Grant Act, which used federal funds from public land sales to create institutions for agricultural and mechanical higher education.[22,23] The Morrill Act meant that for the first time, agriculture was taught outside the family farm. Section 4 described the purpose of the land-grant institutions:

> without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.[24]

Notable in this passage is the breadth of focus of the curriculum; agriculture was only part of the education of a well-rounded farmer. Usually, this formal instruction took the form of a two-year program in the latter half of a four-year course of study at the land-grant universities.[25] Instruction was practical in nature, since American universities in the late nineteenth century were "pervaded with a utilitarian ideal of the university as a social service institution."[26] Thus,

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[21] Mayer, André, and Jean Mayer. "Agriculture, the Island Empire." *Daedalus* 103, no. 3 (July 1, 1974): 83–95. doi:10.2307/20024221, 88.

[22] Ibid.

[23] National Research Council, Committee on the Future of the Colleges of Agriculture in the Land Grant University System. *Colleges of Agriculture at the Land Grant Universities: Public Service and Public Policy*. Washington, D.C: National Academy Press, 1996. http://ccl.idm.oclc.org/login?url=http://site.ebrary.com/lib/claremont/Doc?id=10054982.

The list of land grant institutions was expanded in 1890 to include more schools offering agricultural and mechanical education, and again in 1994 to include 29 Native American tribal colleges. Because the 1994 land grant institutions are significantly different from their nineteenth-century predecessors in academic focus and generally do not offer agriculture programs, I have used "land grant institution" to refer to the federally funded colleges of agriculture established under the 1862 and 1890 Congressional acts.

[24] *Morrill Act. 7 USC*, 1862. http://www.ourdocuments.gov/doc.php?doc=33&page=transcript.

[25] Osborne, Ed. "Taking Agricultural Education to the Next Level." *Journal of Agricultural Education* 52, no. 1 (March 1, 2011): 1–8. doi:10.5032/jae.2011.01001.

[26] Ibid. 90.

the new institutions sought to equip future farmers with the technical skills they would need rather than to teach abstract theoretical concepts. Around the same time, primary and secondary schools began to incorporate topics related to farming into the general education curriculum, often with an emphasis on natural sciences. Teachers in rural areas, where the majority of schools were located, used instruction about farming to make the curriculum relevant to the students they taught as well as to prepare them for the higher education now available at the land-grant institutions.[27] As a result, early agricultural education was available to the general public as part of the primary and secondary school curriculum.

Unfortunately, the newly established institutions met with early challenges. Organized into narrowly focused departments that were unprepared to address complex issues and plagued by internal and external political problems, the USDA was unable to carry out its research mission effectively. Land-grant universities faced different challenges, a lack of qualified instructors chief among them.[28] Schools to prepare agricultural educators did not yet exist, so the newly-established institutions came up short as they scrambled to fill their teaching positions. The professors who were hired for these positions, often pulled in from other departments, came from academic backgrounds and lacked farming experience, leaving them ill-prepared to teach the hands-on curriculum they were provided.

Buoyed by strong support from the agrarian lobby, Congress passed a number of acts meant to address these problems. The Hatch Act of 1887 established agricultural experiment stations to help the USDA and land-grant institutions carry out focused research, and the Smith-Lever Act of 1914 authorized federal funding to support these extension activities.[29] Extension agencies, which carry out research on common agricultural problems and communicate the results to farmers, play a vital role in increasing scientific understanding of agriculture and thus provide an ever-increasing knowledge base for agricultural education. The 1907 Nelson Amendments to the Morrill Act financed the training of agricultural instructors, improving the

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[27] *Understanding Agriculture: New Directions for Education*, 1988, 54-55.

[28] Shinn, E. H., and F. A. Merill. *A Study of Land-grant College Curricula Relative to Special Courses for Agricultural and Home-economics Extension Teachers*. Washington, D.C. : Extension Service, U.S. Dept. of Agriculture, 1927. http://archive.org/details/studyoflandgrant59shin.

[29] Sayre, Laura. “Introduction: The Student Farm Movement in Context.” In *Fields of Learning : The Student Farm Movement in North America.*, 1–28. University Press of Kentucky, 2011, pp. 9.

quality of teaching.[30] In the Smith-Hughes Act of 1917, the federal government defined standards for vocational agricultural education for the first time, mandating supervised agricultural experiences (SAEs) for all students of agriculture, and provided federal funds to maintain these programs.[31] Together, these measures solidified the role of the government as the main source of financial support and oversight for agricultural education, bringing greater centralization and legitimacy to the relatively new discipline.

Progressive Influences on Agricultural Education

Early agricultural education was surprisingly well-rounded, thanks to the influence of the Progressive movement. Around the turn of the twentieth century, education at all levels was undergoing significant reforms. While educational philosophers often focused on children, many turned their attention to colleges and universities as well.[32] Four of these philosophers in particular, John Dewey, Liberty Hyde Bailey, Rufus W. Stimson, and Garland A. Bricker, made unique contributions to the way agriculture was taught in higher education.

John Dewey, who has been called “without doubt the most influential educational theorist of the twentieth century,”[33] articulated Progressive theories on natural science education and experiential learning. His work, from *Democracy and Education* (1916) to *Experience and Nature* (1925) and *Experience and Education* (1938), met with wide acclaim; although he did not specifically address agriculture, his writings helped justify the treatment of agriculture as a natural science that should be taught through hands-on experience. He was instrumental in the “nature-study movement”, which promoted gardens in schools as a way of connecting children to nature.[34] In *Experience and Education*, Dewey articulated the concept of “experiential learning” for the first time, defining it as “learning through real-life contexts.”[35] This, of course, was how parents had always taught their children to farm, but transplanting agricultural education into the

[30] Osborne, 2011.
[31] Bird, William, Michael Martin, and Jon Simonsen. “Student Motivation for Involvement in Supervised Agricultural Experiences: An Historical Perspective.” *Journal of Agricultural Education* 54, no. 1 (March 18, 2013): 31–46. doi:10.5032/jae.2013.01031, 37.
[32] Ibid.
[33] Kolb, David A. *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1984, 12.
[34] Sayre, 2011.
[35] Knobloch, Neil A. “Is Experiential Learning Authentic?” *Journal of Agricultural Education* 44, no. 4 (2003): 22–34, 22.

university setting threatened to make it a more academic, theoretical subject. Dewey's writings helped avoid such a development, causing experiential learning to remain a central tenet of agricultural education even as it developed into a formal program at the land-grant institutions.

Liberty Hyde Bailey applied Dewey's theories of experiential education to the agricultural context, advocating for wider use of teaching farms. Bailey was a strong proponent of the land-grant institutions, arguing in *The Country-Life Movement* (1911) that "the American college-of-agriculture… is the most highly developed agricultural education in the world."[36] Nonetheless, he saw opportunity for improvement, particularly by increasing the amount of on-farm instruction in agricultural programs. Bailey wrote, "To give only laboratory and recitation courses may be better than nothing, but land-teaching, either as a part of the institution or on adjacent farms, must be incorporated with the customary school work if the best results are to be secured."[37] A proud agrarian, he also viewed agricultural education as a tool to revitalize rural communities.

Rufus W. Stimson likewise promoted experiential education in agriculture, in his case through "supervised farming." Stimson developed the educational technique of "supervised farming" at the Smith Agricultural School, a vocational secondary school, in 1908 in Northhampton, Massachusetts.[38] Students at the school took on independent projects under the supervision of an experienced instructor as they learned to farm. This method caught on, was made mandatory by the Smith-Hughes Act less than a decade later, and remains common at land-grant institutions today in the form of supervised agricultural experiences (SAEs).[39]

Garland A. Bricker focused on the *teaching* side of agricultural education, contributing to the recognition of agriculture as a formal academic subject. In *Agricultural Education for Teachers* (1914), he noted that the growing demand for agricultural education had outpaced the supply of qualified teachers.[40] He felt strongly that farming experience was not enough to qualify someone to teach agriculture, and that institutions for agricultural educators must be established

[36] Bailey, L. H. *The Country-life Movement in the United States*. New York: Macmillan Co, 1911, 65.
[37] Ibid. 81.
[38] Osborne, 2011, 57.
[39] Bird, William, Michael Martin, and Jon Simonsen. "Student Motivation for Involvement in Supervised Agricultural Experiences: An Historical Perspective." *Journal of Agricultural Education* 54, no. 1 (March 18, 2013): 31–46. doi:10.5032/jae.2013.01031.
[40] Bricker, Garland Armor. *Agricultural Education for Teachers*. American Book Company, 1914, 9.

instead.[41] In a time when proponents of agriculture were seeking to establish its legitimacy as an academic subject, Bricker's writings led to greater reflection on the processes of curriculum development and instruction in an agricultural setting. Together, Bricker and other Progressive writers contributed to the theory behind agricultural education at land-grant institutions.

How was all this theory actually put into practice in the classroom? Science-oriented, broad in scope, and experiential, agricultural education as envisioned by the Progressives was an important component of the education of both farmers and non-farmers. Science was seen as the solution to agricultural problems, an attitude shown by this passage from a letter written by an agricultural educator in 1928: "The farmer who just farms on the basis of his experience is passing. The farmer who can draw upon scientific knowledge and apply that knowledge to the soil is the kind of farmer who will dominate the situation in the future."[42] Implicit support of this science-oriented approach is likewise visible in a 1927 journal article by F. A. Buechel, a faculty member at the "A. and M. College of Texas," now Texas A & M University.[43] He wrote that agricultural education should be fundamentally *problem*-oriented rather than *production*-oriented, and that the agricultural curriculum should be "a device for bringing together in an organized way and in a rational sequence the materials of such fields of thought and of such academic tools as will contribute most to the student's vision of the industry and his ability to meet its problems."[44] This organized, rational, problem-oriented approach clearly positions agriculture as a science.

Students of agriculture received a strikingly interdisciplinary education. The ideal curriculum for a land-grant institution, as laid out by Buechel, included Agricultural Resources of the World, English Composition, Botany, and Mathematics in the first year; Natural Science, Production Economics, Regional and Comparative Agriculture, General Accounting, and English Literature in the second year; Statistical Method, Agricultural Economics, Marketing, The Financial Organization of Society, and Public Speaking in the third year; and Social Institutions

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[41] Barrick, R. Kirby. "Agricultural Education: Building Upon Our Roots." *Journal of Agricultural Education* no. Winter (1989): 24–29, 25.

[42] Will C. Wood, quoted on Perrin, Charles A. "The Agricultural Curriculum." Master of the Arts in the Department of Education, Claremont Colleges, 1932, 2.

[43] Buechel, F. A. "Land Grant College Curricula." *Journal of Farm Economics* 9, no. 1 (January 1, 1927): 53–62. doi:10.2307/1230566.

[44] Ibid. 53.

and Land Economics, Co-operative Marketing, Business Law and Organization, and Farm Management in the last year, in addition to a number of non-agricultural electives.[45] This disciplinary breadth also appears in a vocational agricultural curriculum from 1932:

> The relation of the agricultural department to the other departments is looked at from a broad point of view. In a broad way it is very plain that it bears a very intimate relation to the work of every other department in the school. The farmer of tomorrow must be trained in his native tongue. He must know how to express himself correctly by the written word, and he must be able to speak forcibly and convincingly when on his feet…Science and agricultural courses go hand in hand. The relation is close between agriculture and social science. The farmer of today must build the superstructure of better social and economic conditions…Mathematics and drawing are used in the everyday life of the farmer. There is nothing that adds more to a splendid, well-rounded country life than the appreciation of art and music.[46]

This disciplinary breadth is closer to a modern liberal arts curriculum than that of a modern land-grant institution, but agricultural education would change significantly in this regard over the course of the twentieth century.

In addition to being widely available and interdisciplinary, early agricultural education was experience-based. Bailey’s teaching farms and Stimson’s “supervised farming” drew on theories of experiential education being advocated by other Progressive reformers, keeping agricultural education hands-on even as it entered the ivory tower of formal academia. After the passage of the Smith-Hughes Act required agriculture students to do “at least six months’ directed or supervised practice work in agriculture,” experiential education was most visible in the form of the “home project.”[47] A 1924 teaching manual for vocational agriculture describes the home project as “a productive farm enterprise, related to the school work and supervised by the instructor, carried to completion on a strictly business basis, requiring careful study,

[45] Ibid. 56-58.
[46] Perrin, 1932, 36.
[47] Schmidt, Gustavus Adolphus. *New Methods in Teaching Vocational Agriculture*. The Century Vocational Series. New York: Century, 1924, 150.

planning, recording, and execution, and summarized and reported upon at its close."[48] Examples given include raising a flock of fifty laying hens to maturity or growing five acres of corn, planning every step thoroughly and keeping detailed records in each case. Class projects where all students were actively involved, for example in collectively raising a herd of cattle, supplemented the home project as experiential components of the vocational agricultural curriculum.[49]

Early agricultural education was available to the general public, thanks to widespread acknowledgement of agriculture's importance to society. A 1932 thesis on agricultural education noted that there were 6.4 million farms in the United States, employing 12 million farmers and producing $14 billion worth of agricultural products.[50] The author's belief in the pre-eminence of agriculture is clear:

> No industry is so important to us at the present time, or requires such a wide range of practical or technical knowledge if we are going to be able to conserve our resources and maintain production to a necessary level. Moreover, agriculture will always be the chief business of our country if we are to exist and prosper as a nation.[51]

With these words, he was echoing a sentiment proclaimed at the highest levels of government by President Theodore Roosevelt. In a 1907 address called "The Man Who Works with His Hands," Roosevelt stated, "If there is one lesson taught by history it is that the permanent greatness of any state must ultimately depend more upon the character of its country population than anything else. No growth of cities, no growth of wealth can make up for a loss in either the number or the character of the farming population."[52]

This belief in the importance of agriculture was made manifest in the inclusion of agriculture in the general educational curriculum. Buechel wrote, for example, that non-farmers

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[48] Ibid. 154.
[49] Ibid. 154.
[50] Perrin 1932, 1.
[51] Ibid. 3.
[52] Roosevelt, Theodore. *The Man Who Works with His Hands : Address of President Roosevelt at the Semi-centennial Celebration of the Founding of Agricultural Colleges in the United States, at Lansing, Mich., May 31, 1907*. Washington, D.C. : U.S. Dept. of Agriculture, Office of the Secretary, 1907. http://archive.org/details/manwhoworkswithh24roos, 6.

and farmers must play complementary roles in ensuring the continued economic vitality of this prominent industry: “These two fields of effort, viz: economic and social research designed to build up a body of dependable knowledge and the training of men equipped by a vision of the field and the statistical technique to actually perform the work, must go hand in hand.”[53] In practice, this meant the development of two distinct curricula, with introductory courses for the general public and experiential, science-based education for agriculture majors:

> For example, there are the short courses in most Land Grant Colleges which are designed to furnish non-collegiate men useful but non-technical information relative to crops and soils, and the feeding, breeding and care of animals. Again we have the four-year college curriculum, composed in the main of technological subjects based upon the natural sciences. These basic four-year curricula are in many Land Grant Colleges modified and made more elastic by organization into groups for the two upper-class years, corresponding to the various departments of the school or college.[54]

Given the importance of agriculture to rural communities and the American economy, it made sense that education on this topic was available to everyone. The final few years of the agriculture degree then built on that general education, helping future farmers gain more depth and specialized skills in their career field. In its most developed form, higher education in agriculture at the land-grant universities was scientific, interdisciplinary, and experiential.

Away From Its Roots

Before long, however, this ideal began to change, and agricultural education became more vocational and specialized. One reason was that the standards imposed by the Smith-Hughes Act had unintended consequences; according to Mayer and Mayer (1974). They write, “The passage of this act marked the point at which ‘vocational agriculture’ diverged from and largely replaced general agricultural education in the schools.”[55] The more stringent requirements for vocational agriculture meant that it was no longer cost-effective to provide education about farming in the public school curriculum and general interest courses at land

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[53] Buechel 1927, 55.
[54] Ibid. 54.
[55] Mayer and Mayer, 1974, 56.

grant institutions. Instead, agricultural education began to be restricted to a small group of future farmers majoring in agriculture.

A divergence in the structure of American higher education brought further changes to the agricultural curriculum and target audience. Mayer and Mayer note that while public and private universities had previously been "scarcely distinguishable by their size or curriculum,"[56] the rise of the conflicting ideals of the research university and the liberal arts college created a growing divide between the practical and the theoretical. Science, in particular, became less common in vocational agriculture to make room for more instruction in on-farm skills.[57] As a result, agricultural curricula devoted little time to building an understanding of the natural systems that support crop production and focused instead on producing food; in the words of one agricultural educator, "Production agriculture… remains the norm."[58] Later in the twentieth century, this trend was strengthened when many states followed the recommendations of a 1977 Iowa State University study that "emphasized production agriculture subjects" as the gold standard. [59]

The target audience of agricultural education changed, too, as universities and vocational institutions continued to diverge; now, only future farmers studied agriculture. An increasingly high percentage of agriculture students came from farming backgrounds, in contrast to the dwindling percentage of farmers in the population as a whole. For example, a 1986 study at the University of Idaho's College of Agriculture showed that over one third of agriculture students had been raised on a farm, and incoming students averaged over three years of on-farm employment experience.[60] Like the unintended consequences of the Smith-Hughes Act, the growing dichotomy among American universities made agricultural education more career-oriented and less accessible to the general public.

Land use changes and government-funded research activities also caused increasing specialization within agricultural education. Following WWII, population increases and the

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[56] Mayer and Mayer, 1974, 90.
[57] Osborne, 2011, 58.
[58] *Understanding Agriculture: New Directions for Education*, 1988, 31.
[59] Ibid. 32.
[60] Slocombe, John W. "Factors Associated With Enrollment In Agricultural Curricula at Land Grant Universities." *NACTA Journal* (December 1986): 26–29.

expansion of the suburbs drove land prices higher in many areas, creating economic pressure on farmers to sell their land. As small farms consolidated, the number of farming jobs decreased and agriculture students began to specialize in other agriculture-related careers. In Los Angeles County, for example, the population increased by 1,887,771 people from 1950 to 1960, but the number of farms decreased by 7,162, or 59%. A study of vocational agriculture courses in high schools in Los Angeles County described the consequences:

> [T]he work placement of the graduates of vocational agriculture courses became more centered in related agricultural jobs, and in continuing education into and throughout college… Fewer of the graduates of vocational agriculture are going onto their own farms. There is neither land nor opportunity for them to be absorbed directly into production farming in the county, or the area.[61]

Similar trends elsewhere in the country, combined with new agricultural technologies that required specialized knowledge to operate, helped turn agricultural education into a number of distinct technical disciplines.

Government research funding exacerbated this specialization. The Hatch Act, which had established research and extension stations, greatly increased the knowledge base of agriculture; as a result, the broad-based general agricultural education gave way to a plethora of more specific majors.[62] By 1994, 54 distinct agriculture-related major tracks were offered at the land grant institutions, showing just how far this trend of specialization had gone.[63] During the Cold War, the federal government emphasized narrow focus areas in their allocation of research funding, causing university departments to pursue greater depth within their own research fields rather than collaborate across disciplines. As a result, collaboration between agriculture and the other natural sciences decreased even further.[64] In 1977, leaders at land-grant institutions around the United States petitioned Congress to transfer oversight of agricultural education programs

[61] Sharon, John Bailey. "Trends in Vocational Agricultural Education in Los Angeles County, 1950-1960." Master of the Arts, Claremont Graduate University, 1964, 15.

[62] National Research Council, Committee on the Future of the Colleges of Agriculture in the Land Grant University System. *Colleges of Agriculture at the Land Grant Universities: A Profile*. Washington D.C: National Academy Press, 1995. http://ccl.idm.oclc.org/login?url=http://site.ebrary.com/lib/claremont/Doc?id=10060452, 35.

[63] Ibid. 37.

[64] Parr, Damian M., Cary J. Trexler, Navina R. Khanna, and Bryce T. Battisti. "Designing Sustainable Agriculture Education: Academics' Suggestions for an Undergraduate Curriculum at a Land Grant University." *Agriculture and Human Values* 24, no. 4 (December 1, 2007): 523–533. doi:10.1007/s10460-007-9084-y.

from the Department of Education to the USDA. As a consequence, in the National Agricultural Research, Extension, and Teaching Policy Act of 1977, the USDA formally took control of agricultural research, extension, and education activities.[65] This transfer of authority showed that teaching future farmers had been replaced by agricultural productivity and profitability as the central mission of agricultural education. Section 1402 explicitly states that the primary purpose of federally funded agricultural education is to "enhance the competitiveness of the United States agriculture and food industry in an increasingly competitive world environment."[66] By this point, agricultural education found itself far from its origins as an interdisciplinary, science-based component of the American general education curriculum. While it had retained the experiential focus (for example, a 1948 vocational agriculture textbook begins by emphasizing the importance of "learning by doing"[67]), it was almost entirely vocational, restricted to future farmers. Sayre writes that "From the perspective of the late twentieth century, the professionalization and institutionalization of agriculture as a science had gone too far, losing all sight of interdisciplinary education or the need to communicate with nonfarmers."[68]

Twentieth-Century Critics of the Land-Grant Institutions

The land-grant institutions had been criticized at various times throughout the twentieth century, but critics became much more outspoken in the 1970s and 1980s. Common themes were a lack of environmental awareness, few interdisciplinary connections, and decreasing attention paid to science.

The nascent environmental movement highlighted the need for a more environmentally friendly approach to agriculture. Wes Jackson and Wendell Berry lamented the degradation of soils and watersheds caused by traditional agriculture, portraying it as a consequence of the comfortable relationship between agrochemical corporations and the agricultural education institutions they financed. David Orr, a professor of environmental studies at Oberlin College,

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[65] Gilmore, Jeffrey L., Allan D. Goecker, Ella Smith, and P. Gregory Smith. "Shifts in the Production and Employment of Baccalaureate Degree Graduates from United States Colleges of Agriculture and Natural Resources, 1990-2005." In *Transforming Agricultural Education for a Changing World*. Washington, DC: National Research Council, 2009.

[66] *National Agricultural Research, Extension, and Teaching Policy Act of 1977*, 1977. http://www.csrees.usda.gov/about/offices/legis/pdfs/nar77.pdf.

[67] Bell, Otis, University of Florida, and Florida. *Building for Better Living*. Gainesville: University of Florida Project in Applied Economics, College of Education, 1948.

[68] Sayre, 2011, 9.

echoed the call for an environmental agricultural ethic but applied it specifically to liberal arts colleges, advocating for the cultivation of what he called "ecological literacy" through the establishment of student farms at these colleges. Orr hoped to enrich liberal arts colleges rather than reform the land-grant system, but his ideas were influential in a broader context.[69]

Others critiqued the traditional agricultural curriculum for being too narrowly disciplinary and not scientific enough. André and Jean Mayer described the increasing isolation of agriculture in higher education as "an intellectual disaster" in their 1974 essay "Agriculture: The Island Empire."[70] They noted that making agricultural education available only to future farmers was detrimental to the general public and even to American foreign policy:

> The failure of our secondary schools and liberal arts colleges to teach even rudimentary courses on agriculture means that an enormous majority, even among well-educated Americans, are totally ignorant of an area of knowledge basic to their daily style of life, to their family economics, and indeed to their survival. It also means that our policies of agricultural trade and technical assistance, as important to our foreign relations as food production is to our domestic economy, are discussed in the absence of sound information, if indeed they are discussed at all.[71]

A second major point of criticism was the trend away from a natural-science approach to agriculture that had begun with the emphasis on vocational education. Mayer and Mayer noted that far from its origins as "the nation's most important scientific interest", agriculture had become "separated from the mainstream of American scientific thought."[72] Contemporary students of agriculture, now a homogeneous group of future farmers, received an education that prepared them to produce agricultural commodities, but without necessarily understanding the underlying natural sciences. MacRae *et al.* (1989) noted that this lack of science was a significant obstacle to making agriculture more environmentally sustainable:

> It is our contention that we rely on too few approaches to agricultural science, that these approaches are not sufficiently comprehensive, and that agricultural scientists

[69] Ibid. 10.
[70] Mayer and Mayer, 1974, 90.
[71] Ibid. 84.
[72] Ibid.

> have traditionally been associated with too few players in the food system to establish a sufficient knowledge base for sustainable agriculture.[73]

By the late 1970s, not only had agricultural education evolved to be more career-oriented and less interdisciplinary and scientific, but it had become less popular as well. Enrollment was declining by up to 3% annually from its peak in 1976-1977 and vocational agriculture programs saw a drop in enrollment of almost 20% from 1975-1981,[74] then another drop of almost 25% from 1981-1986.[75] In the 1980s, economic forces began to drive many farmers out of business, as land prices and dwindling export markets for agricultural commodities made it nearly impossible to eke out a living by farming.[76] This "farm crisis," as it came to be known, proved the final straw: faced with public criticism, declining enrollments, and now dismal economic prospects for their graduates, the land-grant institutions began to begin to reconsider the way they were teaching agriculture.

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[73] MacRae, Rod J., Stuart B. Hill, John Henning, and Guy R. Mehuys. "Agricultural Science and Sustainable Agriculture: a Review of the Existing Scientific Barriers to Sustainable Food Production and Potential Solutions." *Biological Agriculture & Horticulture* 6, no. 3 (1989): 173–219. doi:10.1080/01448765.1989.9754518, 174.

[74] *Understanding Agriculture: New Directions for Education*, 1988, 28. Note that these figures include secondary school enrollment as well as programs at land grant institutions.

[75] Slocombe, 1986.

[76] Manning, Jason. "The Midwest Farm Crisis of the 1980s." *The Eighties Club*. Accessed November 12, 2013. http://eightiesclub.tripod.com/id395.htm.

Chapter 2. Reform and Renewal

Although agricultural education originated at land-grant institutions, it is by no means limited to that context today; after all, the Pomona College Organic Farm is a tiny student farm at a liberal arts college. Furthermore, the contemporary agricultural curriculum shows evidence of a return to the original emphasis on natural science and disciplinary breadth. How did agricultural education get from its low point in the early 1980s to its current state?

Reforms within the land-grant institutions beginning in the 1980s, spurred by public criticism, declining enrollment, and the farm crisis, sought to revitalize the agricultural curriculum. Major themes, often driven by student demand, included restoring scientific depth, increasing interdisciplinary connections, and improving environmental awareness. Student demand also contributed to the expansion of agricultural education beyond the land-grant institutions, driving liberal arts colleges to enter the field of agricultural education for the first time. Significantly, student farms have often been the primary mechanism for the introduction of agricultural education into the liberal arts, a development with important implications for the future.

Reform within the Land-Grant Institutions

Re-evaluation of the agricultural curriculum began in the 1980s, resulting in greater scientific depth, more interdisciplinary connections, and a heightened awareness of environmental sustainability. The declining amount of formal science in the higher education curriculum was not limited to the farming context, as evidenced by a 1980 report by the National Science Foundation and U.S. Department of Education referring to America as a nation of "scientific illiterates." In the aftermath of this report, land-grant institutions tried to determine how to adopt a more scientific approach, for example at a 1992 agricultural education conference convened by the National Research Council's Board on Agriculture and Natural Resources.[77] Speakers addressed the topic from various angles, all acknowledging the importance of changing the curriculum to be more scientific. John C. Gordon called on professors in departments of agriculture to "remake higher and lower education, particularly the part of it concerned with

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[77] *Agriculture and the Undergraduate*. Washington, DC: Board on Agriculture, National Research Council, 1992. http://www.nap.edu/catalog/1986.html.

what we call science education". He argued that "disciplinary probity" was preventing traditional land-grant universities from adequately addressing environmental issues and that "science, particularly the practical sciences and science-based professions, from agriculture to zoology, has retreated within itself and has virtually ceased to influence the broader curriculum."[78] Robert M. Hazen went so far as to title his talk "Scientific Literacy: The Enemy is Us," arguing that the traditional curriculum was too discipline-restricted and prevented non-majors from gaining scientific literacy.[79] Eventually, these theoretical discussions were put into practice: land-grant institutions raised their entry requirements for incoming undergraduates and began to incorporate more formal science into their curricula.[80]

Another criticism of land-grant institutions had been that they were too divided by academic disciplines, and reformers sought to address this as well. A 1994 study called for interdisciplinary research methods to replace the way land-grant institutions had traditionally done agricultural research.[81] Reports in the late 1990s by the National Research Council, Boyer Commission, and Kellogg Commission all called for a more interdisciplinary approach to agricultural education and research.[82,83] The NRC report noted that while traditional departments had prepared students for highly specialized careers, the complexity of the issues facing the contemporary food system made reform necessary.[84]

Recognition of the need to incorporate environmental awareness into the agricultural curriculum was the result of pressures from above and below. As economic conditions forced many farmers to declare bankruptcy during the farm crisis of the 1980s, others tried replacing chemical inputs with natural methods as a way to remain solvent; as a result, these more

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[78] Gordon, John C. "The Environmental Curriculum: An Undergraduate Land- Grant Future?" In *Agriculture and the Undergraduate*, 51–54. Washington, DC: National Research Council, 1992.

[79] Hazen, Robert M. "Scientific Literacy: The Enemy Is Us." In *Agriculture and the Undergraduate*, 95–103. Washington, DC: National Research Council, 1992.

[80]Osborne, 2011, 59.

[81] Bezdicek, David F., and Colette DePhelps. "Innovative Approaches for Integrated Research and Educational Programs." *American Journal of Alternative Agriculture* 9, no. 1–2 (1994): 3–8.

[82] *Returning to Our Roots: Executive Summaries of the Reports of the Kellogg Commission on the Future of State and Land-Grant Universities*. Battle Creek, MI: Kellogg Commission on the Future of State and Land-Grant Universities, 1999. http://www.aplu.org/NetCommunity/Document.Doc?id=187.

[83] Parr, Damian M., Cary J. Trexler, Navina R. Khanna, and Bryce T. Battisti. "Designing Sustainable Agriculture Education: Academics' Suggestions for an Undergraduate Curriculum at a Land Grant University." *Agriculture and Human Values* 24, no. 4 (December 1, 2007): 523–533. doi:10.1007/s10460-007-9084-y.

[84] Ibid.

sustainable techniques gained prominence.[85] Consequently, the USDA established the Sustainable Agriculture Research and Education (SARE) program in 1988 to conduct and publicize research on farming techniques with minimal environmental impact.[86] SARE helped bring sustainability into the agricultural curriculum both indirectly, by providing official recognition of its importance, and directly, through extension programs.

Pressure to create alternative agricultural methods with fewer chemicals came from below as well. The modern environmental movement was beginning to gain ground in the United States during this time, and Rachel Carson's *Silent Spring* brought attention to the disastrous ecological consequences of some of the toxic chemicals used in conventional agriculture. Of course, concern for the environment was not new; indeed, early proponents of agricultural education such as Liberty Hyde Bailey and Garland A. Bricker advocated for the preservation of natural resources. Bricker wrote in 1914 that "by wasteful and unscientific methods of farming, we are preparing to transmit an impoverished soil to the future inhabitants of this country," showing a concern for soil health that would regain prominence in the late twentieth century.[87] Although the land-grant institutions lost sight of this conservation ethic in their twentieth-century focus on production agriculture, modern environmentalists pushed to restore it to the agricultural curriculum in order to address pollution, overuse of fossil fuels, and resource depletion.

It is extremely difficult to assess how the curricula of more than a hundred unique and diverse universities changed in response to these pressures, especially with regard to the level of science and cross-disciplinary integration. Evaluations by internal sources, such as the National Research Council's 2009 report, *Transforming Agricultural Education for a Changing World,* may provide useful, if subjective, insights.[88] Members of the committee that drafted the report include past and present administrators at land-grant institutions, as well as representatives of agrochemical companies such as Monsanto and Dow; thus, the report represents many voices of the conventional agricultural establishment. They feel that science has been successfully integrated in the land-grant institution curriculum today, writing, "Agriculture now so thoroughly

[85] Sayre, 2011, 22.
[86] "Historical Timeline." *Sustainable Agriculture Research & Education*, 2012. http://www.sare.org/About-SARE/Historical-Timeline.
[87] Bricker, 1914, 10.
[88] *Transforming Agricultural Education for a Changing World*. Washington, DC: National Research Council, 2009.

combines basic and applied aspects of the traditional STEM disciplines of science, technology, engineering, and mathematics that the acronym might rightly expand to become STEAM, joining agriculture with the other fundamental disciplines." The authors also laud progress made by the land-grant institutions toward an interdisciplinary approach, although they still issue a call to "broaden the treatment of agriculture in the overall undergraduate curriculum."[89] While this evaluation may be subjective, it does suggest that land-grant institutions feel they have been somewhat effective in their efforts to increase science and cross-disciplinary integration.

The growth of environmental awareness has received even more attention, although the scope of reform is still limited. The land-grant response to the environmental movement was slow at first. A 2002 study provided a possible explanation, noting that land-grant institutions encountered "major difficulties in operating the transition to a sustainable agriculture approach, in part because of well-established associations with agrochemical companies and food corporations that predominantly fund their research and academic programs."[90] These corporations were presumably not eager to support a type of agriculture that used fewer of the commodities they produced. Clearly, criticism by Wes Jackson and Wendell Berry had not changed the cozy financial relationship between industry and agricultural education.

Since then, however, official endorsements and new programs show that land-grant institutions are paying more attention to environmental sustainability. For example, the 2009 NRC report notes that the definition of agriculture is changing, and that "'sustainability' is the watchword of today."[91] The report still promotes traditional production-focused agriculture, but does mention the need to preserve "the natural resource base that underpins all economic activity and the global way of life in the long term."[92] Likewise, when the Association of Public and Land-Grant Universities (APLU) convened in 2010, the first of their seven "Grand Challenges" was to "enhance the sustainability, competitiveness, and profitability of U.S. food and

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[89] Ibid.

[90] Borsari, Bruno. "Assessing Students' Preparedness Towards Sustainability in US and European Undergraduate Agricultural Curricula." *American Journal of Alternative Agriculture* 17, no. 4 (2002): 188–194. doi:10.1079/AJAA200225, 188.

[91] *Transforming Agricultural Education for a Changing World*, 2009, 1.

[92] Ibid. pp. 2.

agricultural systems."[93] That sustainability is listed first of those three goals marks a significant change from the traditional agricultural establishment's previous narrow focus on production.

Land-grant institutions have begun acting on these recommendations, offering programs focused on sustainable and organic agriculture.[94,95] Marianne Sarrantonio, coordinator of the University of Maine's agricultural school, noted in a 2009 interview that most of the land grants now offer at least a minor in sustainable agriculture, if not a full degree program.[96] In fact, of baccalaureate agricultural degrees awarded since 1987, Natural Resources Conservation and Research is both the fastest-growing and the most-popular major: 18.6% of the total undergraduate agricultural degrees were in this area in 2006-2007, as compared to only 4.7% in 1987-1988.[97] Even as decreasing enrollment in traditional agronomy programs is causing these departments to be cut, sustainability-focused agriculture programs are booming. For example, two years after its introduction, the new Organic Production track at the University of Florida's horticulture science program accounts for 27 of the 48 total horticultural science majors.[98] At the University of Massachusetts, the Sustainable Food Systems major has grown from five students a decade ago to over 70 today.[99]

Interestingly, sustainability programs have begun to change the demographic makeup of agriculture departments at land-grant institutions. These programs have traditionally been composed of "white male students in rural areas."[100] Today, 81% of students identify as non-Hispanic white, down only slightly from 87% twenty years ago, and only recently has the gender ratio begun to equalize.[101] However, student demographics appear to be different within

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[93] *A Science Roadmap for Food and Agriculture*. Association of Public and Land-Grant Universities, November 2010. http://escop.ncsu.edu/docs/scienceroadmap.pdf.
[94] Sayre, 2011, 24.
[95] Redden, Elizabeth. "Green Revolution." *Inside Higher Ed*, 2009. http://www.insidehighered.com/news/2009/04/23/agriculture.
[96] Redden, 2009.
[97] 6,276 of the total 33,680 undergraduate agricultural degrees were in Natural Resources Conservation and Research in 2006-7, as compared to only 872 of 18,572 degrees in 1987-8. From Gilmore, Jeffrey L., Allan D. Goecker, Ella Smith, and P. Gregory Smith. "Shifts in the Production and Employment of Baccalaureate Degree Graduates from United States Colleges of Agriculture and Natural Resources, 1990-2005." In *Transforming Agricultural Education for a Changing World*. Washington, DC: National Research Council, 2009, 158.
[98] Redden, 2009.
[99] Harris, Sarah. "Farmers Under 40: Liberal Arts Students Try Their Hand at Farming." Accessed October 8, 2013. http://www.northcountrypublicradio.org/news/story/18013/20110714/farmers-under-40-liberal-arts-students-try-their-hand-at-farming.
[100] *Understanding Agriculture*, 1988, 29.
[101] Gilmore *et al.*, 2009, 160.

sustainability programs. According to Michelle Schroeder-Moreno, coordinator of North Carolina State University's agriculture program:

> We have for example, a lot more, I guess you could say, untraditional people coming back to agriculture via sustainable agriculture and agroecology. I have more women in our minor compared to our traditional agriculture courses. I have on average 50 percent women in my courses, I have more underrepresented minorities, people that perhaps didn't grow up in agriculture and come from non-agricultural backgrounds. Myself included.[102]

Despite the encouraging progress being made on the environmental sustainability front, it is important to note that the scope of this reform remains small. As Damian Parr, Research and Education Coordinator at the UC Santa Cruz Center for Agroecology and Sustainable Food Systems, remarks, "Is it taking over land-grants? Definitely not yet."[103]

Fertile New Ground: Agriculture and the Liberal Arts

The reform of agricultural education was not limited to the land-grant institutions, however. An explosion of on-campus student farms has brought agriculture to liberal arts colleges for the first time since the divergence of the liberal arts model from the research university. Despite the importance of student farms to both liberal arts colleges and land-grant institutions, the liberal arts version of agricultural education differs in important ways from its land-grant counterpart.

Student farms began to regain popularity in the 1970s and 1980s with the back-to-the-land movement, most notably at the University of California at Santa Cruz.[104] Alan Chadwick, a British expatriate with a passion for environmental sustainability, established a garden at UCSC in 1967. Using organic techniques such as French-intensive tilling and biodynamic methods, Chadwick established a garden internship for interested students that gradually led to an official Agroecology program in 1980. Incorporating undergraduate study of sustainable agriculture and formal research, the UCSC Farm has grown from its original four acres to a 25-acre teaching

[102] Redden, 2009.
[103] Ibid.
[104] Ibid.

facility for the UCSC Center for Agroecology and Sustainable Food Systems (CASFS). Researchers at the UCSC Farm contributed to the development of organic production methods of crops that had previously been considered impossible to grow organically, such as strawberries and cotton.[105]

Growing recognition of the need for an agriculturally literate public was also instrumental in bringing agricultural education back to a wider target audience. An important step was the official endorsement of the National Research Council, whose reports had helped drive the reform of agricultural education in other areas as discussed previously. A 1988 National Research Council report on agricultural education called for a broader target audience in addition to other reforms.[106] Initiated in 1985 in response to "concerns about the declining profitability and international competitiveness of American agriculture, as well as concern about declining enrollments, instructional content, and quality in agricultural education programs,"[107] this study is predominantly concerned with the global role of American farmers. Still, the authors make some important statements about domestic agricultural education, including a significant distinction between "agricultural literacy (education *about* agriculture) and vocational agriculture (education *in* agriculture)". They argue that "agricultural education must become more than vocational agriculture" in order to reach beyond the traditionally white male student base, replace the outdated focus on production agriculture, and prepare an agriculturally literate public to support policies making American agriculture competitive abroad.[108] *Understanding Agriculture* was thus an important first step in reversing the twentieth-century trend toward a narrow, career-oriented agricultural curriculum and bringing agricultural education to liberal arts colleges.

Demand for agricultural education in the liberal arts also came from below. Students interested in agriculture have established a multitude of on-campus farms in the past two decades, mostly at liberal arts colleges.[109] The Rodale Institute, the Sustainable Agriculture

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[105] McNulty, Jennifer. "Breaking New Ground." *UC Santa Cruz Fall Review*, Fall 2007.
[106] *Understanding Agriculture: New Directions for Education*, 1988.
[107] Ibid. v.
[108] Ibid. 1.
[109] Mazurkewicz, Melissa, Amy Harder, and Grady Roberts. "Evidence for Experiential Learning in Undergraduate Teaching Farm Courses." *Journal of Agricultural Education* 53, no. 1 (March 1, 2012): 176–189. doi:10.5032/jae.2012.01176.

Education Association, and American Association of Sustainability in Higher Education each maintain separate lists of student farms in the United States. Combining the lists gives 110 farms, 53 of which are located at liberal arts colleges. These numbers are likely underestimates, considering that the 2009 College Sustainability Report Card found that 29% of the 300 leading colleges and universities had some sort of community garden or campus farm,[110] and that four of the five student farms and gardens at the Claremont Colleges didn't make any of the three lists. The trend is recent: the vast majority of the thirty farms at liberal arts colleges were founded in the 1990s or 2000s.[111,112] Leis *et al.* (2011) surveyed student farm managers in the United States, finding that 37% of such farms are located at liberal arts colleges and that the majority of all student farms (59.5%) were founded since 1990.[113] Clearly, agriculture has recently become a topic in high demand at liberal arts colleges.

Sayre profiles this trend in *Fields of Learning: The Student Farm Movement in North America*, noting that it embodies "the revival of an old pedagogical idea: finding ways to combine liberal arts undergraduate education with hands-on, practical farming and gardening experience."[114] Indeed, student farms, with their focus on experiential learning, draw on the theories of early agricultural educators like Liberty Hyde Bailey, although in the liberal arts context they take on a new role.

Student farms established in the past two decades have often followed a similar progression to that of the UC Santa Cruz farm, from idealistic origins to incorporation in the curriculum.[115] Of the 50 farms analyzed in a 2011 survey of student farms in the United States, including farms at both liberal arts colleges and land-grant institutions, 85.1% of institutions offered courses and 59.6% offered a major program in agriculture. An average of five courses is taught at each farm, but the extracurricular benefits of student farms are made clear by the fact

[110] Sayre, 2010, 1.
[111] Rodale Institute. "A Directory of Student Farms." Accessed October 13, 2013. http://www.newfarm.org/features/0104/studentfarms/directory.shtml.
[112] Parr, Damian. "Student Farms in the U.S. and Canada." *Sustainable Agriculture Education Association*, September 4, 2013. http://sustainableaged.org/Projects/StudentFarmDirectory/tabid/85/Default.aspx.
[113] Leis, Anna, Susie M. Whittington, Mark Bennett, and Matthew Kleinhenz. "Student Farms at United States Colleges and Universities: Insights Gained from a Survey of the Farm Managers." *NACTA Journal* no. March 2011 (n.d.): 9–15.
[114] Sayre, 2011, 1.
[115] Leis *et al.*, 2011.

that 15% of institutions with student farms offer no courses in agriculture at all.[116] Many of these farms are small and focused on sustainability: 43.5% of farms were under four acres in size, and 80% were associated with organic and/or sustainable agriculture.[117] The authors note that farm size followed a bimodal distribution with nearly half of farms smaller than 4 acres and 30.4% over 50 acres, a result that is not surprising given that their analysis combined newly founded farms at small liberal arts colleges with long-established teaching facilities at land-grant institutions.

Despite their common use of student farms, liberal arts colleges take a significantly different approach to land-grant institutions when it comes to agricultural education. While some courses at liberal arts colleges do include hands-on work at farms or gardens, others do not; in either case, the experience is not meant as vocational education. Liberal arts colleges are also more likely to treat agriculture as a broad, interdisciplinary subject and offer related courses in disciplines such as philosophy or economics.[118,119] For example, at Middlebury College, courses that have been offered recently include Food Geographies and Political Ecologies of GMOs, and offerings at the Claremont Colleges include Global Politics of Food and Agriculture and Political Economy of Food.[120]

The way liberal arts colleges have approached agriculture has not been universally embraced. James McWilliams criticized the trend towards liberal arts agricultural education in a 2013 *Pacific Standard* magazine article. His main complaint is the way he feels liberal arts colleges promote agrarian ideology in these courses, becoming unwanted participants in the sustainable food movement. He writes of a controversy at Green Mountain College, a liberal arts institution of 700 students, where the students and faculty involved with the campus farm decided to send the elderly plow team oxen to the dining hall. An enormous public backlash ensued, and McWilliams felt that Green Mountain College retreated, neglecting its duty to

[116] Ibid. 11.
[117] Ibid. 12.
[118] Harris, 2011.
[119] "Cultivating Responsibility: Liberal Arts Schools' Contribution to Sustainable Agriculture." *Wildlife Promise*. Accessed October 8, 2013. http://blog.nwf.org/2009/02/cultivating-responsibility-liberal-arts-schools-contribution-to-sustainable-agriculture/.
[120] Personal communication with Middlebury student Katherine Michels.

engage in debate over what sustainability in agriculture means. He questions the ability of liberal arts colleges to challenge industrial agriculture, writing:

> Don't get me wrong: I think monkey wrenching industrial agriculture sounds like a lovely plan. It's just that some entities are better situated to do it than others. When a small liberal arts college steps into the fray with its own working farm, charging students $30,500 a year to work its soil, it unavoidably goes from the ivory tower to the tower of Babel, sacrificing the comforting silence of the private sphere for the raging and unregulated din of the teeming agora. [121]

By arguing that liberal arts institutions like Green Mountain College are poorly suited to enter the dialogue on the contemporary food system, McWilliams criticizes the whole concept of teaching agriculture in the liberal arts. What, after all, is the point of agricultural education at the liberal arts if not to create an agriculturally literate public who can participate in these debates?

The different target audience is perhaps the most important distinguishing factor between education at land-grant institutions and liberal arts colleges. While land-grant institutions cultivate future farmers, graduates of liberal arts colleges go on to careers in a wide variety of fields. Students of agriculture at these schools come from academically diverse backgrounds, and may be "less interested in the actual act of farming than in the food system as a whole and what it's doing to the environment."[122] The rise of agriculture courses at liberal arts colleges could thus contribute to significant changes in the American food system. Less than 1% of Americans are farmers today,[123] whereas all are consumers who wield influence through their purchasing choices. Teaching agriculture in liberal arts colleges can help create an informed public to make the American food system more sustainable.

How does this link work? While few studies have explicitly assessed the relationship between agricultural education and support of sustainable food production, the existing literature

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[121] McWilliams, Richard. "Sustainable Agriculture 9-1-1, or, That Time a College Tried to Feed Its Mascot to Students." *Pacific Standard Magazine,* August 2, 2013. http://www.psmag.com/environment/sustainable-agriculture-9-1-1-the-rise-of-earthy-college-programs-63883/.

[122] Grasgreen, Allie. "Farming Attracts Academically Diverse Students." *USATODAY.COM*, August 2, 2011. http://www.usatoday.com/news/education/2011-08-02-college-student-farms_n.htm.

[123] Ibid.

suggests a positive correlation. First, consumers with a higher level of any sort of education are more likely to produce organic and local produce.[124,125,126] The increased likelihood of buying organic may be because college-educated consumers are more likely to be concerned about pesticide residues.[127] This effect is even stronger when the education is specifically related to agriculture: consumers who recognized the term "integrated pest management," denoting alternative pest management practices, were 20% more likely to buy organic produce.[128] Hands-on gardening experience can also make consumers more likely to buy organic produce. For example, although cosmetic blemishes normally reduce consumers' willingness to buy organic produce,[129] those who have had experience growing fruit are more likely to buy blemished organic apples.[130] Sustainable agriculture encompasses more than just *organic* produce, however, and *local* food purchases are also higher among gardeners. This link could be indirect: purchasers of organic produce are more likely to have CSA (community-supported agriculture) memberships that support local farmers directly, so gardeners who buy organic may also buy local.[131] Furthermore, gardening and enjoyment of cooking both significantly increase local food purchases,[132] so agricultural education that includes hands-on components can lead to consumers who help support the local food system. Since educated (particularly agriculturally literate) consumers and those with gardening experience are more likely to buy organic and local produce, offering agricultural education at liberal arts colleges will help increase the number of these educated consumers and thus strengthen the sustainable food movement.

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[124] Thompson, G. D., and J. Kidwell. "Explaining the Choice of Organic Produce: Cosmetic Defects, Prices, and Consumer Preferences." *American Journal of Agricultural Economics* 80, no. 2 (May 1998): 277–287. doi:10.2307/1244500.

[125] Yue, Chengyan, Helen H. Jensen, Daren S. Mueller, Gail R. Nonnecke, Douglas Bonnet, and Mark L. Gleason. "Estimating Consumers' Valuation of Organic and Cosmetically Damaged Apples." *Hortscience* 42, no. 6 (October 2007): 1366–1371.

[126] Onianwa, O., G. Wheelock, and M. Mojica. "Determinants of Farmer-to-Consumer Direct-Market Shoppers." *Journal of Food Distribution Research* 36, no. 1 (2005): 130–134.

[127] Ott, S., and A. Maligaya. "An Analysis of Consumer Attitudes Toward Pesticide Use and the Potential Market for Pesticide Residue Free Fresh Produce." Nashville, TN, 1989.

[128] Yue, Chengyan, Helen H. Jensen, Daren S. Mueller, Gail R. Nonnecke, Douglas Bonnet, and Mark L. Gleason. "Estimating Consumers' Valuation of Organic and Cosmetically Damaged Apples." *Hortscience* 42, no. 6 (October 2007): 1366–1371.

[129] Thompson and Kidwell, 1998.

[130] Yue *et al.*, 2009.

[131] Kolodinsky, Jane M., and Leslie L. Pelch. "Factors Influencing the Decision to Join a Community Supported Agriculture (CSA) Farm." *Journal of Sustainable Agriculture* 10, no. 2–3 (April 22, 1997): 129–141. doi:10.1300/J064v10n02_11.

[132] Zepada, Lydia, and Jinghan Li. "Who Buys Local Food?" *Journal of Food Distribution Research* 37, no. 3 (November 2, 2006).

Chapter 3. Framing Agricultural Education for the Liberal Arts

Unlike the movement that first established formal agricultural education, the more recent liberal arts wave has thus far not devoted much time to the question of *how* agriculture should be taught. There are certainly commonalities among liberal arts colleges, most obviously the incorporation of student farms and interdisciplinary approach, but the newness of the movement means that there is no cohesive strategy to reach the goal of creating an agriculturally literate public. An analysis of the first movement of agricultural education, its twentieth-century critics, and some more recent literature, identifies a few central themes that ought to be used as guidelines in developing an agricultural curriculum for the liberal arts. For maximum impact, such a curriculum should be *scientific*, *experiential*, and *place-based*.

Reconciling Sustainable Agriculture with Science

The relationship between agriculture and science was long accepted as natural and fundamentally important, but in recent years has become more controversial. The educational potential of farms was not officially recognized at first, but they were nonetheless an important arena of learning. David Orr, a present-day advocate of student farms in the liberal arts context, argues that even before the advent of formal agricultural education, "Farms did what no other institution has ever done as well. They taught directly, and sometimes painfully, the relationship between our daily bread and soil, rainfall, animals, biological diversity, and natural cycles, which is to say land stewardship."[133] Since then, though, the combination of diminished attention to science in agricultural education and the skepticism of some environmentalists towards science in general has called that relationship into question. Mayer and Mayer wrote in 1974 that although agriculture is "the mother of sciences" and "the science which makes human life possible," many people refuse to accept the connection between science and agriculture.[134]

Today, the relationship between sustainable agriculture and science is even adversarial at times. Because the Green Revolution's use of technology to expand agricultural yields resulted in unforeseen harm to the environment, advocates of more ecologically friendly farming sometimes reject science entirely. A number of recent editorials have noted the prominence of anti-science rhetoric by environmental activists who oppose genetically modified organisms

[133] Orr, 1992, 117.
[134] Mayer and Mayer, 1974, 83.

(GMOs).[135,136,137,138] An environmental blog post titled "Farming and Knowledge Monocultures are Misconceived" serves as one example of this attitude: the authors argue that science itself is only an "ideological tool" used to promote industrialized agriculture.[139] Such an out-of-hand rejection of an entire way of reasoning damages the credibility of the sustainable agriculture movement. Some anti-GMO activists who portray themselves as supporters of sustainable agriculture have even gone so far as to attempt to sabotage experimental research plots of scientists investigating the ecological impact of genetically modified wheat.[140] Fred Pearce warns that regardless of which side of the GMO debate one supports, the most important issue is "the mindset behind those positions." The danger is that "by taking anti-scientific positions, environmentalists end up helping the anti-environmental sirens of the new right."[141]

Even beyond the potential political implications of anti-science attitudes, a complete rejection of scientific reasoning by proponents of sustainable agriculture risks alienating a potential source of support. Scientific research can prove the benefits of environmentally friendly farming techniques as compared to conventional methods and help identify best-practice methods for the future. The authors of a recent study on teaching the nature of science using sustainable agriculture note that "claims of the (non-)sustainability of a given agricultural practice generally hinge on scientific evidence and the reliability of that evidence, or at least the perception of its reliability."[142] Furthermore, they write, "the public's view of science is weakened and/or confused; it may be easier for a student who is concerned about the environment to be dismissive of science than it is to work from science toward environmental

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[135] Miller, Henry I., and Gregory Conko. "The USDA's Anti-Science Activism." *Regulation Magazine* no. Summer (2011): 16–21.
[136] Pearce, Fred. "Why Are Environmentalists Taking Anti-Science Positions?" *Environment360*, October 22, 2012. http://e360.yale.edu/feature/why_are_environmentalists_taking_anti-science_positions/2584/.
[137] Shermer, Michael. "The Liberals' War on Science: Scientific American." Accessed September 27, 2013. http://www.scientificamerican.com/article.cfm?id=the-liberals-war-on-science.
[138] Hoofnagle, Mark. "Environmentalists Must Face Down the Anti-Science in Their Own House." *Denialism Blog*, June 15, 2013. http://scienceblogs.com/denialism/2013/06/15/environmental-groups-must-face-down-the-anti-science-in-their-own-house/.
[139] Wynne, Brian, and Georgina Catacora-Vargas. "Farming and Knowledge Monocultures Are Misconceived." *SciDevNet*, March 9, 2013. http://www.scidev.net/global/agriculture/opinion/farming-and-knowledge-monocultures-are-misconceived.html.
[140] "Misplaced Protest." *Nature* 485, no. 7397 (May 10, 2012): 147–148. doi:10.1038/485147b.
[141] Pearce, 2012.
[142] Cessna, Stephen, Douglas Graber Neufeld, and S. Jeanne Horst. "Teaching the Nature of Science in a Course in Sustainable Agriculture." *Natural Sciences Education* 42, no. 1 (2013): 36–42.

goals."[143] Dismissing science altogether in this way could cause sustainable agriculture activists to be viewed as out-of-touch in a modern world that relies on technology in myriad ways. Recent studies have emphasized the value of scientific literacy for all undergraduates studying agriculture,[144] but science-based approaches to agricultural education are particularly important in ensuring the future of a broad-based, credible sustainable agriculture movement.

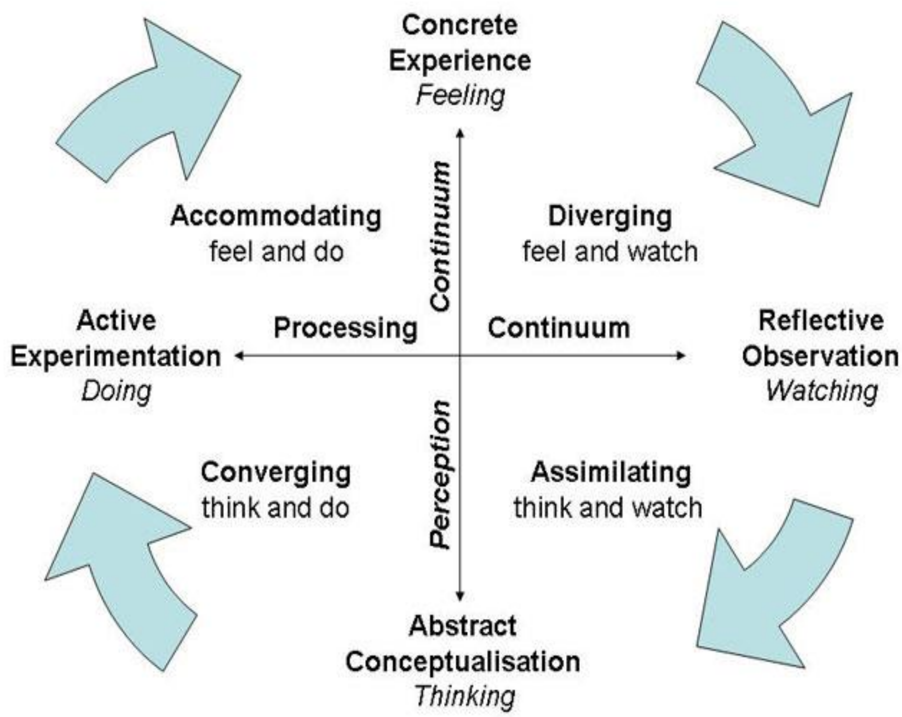
Why Hands-On Experience Matters for Non-Farmers

An agriculture curriculum for the liberal arts should also be *experiential*. Like the foundation of agriculture in science, experiential agricultural education is not a new concept.[145,146] The roots of an experiential education philosophy can be traced in the work of Jean Piaget in the 1920s. A Swiss child psychologist, Piaget posited that all knowledge was created through one's interactions with the environment. Experience as an educational philosophy in the United States was pioneered by John Dewey during the Progressive Era, then developed further by subsequent educational theorists. Dewey's *Experience and Education* appeared in 1938 and argued that firsthand experience was the most effective learning method for students; the widespread readership of this book helped popularize the concept in the United States.

However, the technique was not without its critics. David Kolb's book *Experiential Learning: Experience as the Source of Learning and Development,* which appeared in 1984, acknowledged some common points of criticism: "Some see it as gimmicky and faddish, more concerned with technique and process than content and substance. It often appears too thoroughly pragmatic for the academic mind, dangerously associated with the disturbing anti-intellectual and vocationalist trends in American society."[147] To help experiential learning gain recognition as a legitimate educational method, Kolb formalized it in a four-stage cyclical model

[143] Ibid. 36.
[144] Splan, Rebecca, Shea Porr, and Thomas Broyles. "Undergraduate Research in Agriculture: Constructivism and the Scholarship of Discovery." *Journal of Agricultural Education* 52, no. 4 (December 1, 2011): 56–64. doi:10.5032/jae.2011.04056.
[145] Knobloch, Neil A. "Is Experiential Learning Authentic?" *Journal of Agricultural Education* 44, no. 4 (2003): 22–34.
[146] Splan, Rebecca, Shea Porr, and Thomas Broyles. "Undergraduate Research in Agriculture: Constructivism and the Scholarship of Discovery." *Journal of Agricultural Education* 52, no. 4 (December 1, 2011): 56–64. doi:10.5032/jae.2011.04056.
[147] Kolb, David A. *Experiential Learning: Experience as the Source of Learning and Development*. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1984, 3.

that included “active experimentation,” “concrete experience,” “reflective observation,” and “abstract conceptualization.” As students experiment actively, they encounter new forms of concrete experience. However, for learning to occur, time must be devoted to reflection and abstract thinking about the context of the experience. Experiential learning is tailored to the individual, too, as students with different learning styles will spend different amounts of time in each stage.[148] Kolb’s cyclical model helped experiential learning gain credibility as an educational method that was more than just mindless activity.



Kolb’s experiential learning model (by Saul McLeod, used with permission of the author).

Experiential learning has long been a core component of agricultural education in particular. Liberty Hyde Bailey argued in 1911 that “to give only laboratory and recitation courses may be better than nothing, but land-teaching, either as a part of the institution or on

[148] Ibid. 33.

adjacent farms, must be incorporated with the customary school work if the best results are to be secured."[149] Seaman A. Knapp, founder of the USDA extension agencies, used demonstration farms to promote "learning by doing."[150] These model farms were made available to farmers so that they could see best-practice technologies firsthand and apply them to their own farms. Rufus W. Stimson, a secondary school teacher, pioneered the technique of "supervised farming" at Smith's Agricultural School, a vocational high school, starting in 1908. The Supervised Agricultural Experience (SAE), a core component of traditional agricultural education, grew out of this method.[151] SAEs are still being used today, in line with the recommendation of the National Research Council that every undergraduate student of agriculture participate in such experiences.[152] One example is a senior capstone exercise in the agricultural program at Iowa State University, in which students manage a working farm.[153] Recently, studies have emphasized the effectiveness of SAEs as teaching tools on student farms at land-grant institutions.[154,155]

Despite the evidence supporting experiential education, liberal arts colleges have tended to address agriculture from a theoretical perspective. An understanding of the political and economic systems that frame the modern food system is extremely important, but the personal and societal benefits of a hands-on approach to agriculture should not be discounted. Spending time gardening and farming has a range of positive effects, from better mental health to more active environmental conservationists.

The experiential learning approach allows students to reap the well-documented personal benefits of gardening, including improved physical and mental health[156]. A 2009 study of the use of gardens and other green spaces to improve health outcomes in nursing noted that gardening

[149] Bailey, 1911, 83.
[150] Ibid. 22.
[151] Knobloch, 2003, 24.
[152] *Understanding Agriculture: New Directions for Education*, 1988, 41.
[153] Steiner, Charles R. "Internationalizing the AG 450 Experience: Student Farm Managers." In *Proceedings of the 21st Annual Conference*. San Antonio, TX, 2005.
[154] Mazurkewicz, Melissa, Amy Harder, and Grady Roberts. "Evidence for Experiential Learning in Undergraduate Teaching Farm Courses." *Journal of Agricultural Education* 53, no. 1 (March 1, 2012): 176–189. doi:10.5032/jae.2012.01176.
[155] Steiner, 2005.
[156] Bowler, Diana E, Lisette M Buyung-Ali, Teri M Knight, and Andrew S Pullin. "A Systematic Review of Evidence for the Added Benefits to Health of Exposure to Natural Environments." *BMC Public Health* 10 (August 4, 2010): 456. doi:10.1186/1471-2458-10-456.

can lead to “more effective stress management, improved cognitive functioning, a sense of community belonging, and accelerated recovery from illness.” In addition, maintaining a garden is a form of physical activity that can improve health and “may even cultivate ecological sensibilities that motivate us to protect the health of our planet.”[157]

Many authors have written about the detrimental mental health consequences of modern society’s distance from nature, using terms such as “nature deficit disorder”[158] and “biophobia.”[159] Richard Louv describes nature deficit disorder in *Last Child in the Woods* as the product of a modern society where the natural environment has been so extensively developed that it is barely visible. A lack of interaction with nature leads to difficulty concentrating and high levels of stress. It can even cause apathy towards environmental problems: “Lacking direct experience with nature, children begin to associate it with fear and apocalypse, not joy and wonder,” Louv writes.[160] Biophobia, a related condition, occurs when isolation from the natural world leads to an urge to dominate nature. David Orr writes that this drive to control nature can even become self-perpetuating: “The manifestation of biophobia, explicit in the urge to control nature, has led to a world in which it is becoming easier to be biophobic.”[161] These phenomena could occur just as easily in college as in kindergarten, in students overwhelmed by studying global environmental problems on a heavily landscaped campus. Indeed, studies using university and college students as participants have found that green spaces provide a variety of mental health benefits.[162] Allowing college students to get out of the classroom and into the garden in an experiential learning context could help avoid these problems.

On the societal scale, hands-on farming can help improve ecological literacy, make abstract ideas concrete, and develop new environmentally friendly methods. Ecological literacy could be defined as an understanding of natural systems that can inform our decision-making,

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157 Hansen-Ketchum *et al.*, 2009.

158 Louv, Richard. *Last Child in the Woods: Saving Our Children From Nature-Deficit Disorder*. Chapel Hill, NC: Algonquin Books, 2005.

159 Orr, David W. *Earth in Mind: On Education, Environment, and the Human Prospect*. Washington, DC: Island Press, 1994.

160 Louv, 2005, 135.

161 Orr, David W. *Ecological Literacy: Education and the Transition to a Postmodern World*. SUNY Series in Constructive Postmodern Thought. Albany: State University of New York Press, 134.

162 Bowler, Diana E, Lisette M Buyung-Ali, Teri M Knight, and Andrew S Pullin. “A Systematic Review of Evidence for the Added Benefits to Health of Exposure to Natural Environments.” *BMC Public Health* 10 (August 4, 2010): 456. doi:10.1186/1471-2458-10-456.

and thus stands in opposition to nature deficit disorder and biophobia. David Orr writes that because experience on farms was an important source of knowledge about the natural world until relatively recently, "the sharp decline in the number of farms and the shift toward industrial farming has had serious consequences for our collective ecological intelligence."[163] Bringing on-farm experience to a greater number of people can thus help address this decline.

Furthermore, hands-on work can help students make abstract ideas concrete; as Sayre puts it, a student farm can be "a place where abstract intellectual discussions about sustainability are put to the test."[164] For example, as Pretty points out, experience with different kinds of farming techniques can help students define sustainable agriculture, a term with no single meaning.[165]

Students of farming and gardening can also help develop new methods that improve on current technologies; as sustainable agriculture pioneer Robert Rodale notes, "Today's organic gardens are the experimental plots for tomorrow's agriculture."[166] He sees the greatest potential for these innovations at enterprises where economic profitability of the enterprise doesn't limit what can be attempted.[167] Student farms, generally funded by colleges or universities and thus independent of market forces, are a perfect example of this context.

Place-Based Education: Learning about the Local

Agriculture is fundamentally local, and agricultural education started out that way as well. Unique climate and soil conditions ultimately determine what crops and farming techniques are best-suited to a certain farm, although irrigation and other technologies allow some flexibility. Agriculture rooted in a particular place was also a popular theme for agrarian thinkers who saw it as a way to help keep rural communities vibrant. Liberty Hyde Bailey, a writer in this tradition, wrote in 1911 "that there should be strong local centers of interest in rural communities, for thereby we develop local pride and incentive."[168] As early agricultural

[163] Ibid. 117.
[164] Sayre, 2011, 12.
[165] Pretty, Jules N. "Participatory Learning for Sustainable Agriculture." *World Development* 23, no. 8 (August 1995): 1247–1263. doi:10.1016/0305-750X(95)00046-F.
[166] Logsdon, Gene. *The Contrary Farmer*. The Real Goods Independent Living Books. White River Junction, VT: Chelsea Green Pub. Co, 1994, 38.
[167] Ibid. 40.
[168] Bailey, 1911, 77.

education was mostly taking place on family farms and in rural communities, it was generally tailored to local conditions.

With the rise of modern agriculture in the second half of the twentieth century, though, things began to change. Chemical fertilizers and new technologies for irrigation and season extension meant that local soil and climate conditions were no longer as limiting as they once were, and the agrarian tradition was overpowered by the Green Revolution. These changes to agriculture resulted in corresponding changes to agricultural education: Orr writes that the decline of family farming led to “the separation of the study of agriculture from its community, cultural, and ecological context.”[169]

In the past few decades, however, place-based education has been promoted again in a variety of contexts, showing the potential for re-integrating a local focus into agricultural education. Writers on nature deficit disorder and related conditions often advocated connections to local natural environments as a remedy; for example, Louv writes:

> If children do not attach to the land, they will not reap the psychological and spiritual benefits they can glean from nature, nor will they feel a long-term commitment to the environment, to the place. This lack of attachment will exacerbate the very conditions that created the sense of disengagement in the first place – fueling a tragic spiral, in which our children and the natural world are increasingly detached.[170]

Similarly, Orr writes, “I do not know whether it is possible to love the planet or not, but I do know that it is possible to love the places we can see, touch, smell, and experience.”[171] He notes that the modern American environmental movement grew out of a number of local efforts to preserve places that the activists felt connected to, from John Muir and Hetch Hetchy to Horace Kephert and the Great Smoky Mountains National Park.[172] Wes Jackson applies this reasoning specifically to sustainable agriculture in his book *Becoming Native to This Place*, describing how farming systems should be modeled on

[169] Orr, 1994, 119.
[170] Louv, 2005, 159.
[171] Orr, 1994, 147.
[172] Ibid. 161.

the ecosystems that evolved to thrive under local conditions. At The Land Institute in Kansas, Jackson is working to develop perennial versions of grains that can be cultivated in agroecosystems based on the native prairie landscape.[173]

Locally specific education is thus well-established as a way to cultivate environmental awareness, but more recently it has been used to promote other causes such as social justice as well. Indeed, the term "place-based education" was developed in this context by The Orion Center in the 1990s. Nel Noddings' "Place-Based Education to Preserve the Earth and its People" outlines four major aspects of place, all of which can benefit from activism as the result of place-based education:

> 1) the political/psychological – how a psychological attachment to place affects political attitudes; 2) the environmental – how care for one's natural surroundings may contribute to a commitment to care for the whole Earth; 3) the relation between local and global citizenship – how educational strategies can use love of place to develop knowledge and skills useful in the larger world; and 4) love of place and human flourishing – what place can mean in individual lives.[174]

Similarly, David Gruenewald and Gregory Smith emphasize the broad applications of this method, posing place-based education as "the educational counterpart of a broader movement toward reclaiming the significance of the local in the global age."[175] In *Place-Based Education: Connecting Classrooms and Communities*, David Sobel writes that "Place-based education converts the activist plaint of Not in My Backyard (NIMBY) to Please in My Backyard (PIMBY)," suggesting that using locally specific curricula can help students and their communities respond in collective and constructive ways to the issues they face.[176]

The locavore movement is one approach to local agriculture, but place-based education for agriculture should go far beyond a discussion of "food miles." Efforts to

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[173] Jackson, Wes. *Becoming Native to This Place*. Washington, D.C.: Counterpoint, 1996.
[174] Noddings, Nel. "Place-Based Education to Preserve the Earth and Its People." In *Educating Citizens for Global Awareness*. New York: Teachers College Press, 2005, 57.
[175] Gruenewald, David A., and Gregory A. Smith, eds. *Place-Based Education in the Global Age*. New York: Lawrence Erlbaum Associates, 2008, xiii.
[176] Sobel, David. *Place-Based Education: Connecting Classrooms and Communities*. Nature Literacy Series. Great Barrington, MA: The Orion Society, 2005, 7.

create a more local food system have been criticized for being shortsighted and limiting consumer choice in regions with short growing seasons. Place-based agricultural education does not necessarily mean promoting a purely local food system; instead, it should focus on tailoring production methods to the unique soil, climate, and demography of a given location. Orr writes that "Taking places seriously would change what we think needs to happen at the global level. It does not imply parochialism or narrowness."[177] In that sense, place-based agricultural education can help define sustainability on a local scale, helping contribute to a more sustainable global agricultural system.

As liberal arts colleges look to enter the field of agricultural education, they should draw lessons from its roots in Progressive educational theory as well as more recent scholarship and design curricula that are scientific, experiential, and place-based. These conditions allow substantial flexibility on the part of institutions, since for a curriculum to be locally specific, it must be unique. What would such a curriculum look like at Pomona College? The following chapter describes one potential way to bring these themes together for a course taught at the Pomona College Organic Farm.

[177] Orr, 1994, 160.

Chapter 4. The Pomona College Organic Farm: An Underused Resource

The Pomona College Organic Farm has been around for more than a decade, but has yet to reach its full potential as an educational resource. Entirely run by a small group of students at first, the Farm has matured into a vibrant space today that is strongly connected to diverse groups on campus and in the wider community. Still, the space is used only infrequently for academic work, despite strong student demand for agriculture-themed courses. In an effort to address this gap, I developed a curriculum for a half-credit independent study at the Farm and tested it with a group of six students in fall 2013.

A Brief Academic History of the Farm

The Pomona College Organic Farm arose thanks to the efforts of a group of dedicated students in the late 1990s. Starting with a few compost piles in an open area of The Wash, an area of vegetation live oak preserve in the southeast corner of the Pomona College campus, the students expanded to plots of vegetables in 1999, the first incarnation of the Farm. Fruit trees were added the next year and the group became a formal student organization, the "Gorilla Farming Club." Administrative recognition of the Farm began in the early 2000s, resulting in the creation of the first official guidelines for use of the Farm by a student-faculty committee. A "Save the Farm" movement starting in 2005 kept the space from being reallocated for other purposes and established formal boundaries and administrative oversight of the Farm. The first academic offering there, Professor Hazlett's "Farms and Gardens" course, began in spring 2006 under the auspices of the Environmental Analysis program. As this curricular connection developed, the EA department stepped into the role of providing financial and administrative support for the Farm.[178]

Since these humble beginnings, the Farm has matured into an invaluable resource for students and community members. Currently, the Farm is under the oversight of a full-time Farm Manager, Adam Long, who coordinates general maintenance, academic involvement, and community connections. An active student Farm Club facilitates connections to the student body,

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[178] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques." Pomona College, 2013. http://scholarship.claremont.edu/pomona_theses/84.

hosting weekly workshops on topics such as how to prepare a garden bed and putting on events such as the annual Harvest Festival. A small number of students are employed each semester to help with general maintenance around the Farm while learning about organic agriculture. Open volunteer hours each Saturday have engaged students, faculty, staff, and members of the wider Claremont community with the Farm, attracting groups such as a teen environmental group from local nonprofit Uncommon Good and a Cub Scout troop as well as individual volunteers.

The vegetables, herbs, and fruits from the Farm are used as a way to build connections to other communities around campus. Farm Club initiated a biweekly Farm Stand in fall 2011 to bring Farm produce to students, faculty, staff, and community members for a very low cost. Produce is also sold to the Sagehen Café at Pomona and the Grove House at Pitzer to highlight the importance of locally grown organic food in those visible campus locations. Still, the Farm remains focused on education rather than production, as described in its mission statement:

> The Farm's mission is to give students, faculty, and staff of the Claremont Colleges and local community members a hands-on education in various methods of small-scale ecological farming in scientific, social, and organizational terms. The Farm strives to be a transdisciplinary space supporting the academic and non-academic values of a liberal arts education.[179]

Still, the Farm has yet to live up to its potential as an academic resource, with only a few courses utilizing the Farm as part of their curricula. In the Farm's early years, this may have been due in part to a somewhat adversarial relationship with the Pomona College administration. Due to allegations of illegal behavior, Dean of Students Anne Quinley and other members of the administration were "not generally supportive of the Farm."[180] Since then, the relationship has improved significantly, but academic use of the Farm is still sporadic. Professor Hazlett's "Food, Land, and the Environment" course in the Environmental Analysis program has been by far the most consistent course at the Farm, occurring every spring since 2006. This course introduces students to agroecology, the study of agricultural systems based on the natural environment, and includes weekly hands-on exercises at the Farm.

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[179] http://farm.pomona.edu/about/mission/.
[180] Ibid. 14.

Courses in other disciplines have used the Farm on a more infrequent basis. Professor Worthington led a group of 20 students in an independent study on green architecture in 2001, resulting in the construction of the Earth Dome that remains one of the Farm's most visible landmarks. Professor Worthington's course was modified into "Politics of Community Design," which he has continued to offer intermittently since then. Other courses that have occasionally conducted projects at the Farm include Global Politics of Food and Agriculture, Politics of Environmental Activism, Global Politics of Water, Environmental Studies, Intro Geology, and courses in the Sociology, Classics, and Biology departments.[181,182] These courses have provided a limited number of students with the opportunity to engage firsthand with sustainability on an academic level over the years since the Farm's founding. Finally, a number of senior theses have been written at least in part about the Farm.[183] Academic use of the Farm seems to be increasing, with eight courses using the Farm for activities by mid-November in the fall 2013 semester.

Academic use of the Farm has occasionally extended beyond the Claremont Colleges community as well. Samuel Lewis PO '11 developed a curriculum focused on exploring food justice and environmental justice through gardening as his senior thesis. Over the course of six weeks in summer 2010, he co-taught this curriculum with Scripps student Priscilla Bassett '11 to a group of eleven local students. The students learned about inequitable access to healthy food and other environmental justice and food justice issues while cultivating plots at the Farm.[184]

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181 Ibid. 12.

182 Pomona College Organic Farm Annual Report 2012-2013.

183 Bingham, K., 2001, Weed Tales: An Exploration of a Small Piece of Land in Claremont, California; Koelle, H., 2003, Exploring Environmental Lifestyle Changes at the Claremont Colleges; Fields, C., 2006, Utopianism in the Discourse of Sustainable Agriculture: Re-envisioning; Press. M., 2006, Growing a Better Food System, An Analysis of the Impact of California School Gardens on the Sustainable Food and Food Security Movements; Meyers, S., 2009, Time to Get Real: A Food Assessment of Dining at Pomona College; Comet, A., 2009, Reviving the Foodshed: The Historical Foundations of a Sustainable Food Culture in Claremont, Ca; Graff., K., 2009, Soil Chemistry and Metal Pollution at the Pomona Organic Farm; Lopez, K., 2009, Natural Medicine: Personal Responsibility and Self-Empowerment; Lewis, S., 2010, Cultivating Youth Earth Connections Summer Internship Program (YEC): A Hand-on Environmental Justice Focused Farming Program at the High School Level; Lara-Arredondo, G., 2010, From Sewers to Composting Toilets: The Key to Closing the Nutrient Cycle?; Behr, J., 2010, Chickens in the City: How Urban Husbandry Can Save Animals, Humans, and the Planet They Share. From Adam Long, personal communication, November 14, 2013.

184 Lewis, Samuel. "Cultivating Youth Earth Connections Summer Internship Program (YEC): A Hands-on Environmental Justice Focused Farming Program at the High School Level." Bachelor of Arts, Pomona College, 2010.

Given the incredible potential of a student farm as a learning tool, one course per year at the Farm is clearly insufficient. A survey of student farms in the United States showed that on average, five to six courses are offered annually in conjunction at these farms.[185] Professor Hazlett's "Food, Land, and the Environment" course is consistently filled to capacity with a long waitlist, showing that student demand for such courses is high here. The results of a student survey conducted in early fall 2013 at the Claremont Colleges provide further evidence for this demand. Of 86 respondents from 23 different majors (and 5 respondents who were undecided), 90% were interested in taking a course at the Farm.[186] Up until that point, however, fewer than 18% of students who had been to the Farm had come as part of an academic course.[187]

How could future academic offerings complement the current "Food, Land, and the Environment" course to take better advantage of the untapped educational resource that is the Pomona College Organic Farm? Integrating the Farm into existing courses is one obvious solution. Courses in almost any discipline could relate their subject material to agriculture since, as Carlson writes, "Modern agriculture touches on nearly all of the pressing environmental and social issues facing America today — water, energy, immigration, biodiversity, public health, rural poverty, suburban sprawl, climate change, and even religion and ethics."[188] Outreach in fall 2013 to inform professors about the potential to integrate the Farm into their courses was moderately successful, resulting in Professor Robins' Soil Science course analyzing soil profiles at the Farm for a laboratory exercise, but further such connections are needed.

A second approach is to develop entirely new agriculture-focused course offerings to meet the strong student demand shown by EA85 over-enrollment and the fall 2013 survey. In developing such courses, both thematic and structural aspects should be considered carefully. The preceding chapter addressed the thematic aspects of an agricultural education curriculum for liberal arts colleges, arguing that it should be scientific, experiential, and place-based. To complement the structure of "Food, Land, and the Environment," future courses could be offered in the fall semester, for half a credit, and/or in an independent study format. Students are enthusiastic about the possibility of taking such courses: over half of students surveyed

[185] Leis *et al*. 2011.
[186] To the question, "Would you be interested in taking a course at the Farm, if it fit with your schedule?", 66% responded "Yes," and 24% responded "Maybe."
[187] See Appendix A.
[188] Carlson, Scott. "The Farmer in the Quad." *The Chronicle of Higher Education*, March 28, 2008.

expressed interest in a fall semester course.[189] Putting theory into practice, in the best tradition of student farms, I have developed a sample curriculum for a course meeting these specifications that is available to future students for use at the Farm. Piloting this course with a group of six students during fall 2013 provided the chance to evaluate the curriculum and offer suggestions for future improvement.

Course Development and Goals

I designed this course, "Introduction to Organic Farming," as a half-credit independent study to be offered in the fall, for maximum contrast to the structure of "Food, Land, and the Environment." It is structured as a series of units on different topics in organic farming, ranging from tillage to insects to classic authors in sustainable agriculture. A list of topics was assembled by reviewing a number of agroecology and sustainable agriculture textbooks.[190,191,192,193,194,195] The final subset of topics was chosen in part based on the results of the fall 2013 survey, in which students were asked to select all topics they would be interested in studying.[196] The course culminates in an independent final project on a topic of one's own choosing, so that students can explore topics of particular interest. As a half-credit course, it has one set of readings and one hands-on exercise per week, but I have provided additional materials for each unit that could be added to create a full-credit version. In fall 2013, we found that a weekly two-hour afternoon

Students prepare to maintain the group plots during the independent study course in fall 2013.

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[189] See Appendix A.

[190] Miles, Albie, and Martha Brown, eds. *Teaching Organic Farming & Gardening: Resources for Instructors*. Santa Cruz, CA: University of California Santa Cruz, 2005.

[191] Altieri, Miguel A. *Agroecology: The Science Of Sustainable Agriculture*. Second Edition. Westview Press, 1995.

[192] Barker, Allen V. *Science and Technology of Organic Farming*. First Edition. CRC Press, 2010.

[193] Gliessman, Stephen R. *Field and Laboratory Investigations in Agroecology.* CRC Press, 2013.

[194] Gliessman, Stephen R. *Agroecology: The Ecology of Sustainable Food Systems*. 2nd edition. CRC Press, 2006.

[195] Vandermeer, John H. *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011.

[196] See Appendix A for the full list.

meeting was appropriate, although students occasionally came in outside of that time to work on their independent projects or maintain the group plots.

During the curriculum development process, I tried to adhere as closely as possible to the ideal of a scientific, experiential, place-based course described in previous chapters. In developing a "scientific" curriculum, my goal was to employ aspects of the scientific method and cultivate a spirit of scientific inquiry wherever possible, while still making the subject matter accessible to students of all academic backgrounds. I tried to choose readings from a variety of sustainable agriculture textbooks that approached topics from a natural science perspective but were manageable in length and of a suitable level. I reviewed all relevant chapters of each of the six agroecology textbooks for each unit, chose a single reading or a few shorter readings that I felt were best-suited to this course, and sought out supplementary sources where I felt they were necessary.

To help the curriculum effectively use the experiential learning method and be strongly rooted in place, I developed a hands-on exercise with a specific educational goal to use at the Farm each week. It was important to me to have the activity be focused on learning a particular concept or skill, having read a recent study of student farms as teaching tools that noted, "Opportunities for experience that are included in teaching farm courses should have purpose and be more than just mere activity."[197] Sample activities include designing a garden bed to take advantage of differing light requirements of common crops and testing soil and compost samples for major plant nutrients.[198] These opportunities were meant to provide for direct engagement with subject material covered in the reading, while also taking full advantage of the Farm's unique place identity. The exercises that I developed should by no means be viewed as the only activities that could be used in future courses at the Farm or even as fully complete. Testing them out each week was an invaluable opportunity to evaluate their effectiveness, and showed that they could be revised and improved. Gliessman's *Laboratory Exercises in Agroecology* is an excellent resource for ideas for alternative exercises in future years.

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[197] Mazurkewicz, 2012.
[198] See the appendices for course materials.

Students in the independent study course test nitrate content of soil and compost samples in a hands-on activity.

To make the curriculum place-based, I took advantage of local resources as much as possible in each exercise and included readings from previous scholarly work done at the Farm. For example, I used amaranth and tomatoes, two crops commonly grown at the Farm, to illustrate two different kinds of photosynthesis, and two reading assignments were final projects written by students in “Food, Land, and the Environment” about irrigation and bees at the Farm. Again, there is great potential to take the theme of place-based education further in the future, perhaps by integrating small-scale GIS mapping, including final projects done by students this semester as readings, or reaching out to local communities.

Reflections and Suggestions for Future Improvement

Student reflections and my own observations throughout the semester provided the chance to reflect on the curriculum and suggest future improvements. Written reflections occurred three times over the course of the semester and were invaluable sources of feedback.[199] Students who participated in the course had varying degrees of experience with gardening or farming and differed in their level of exposure to science, so their opinions on a scientific approach to studying agriculture were very important to me.

Course Structure

One of the most significant realizations I had this semester occurred when we met for the first time. The students looked at me expectantly, and I realized that I had neglected to fully consider what my role would be. I had thought of an independent study curriculum as something that the students would be able to do by themselves, and I had planned to be a fly on the wall, observing and reflecting on the curriculum from a distance. On the first day, I quickly realized

[199] See Appendix B for questions included in each reflection.

that wouldn't be the most effective use of time for any of us. I had chosen the course materials and prepared the activities for a reason, and the students expected me to explain what we were doing and why we were doing it. So, although I clarified from the beginning that I was totally unqualified to teach an academic course, I took a more active role than I had originally anticipated. This ended up being the role of a facilitator, rather than a professor: I usually introduced the exercise, asked a few questions about the reading or previous topics to spark some discussion, and then assisted as needed while they worked on that day's project.

I found this course structure to be fairly effective, although it could certainly be done otherwise in the future. My original hesitation in leading the activities was that my involvement would detract from the learning process of the other students; after reading so much about experiential education, I certainly didn't want to inhibit valuable learning opportunities. A number of authors have pointed out that self-motivated learning is most effective in the context of supervised agricultural experiences.[200,201] Some have even argued that "teaching threatens sustainable agriculture."[202] But no matter how motivated a student is (and the students enrolled in the independent study showed plenty of initiative), when time is limited, it's helpful to have someone else try out the soil test kit beforehand and make sure all the materials for each week's activity are on hand. Having gardening background knowledge was also extremely helpful, since the six students had varying degrees of experience with growing plants. Some of the activities, such as the French-intensive tillage workshop, could have been extremely frustrating without someone present who had actually used the method before. And finally, there was more coordination of the administrative aspects of the course than I had expected (printing out materials for the activities, getting everyone's paperwork to the registrar, collecting assignments, ordering materials for workshops and independent projects, etc.), and having a single point person for those tasks simplified things.

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[200] Bird, William, Michael Martin, and Jon Simonsen. "Student Motivation for Involvement in Supervised Agricultural Experiences: An Historical Perspective." *Journal of Agricultural Education* 54, no. 1 (March 18, 2013): 31–46. doi:10.5032/jae.2013.01031.

[201] Francis, C.A. "Participatory Education for Sustainable Agriculture: Everyone a Teacher, Everyone a Learner." *Journal of Sustainable Agriculture* 18, no. 1 (2001): 71–83.

[202] Ison, Raymond L. *Teaching Threatens Sustainable Agriculture*. Gatekeeper Series. London: International Institute for Environment and Development, 1990. http://www.fao.org/sd/erp/toolkit/Books/SARDLEARNING/CD-SL/Sources/teaching%20threatens%20sustainable%20agriculture.pdf.

The students in the course were divided on whether they would have liked a more formal leader. One student reflected:

> Since I was very intentionally taking this as a partial credit add-on to an already full schedule, I've enjoyed the loose structure. If I was taking it more formally for a full credit, I would want and expect more guidance, more tests of knowledge from readings, more assignments, and a formal leader. The independent study format was appropriate for a test drive.

Others expressed a desire for more guidance, noting for example, "I think that I could benefit from more guidance because I am really busy and find it hard to focus on my farm work when I have other pressing assignments."

The role I played could be filled in the future by anyone with a willingness to take on the few extra hours per week needed to prepare the readings and activities, perhaps a Farm Manager, teaching assistant, or student volunteer. Students without prior gardening experience who are interested in using this curriculum could contact the Farm Manager or Farm Club to see if there are students who could fill such a role.

The general structure of the course, with hands-on activities at the beginning of the semester and time for independent projects later on, corresponded well with the seasonal limitations of the fall semester. Daylight savings time occurred right before we started to move independent projects, and students were generally able to accomplish what they needed to do during class or come in outside of the weekly meeting time. Two students noted that they would have liked to start the independent project even earlier in the semester, to allow more time for plant growth. We had chosen topics six weeks before the end of the semester, so future students could try starting earlier than that. The two-hour time block worked well, although longer exercises would certainly be possible.

Readings and Course Materials

Student feedback about readings and course materials was generally positive. Most said that the level of science in the readings was "appropriate," although one noted that "In general, I prefer less-sciency materials but that is just a matter of my reading pleasure." A common theme was the desire for more discussion to reinforce the readings. One student reflected that "not all concepts from the readings are repeatedly reinforced in class time and it's harder to absorb all that information individually when it's not directly discussed and applied," and another wrote, "I believe the readings were quite informative but hard to retain if not discussed in class. The readings that stayed with me were ones we applied discussion and activities to in class." I had originally intended to have our group discuss that week's reading at the beginning of every class, but in practice had often only chatted briefly about the reading or skipped discussion altogether in the excitement of getting to the hands-on activities.

Being held accountable for the material contained in readings was also something that multiple students brought up in their reflections. I had decided not to give any sort of reading quizzes or learning assessments, assuming that students would prefer the internal motivation of learning for its own sake than the external motivation imposed by formal evaluation. However, one student suggested that "if students were held more accountable for the readings, it would ensure that everyone is getting all the information. I definitely slacked on some of the readings, but didn't feel like I would get held accountable for it. Maybe simple pop quizzes could be helpful, or more frequent reflections." Another admitted, "To be honest, I only skim through them but I still pick out useful bits." Future students could consider their personal learning styles and preferred sources of motivation when deciding whether to have formal weekly reading assessments. An external assessment could be a useful tool in some circumstances to help make sure students keep up with the readings and are prepared for each week's activity.

Hands-On Exercises

Students generally enjoyed the hands-on activities and felt that they were useful learning tools, although they had many good suggestions for improvement. They were aware that this course was designed around the concept of experiential learning from the beginning, and provided positive feedback about that intention, noting for example, "I'm interested in learning more about sustainable/organic farming and taking a more direct hands on approach in that learning to supplement general farming book knowledge." After participating in these activities throughout the semester, all of the students remained positive about the experiential approach, answering affirmatively to the question, "Were the hands-on activities useful as learning exercises?"

Students identify common weeds during the first week of the Weed Lab, an exercise that could be improved in future years.

Students also provided astute feedback on how to improve specific exercises, particularly the Weed Lab and Soil and Compost Chemistry Lab. For the Weed Lab, in which we identified common weeds and compared how quickly they returned after hand weeding, students suggested adding "a class discussion about what our collective conclusion was" and "more identification of a plant and then passing it around to make sure everyone can identify it." The Soil and Compost Chemistry Lab, in which we used a LaMotte soil test kit to analyze pH, nitrate nitrogen, and phosphorus in samples of soil and compost, was quite popular. Surprisingly, the test kit, which I had been excited to use because it was the most visibly scientific of the materials we used in the course, received mixed reviews. One student remarked that the soil tests "were cool but they relied on the chemistry kit so it felt a little formulaic. I think it would be a lot neater to test out a DIY soil sample procedure but I don't know what the options for that are like." Another noted, "I especially liked the soil testing- it would have been nice to have more testing equipment, but I think it was also useful to figure out how to do all the tests using limited resources."

Guest speakers were unanimously praised as informative and as an interesting alternative to hands-on investigations. Local pruning expert Tom Spellman and beekeeper Russ Levine had given guest lectures on their areas of expertise, providing us with the chance to hear firsthand about areas of the Farm that we lacked the necessary background to work with directly. Farm Manager Adam Long had also given brief lectures on the history of the Farm, irrigation, and weed identification. Students reported enjoying these sessions and suggested having even more guest speakers in the future. Farm Club, which has brought in a variety of guest speakers for workshops in the past, could be a good resource for future students interested in connecting with outside experts.

Conclusion

“Imagine spending upwards of $30,000 a year,” writes James McWilliams, “so your kid can go to a liberal arts college and learn the fine art of milking a cow.”[203] His skepticism toward the role of agriculture in the liberal arts can perhaps be understood, given that throughout most of the twentieth century, agricultural education was offered only to future farmers. It is important to recognize, though, that agriculture has fundamentally changed since the land-grant institutions were established, as their critics argued in the 1970s and 1980s. The themes of scientific depth, interdisciplinary connections, and environmental sustainability that were addressed by reforms to the land-grant curriculum typify the contemporary approach to agriculture, a field undergoing rapid change. This new agriculture, introduced to the liberal arts curriculum via the recent student farm movement, offers the chance to reform the American food system to decrease its negative environmental impacts. To achieve such a change, however, requires active participation by informed consumers and policymakers. Teaching agriculture in the liberal arts can prepare these future change-makers by helping them understand the underlying natural science, connect with nature enough to care about preserving it, and develop strong local ties that will make them effective activists. The science-based, experiential, and locally specific curriculum I developed is only one model for agricultural education in the liberal arts. In coming years, I hope that liberal arts colleges will continue to increase their academic offerings related to farming. I hope that they prepare future advocates for sustainable agriculture, whether political leaders or informed consumers. And most of all, I hope that this movement continues to happen here, at the invaluable resource that is the Pomona College Organic Farm.

[203] McWilliams, 2013.

Appendix A: Organic Farming Survey Results

This survey was sent out in late August and early September 2013 to students at the Claremont Colleges via the Pomona College Organic Farm Facebook page, the Chirps Pomona student email newsletter, and the Environmental Analysis student email listserve. The purpose was to obtain information about potential interest in courses at the Farm and to identify characteristics of the students who participate in the Farm in various ways. Questions and answer options are given in the original wording; the number of respondents is given in parentheses after each question. The survey can be accessed and the results further analyzed by a number of parameters at https://www.surveymonkey.com/analyze/?survey_id=43374982&OPT=NEW.

1. What school do you attend? (86)
   a. Pomona: 78 (90.7%)
   b. Pitzer: 5 (5.81%)
   c. CMC: 0 (0%)
   d. Scripps: 2 (2.33%)
   e. Harvey Mudd: 1 (1.16%)
2. Which year are you in? (85)
   a. First year: 12 (14.12%)
   b. Sophomore: 21 (24.71%)
   c. Junior: 14 (16.47%)
   d. Senior: 38 (44.71%)
3. Major/minor (80) [Note: only majors are listed below. Numbers may not add up due to double majors.]
   a. Economics (6)
   b. Neuroscience (3)
   c. Media Studies (3)
   d. Linguistics and Cognitive Science (3)
   e. Biology (10)
   f. EA (16)
   g. Math (8)
   h. Computer Science (3)
   i. History (6)
   j. PPA (4)
   k. English (4)
   l. Chicano Studies (1)
   m. Music (2)
   n. Geology (1)
   o. International Relations (1)
   p. Undecided (5)
   q. Spanish (1)
   r. Physics (1)

   s. Religious Studies (3)
   t. Psychology (2)
   u. Politics (2)
   v. Molecular Biology (2)
   w. Medical Anthropology (1)
   x. Chemistry (1)
4. Gender (83)
   a. Female: 52 (62.65%)
   b. Male: 29 (34.94%)
   c. Other: 2 (2.4%)
5. Have you ever been to the Pomona College Organic Farm? (83)
   a. Yes, many times: 45 (54.22%)
   b. Yes, once or twice: 28 (33.73%)
   c. No, but I've heard of it: 9 (10.84%)
   d. There's a farm at Pomona?: 1 (1.2%)
6. If you have been to the Farm, what brought you there? (73)
   a. Farm Club events (Harvest Festival, Pesto Party, music events, workshops, volunteering): 48 (65.75%)
   b. Maintaining my own plot: 21 (28.77%)
   c. Courses taught at the Farm: 13 (17.81%)
   d. Just hanging out: 51 (69.86%)
   e. Other (please specify): 24 (32.88%)
7. Would you be interested in taking a course at the Farm, if it fit with your schedule? (83)
   a. Yes: 55 (66.27%)
   b. No: 8 (9.64%)
   c. Maybe: 20 (24.10%)
8. Please rank the following formats in order of preference. (74)

	1	2	3	Total	Average Ranking
Half-credit independent study	**27.03%** 20	**45.95%** 34	**27.03%** 20	74	2.00
Full-credit independent study	**21.62%** 16	**32.43%** 24	**45.95%** 34	74	1.76
Professor-taught course	**51.35%** 38	**21.62%** 16	**27.03%** 20	74	2.24

9. In which semester(s) would you take a course at the Farm? (75)
    a. Fall: 40 (53.33%)
    b. Spring: 67 (89.33%)
10. What topics would you be interested in learning about? Check all that apply. (76)

Tillage/bed preparation	28, 36.84%
Compost	49, 64.47%
Plant Growth (germination, photosynthesis, plant nutrition)	45, 59.21%
Weeds and organic weed management	31, 40.79%
Insects (pollination, organic pest management)	41, 53.95%
Soil science and fertility	44, 57.89%
Cover cropping	20, 26.32%
Polyculture	41, 53.95%
Crop rotation	45, 59.21%
Permaculture and agroforestry	40, 52.63%
Orchards (fruit trees, pruning, grafting)	48, 63.16%
Animals in sustainable agriculture	49, 64.47%
Irrigation	39, 51.32%
Plant pathology/diseases	40, 52.63%
Classic authors in sustainable agriculture	22, 28.95%
Current research in sustainable agriculture	44, 57.89%
Development of agriculture	32, 42.11%
Social and political issues in sustainable agriculture	52, 68.42%
Aquaponics and hydroponics	42, 55.26%
Other (please specify)	2, 2.63%

Appendix B: Reflection Questions

Reflection 1

1. What prior experience have you had with organic farming and/or gardening, if any?
2. Why are you interested in this course?
3. What do you hope to gain/learn from this course? How is exploring farming from an academic perspective similar to or different from what you've done before?
4. How would you define sustainability in agriculture?
5. What topic(s) are you most excited to learn about?
6. This course is going to take a scientific, experiential approach to agriculture. Have you had experience with natural science courses before that relate to agriculture?
7. How comfortable, on a scale of 1-10, are you with approaching farming from a scientific perspective?

Reflection 2

1. What unit have you learned the most practical skills from? Which unit have you learned the most science from?
2. Is the course what you expected it to be? Please explain.
3. Have the activities been useful as learning exercises?
4. Which activity have you enjoyed most? Least?
5. Has anything we've learned so far changed the way you think about farming? If so, how so? If not, why not?
6. If you could change anything about the course in the remainder of the semester, what would you change?

Reflection 3

1. Were the hands-on activities useful as learning exercises? If not, which ones would you change?
2. Were the readings informative and useful? Was the level of science appropriate?
3. Did you feel the independent study format was appropriate? Would you have liked more guidance, or less? Would you have liked a more formal leader (a TA, professor, etc.)?
4. If you could change anything about the course for future years, what would you change?

Reflection 4

1. What was the most important thing you learned from this course?
2. If you have taken Food, Land, and the Environment, how is this course different? What aspects of each do you like best?
3. Did this course change the way you think about farming? If so, how so? If not, why not?

Appendix C: Course Syllabus

Introduction to Organic Farming

Course Description

The sustainable agriculture movement is rapidly gaining popularity in the United States, touted as an alternative to the current food system's high rates of energy consumption and pollution. Organic farming, one type of sustainable agriculture, seeks to cultivate crops without relying on the toxic, environmentally harmful pesticides and fertilizers that are prevalent in industrial agriculture. However, the organic approach to farming is much more than just omitting certain chemicals, seeking to use methods based on natural systems. This independent study will cover topics ranging from tillage and bed preparation to plant propagation to pest management, with a combination of theory and hands-on practice. It will take a science-based, experiential, and place-based approach, investigating each week's topic through a hands-on scientific investigation at the Pomona Farm.

Goals of the Course

Students will:

- Learn about organic agriculture using an experiential, science-based, locally focused approach
- Improve their understanding of how natural systems affect agriculture and appreciate the natural resources that go into food production
- Gain experience with some of the basic techniques of organic agriculture, be able to articulate the reasoning behind each technique, and think critically about the influence of different farming methods on the environment
- Understand the relevance of sustainable agriculture to the liberal arts and the importance of this field to society, becoming better prepared to create positive change in the contemporary food system

Course Structure

This course is designed for the fall semester, to complement current EA spring course offerings at the Farm. It is designed to be a half-credit course, although it could be turned into a full credit by adding an additional reading per week from the optional resources listed. The course is structured as a series of 14 week-long units on topics in organic agriculture; this allows for some flexibility with Fall Break and Thanksgiving Break in the 16-week semester. Note that some of the labs (particularly the Herbivory Lab) require you to plan ahead when planting beds, so it is suggested to read through all of the labs before the semester begins to see what preparation is required.

Schedule

Week	Topic	Reading	Exploration
1	Introduction	Altieri 179-187 and 194-195; Vandermeer 164-5 and 330-333	Introduction to the Farm and this course (20 min) Independent study logistics (10 min) Seedling Planting (1 hour)
2	Tillage	*Teaching Organic Farming and Gardening*: Section 1.6 pp. 9-17; 46	Reflection 1 (15-20 min.) Discussion (10-15 min.) Tillage Workshop (1.5 hours)
3	Plant Growth	Gliessman 35-42, 47-55	Discussion (15 min) Independent Project Ideas (10 min) Planning a Garden Bed (1.5 hours)
4	Weeds	*Teaching Organic Farming and Gardening*: Weed Biology; Cultural Weed Management Practices; Long 89-100	Weed Lab Week 1 (1.5 hours)
5	Soil Science	Long 2013 27-46; Gliessman 99-114	Reflection 2 (15-20 min) Measuring Soil Physical Parameters (1.5 hours)
6	Animals	Gliessman 269-285; Watch YouTube chicken tractor video	Discussion (15 min) The Mobile Chicken Coop (30 min-1 hour) Weed Lab Week 3 (45 minutes)
7	Compost	*Teaching Organic Farming and Gardening*: Making and Using Compost	Weed Lab Week 4 (15 minutes) Compost and Soil Chemistry (1.5 hours)
8	Insects	Detailed Lecture Outline: Managing Arthropod Pests; Gliessman 233-4	Reflection 3 (15-20 min) Discussion (15 min) Herbivory Lab (1-1.5 hours)
9	Fruit Trees	Hartmann 343-349; Altieri 247-260	Work on independent projects
10	Cover Crops	*Teaching Organic Farming and Gardening:* Soil Fertility Management; Choosing Cover Crops	Discussion (15 minutes) Cover Crop Planting (1 hour)
11	Irrigation	*Teaching Organic Farming and Gardening:* Irrigation	Work on independent projects
12	Classic Readings in Sustainable Agriculture	Pick one reading from those listed in 12a: Classic Readings in Sustainable Agriculture	Discussion (1 hour) Work on independent projects

13	Current Research in Sustainable Agriculture	Find a journal article about recent findings in sustainable agriculture	Discussion (30 minutes) Work on independent projects
14	Polyculture and Companion Planting	Liebman 208-215; Mollison 58-63; Work on independent projects	Independent Project Presentations

Resources

Assigned readings can be found on Google Drive at https://drive.google.com/folderview?id=0B4d1IuDacWpWTTFxMVMxR0Nad0U&usp=sharing; additional, optional resources for each topic are also available in the folder for that topic. Topics are arranged in the suggested chronological order, but could be moved around as needed. The Honnold-Mudd library also has a good collection of relevant books and access to online journals. Professor Hazlett has a number of useful books, including the Altieri, Gliessman, and Vandermeer texts and *Teaching Organic Farming and Gardening*. Farm Club maintains a library of sustainable-agriculture-themed books in the Dome down at the Farm, with books by Masonobu Fukuoka, Wendell Berry, and Wes Jackson among others.

Grading

In fall 2013, this independent study was taken for a letter grade (not pass/no credit). Grading was based on a combination of the final project (30%), journal reflections and written assignments (20%) and attendance/participation (50%). The independent project, due at the end of the semester, is a practical application of one of the topics covered in the course with a written analysis of your findings. (Possible examples: an investigation of the nutrients found in compost, a building project such as a hoop house or worm bin, or a test of a new pest management technique. Possibilities are endless!) The written final projects will be posted on the Farm web page and/or put in the Dome for future Farm visitors to enjoy. Journal reflections will be collected four times over the course of the semester. Attendance will be recorded to serve as the basis for the attendance/participation grade.

Appendix D: Course Materials

This appendix includes the handouts for each week: titles with "A" after the number are descriptions of the homework for that unit, and titles with "B" are the hands-on activities. These course materials, as well as the assigned readings (also titled with "A" after the number) and optional additional materials (with "C" after the number) can be found on Google Drive at https://drive.google.com/folderview?id=0B4d1IuDacWpWTTFxMVMxR0Nad0U&usp=sharing.

1A: Approaches to Organic Farming

Introduction

Historically, farmers have tried out a multitude of approaches to natural methods of farming, and there is no single way to farm organically. The Pomona College Organic Farm has two types of organic farming on display: a more traditional row crop approach on the East Farm and a (still-developing) permaculture/food forest approach on the West Farm. This week's readings will explore different approaches to organic agriculture.

How is "organic" defined?

The USDA defines organic production as:

> "A production system that is managed in accordance with the Act (The Organic Foods Production Act [OFPA] of 1990, as amended in the NOP) to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity. Further, it is a system of agriculture that encourages healthy soil and crops through such practices as nutrient and organic matter recycling, crop rotations, proper tillage, and the strict avoidance of synthetic fertilizers and pesticides for at least three years prior to certification."[204]

"Traditional" Organic Farming: Row Cropping

Row cropping can look somewhat like conventional farming, although organic farms tend to work on a smaller scale and grow a greater diversity of crops than conventional farms. Polyculture and intercropping, where plants of different kinds are interspersed, are techniques much more common in organic than conventional agriculture.

Read Altieri pp.179-187, "Organic Farming," and pp. 194-195, "Constraints to Organic Farming".

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[204] 2005. Detailed Lecture 1 Outline for Students. *In:* BROWN, A. M. A. M. (ed.) *Teaching Organic Farming and Gardening: Resources for Instructors.*Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems.

Permaculture

Permaculture is the concept of designing agricultural systems that remain in place indefinitely, rather than being harvested and replanted every year. Permaculture installations are designed around "guilds" of plants that have mutually beneficial interactions. Some of the West Farm was intended to fit this model.

The following passage explains the concept of guilds a little more:

"The unique inherent needs, yields, physical characteristics, behaviors, and adaptive strategies of an organism govern its interactions with its neighbors and its nonliving environment. They also determine the roles each organism plays within its community. The food web is one key community structure that arises from each species' characteristics. Organisms also form various kinds of "guilds" that partition resources to minimize competition or create networks of mutual support.

When we design a forest garden, we select plants and animals that will create a food web and guild structure, whether we know it or not. It behooves us to design these structures consciously so we can maximize our chances of creating a healthy, self-maintaining, high-yield garden. For example, the vast majority of solar energy captured by natural forest food webs ends up going to rot. We can capture some of this energy for our own use by growing edible and medicinal mushrooms, most of which prefer shady conditions. We can design resource-partitioning guilds by including plants with different light tolerances in different vegetation layers, for instance, or mixing taprooted trees such as pecans and other hickories with shallow-rooted species such as apples or pears. We can build mutual-support guilds by ensuring that pollinators and insect predators have nectar sources throughout the growing season. Insights into the guild structure of ecosystems provides clear direction for design as well as research into many aspects of agroecology."[205]

Agroforestry/ Forest Gardening

Agroforestry (also known as forest gardening) is one type of permaculture that places the trees in the central role.

"Agroforestry denotes a sustainable land and crop management system that strives to increase yields on a continuing basis, by combining the production of woody forestry crops (including fruit and other tree crops) with arable or field crops and/or animals simultaneously or

[205] Jacke, Dave. "About Forest Gardening". Edible Forest Gardens: the Ecology and Design of Home-Scale Food Forests, 2008. 8/16/2013. <http://www.edibleforestgardens.com/about_gardening>.

sequentially on the same unit of land, and applying management practices that are compatible with the cultural practices of the local population."[206]

Natural Systems Agriculture

Another type of permaculture envisions agroecosystems that are based on the local ecosystems. One famous example is Wes Jackson at The Land Institute in Salina, Kansas.

Read Vandermeer pp.332-333, "Natural Systems Farming," for more.

Biodynamic Farming

Viewed by some as more mysticism than farming, biodynamic agriculture was developed by Rudolf Steiner, the same philosopher who developed Waldorf education and anthroposophical medicine.

Read Vandermeer pp. 164-165, "Some Prewar Entrants: Biodynamic and Other 'Spiritual' Movements", for more.

Optional Additional Resources

1. Gliessman, Stephen R. "The Agroecosystem Concept." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 23-32. Print.
    a. Gliessman presents an overview of the concepts of "ecosystem" and "agroecosystem", with a useful "Agroecosystems" section (pp. 29-31) that defines agroecosystems and compares them with natural ecosystems.
2. The Huntington Ranch, a relatively new sustainable urban agriculture installation at the Huntington Gardens, is a great local example of food forests.
    a. Website: http://www.huntington.org/huntingtonlibrary.aspx?id=8238
    b. An LA Times article about the Ranch: http://latimesblogs.latimes.com/home_blog/2010/11/huntington-ranch.html
3. Other permaculture resources:
    a. The Permaculture Research Institute: http://permaculturenews.org/category/plants/food-forests/
    b. Permaculture Institute: http://www.permaculture.org/nm/index.php/site/Permaculture-Food-Forest/
    c. Robert Hart, *Forest Farming: Towards a Solution to Problems of World Hunger and Conservation*. This text was the first to formally frame the idea of "forest farming".
4. Polyculture and agroforestry will be covered more in later weeks; see those units for more resources on those topics.

[206] International Council for Research in Agroforestry, 1982; from *Agroecology: The Science of Sustainable Agriculture*, by Miguel A. Altieri, 1995, p. 247.

1B: Introduction to the Farm

Welcome to the Farm! Here's a self-guided tour with some history of the Farm to help you get familiar with the space.

An aerial view of the Farm from spring 2011 (Source: Long 2013, p.86).

Tour Route: Earth Dome – Chickens – Student plots on the west side – Hammer throw field – East side beds – Greenhouse – Compost pile – Fruit trees on the east side

Earth Dome: Start at the Farm's most recognizable structure, the Earth Dome, which also happens to be the site of some of the Farm's most interesting history. The following excerpt is from Adam Long's 2013 EA thesis[207]:

> ***History of the Farm***
>
> The Pomona College Organic Farm (the Farm) is located at the southern end of what is commonly known as "The Wash," a low area which was a natural drainage for water from floods. The Coast Live Oaks that populate The Wash today likely have grown there for hundreds of years, their limbs providing shade and acorns food for the Serrano people who used to populate this region. Spanish settlers in early 1800s forced the Serrano people off their lands, and all had left by the mid-1880s, around the time that Pomona College was founded. Since the early days of the college, The Wash was a favorite spot for "picnics and other activities," and so in 1905 trustee Nathan Blanchard provided the funds to purchase and set aside the 40 acres as a live oak preserve. Only 10 acres of that land remains untouched today, and the rest has developed for other uses such as playing fields, buildings, and other infrastructure.

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[207] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013.

Farm Beginnings

One part of The Wash, an open area used as a gravel pit and trash dump, caught the eye of a few Pomona College students in the late 1990s. In the fall of 1998, they began using The Wash as a site for spreading composted food scraps from the dining halls as part of the student initiated Compost Club. The Farm was eventually born in the spring of 1999 when these students shaped the accumulated soil and compost into a few beds. Although very little survived this first summer at the Farm, students came back in the fall of 1999 inspired to continue work, and they planted more vegetables and founded the original Associated Students of Pomona College (ASPC) “Gorilla Farming Club”. Students, faculty, staff, and community members spent countless hours every day during this first year removing trash and rocks, building up the soil with compost and nitrogen-fixing clover, and maintaining vegetable plots. Starting in the spring of 2000, a wide variety of fruit trees were planted across the Farm and enough produce was grown to donate to local food banks.

During these early years, the Farm was still run almost entirely by students and community members as largely uncontrolled grassroots effort. Soon, however, the college took the first steps to officially recognize the existence of the Farm and provide guidelines for its use. In the early 2000s, the Dean of Students Office created a student-faculty committee to set basic rules for temporary use of the Farm. The rules they developed, such as no planting under oak trees, no fires, and no illegal activity have been adapted and are still in use today. However, some students disregarded these rules and built fire pits, planted in restricted areas, and used the Farm as a site for illegal activity, which fostered a distrusting relationship between the early Farm students and the administration at the time. At the same time, there were a few students who worked hard to keep the Farm looking neat and attractive and were influential in healing the negative feelings that characterized the early relationship between the Farm and the administration.

Academic Involvement and the Earth Dome

There were several successful early efforts to connect the Farm with academics at the college. In the fall of 2001, a student organized 19 others for an independent study class with Professor Rick Worthington about green architecture, which was later titled “The Politics of Community Design.” Since 2001, this class has been taught 7 or 8 times, along with other classes such as “The Politics of Food and Agriculture,” The Politics of Water,” The Politics of Environmental Activism,” and “Environmental Studies,” which often included projects at the Farm. Not only did these classes use the Farm as a real-world laboratory for class topics, they also designed and implemented a wide variety of sustainability related projects inspired by research and field trips.

One such visit to The California Institute of Earth Art and Architecture (Cal-Earth) in Hesperia, California in late 2001 exposed students to architect Nader Khalili’s “superadobe” structures. These structures are permanent, earth-based buildings constructed by filling long fabric tubes with dirt, stacking these coils into walls, arches, and domes, and then covering the surface with plaster. Farm students were inspired by one of Mr. Kahlili’s earthen dome designs and made an initial proposal to construct what they called an “Earth Dome” at the Farm. Many reasons have been given for the value of constructing such a feature. Primarily, the Earth Dome was intended as a way to further the Farm’s ability to be model of an earth-based sustainable homestead and provide students and others hands-on experience with natural construction techniques, in addition to providing a space those at the Farm could use for meetings, storage, and other activities. But another goal was that Earth Dome would serve as permanent feature at the Farm that would discourage the land from being put to alternate use.

This first dome project started during the spring and summer of 2002 with funding from Ronald Lee Fleming ‘63, father of active Farm student Severine von Tscharner Fleming ’04. The students intended the dome to be small enough that it would not need a building permit, per square footage and human occupancy limitations set by the City of Claremont. While some maintain the structure complied with these regulations, others have noted that the first dome was pushing the limitations provided by the city. As a result, the dome was fenced off before classes in the fall of 2002 and then destroyed by the college due to the concerns that it was against code.

The second Earth Dome, which survives to this day, was started in April 2003 with a proposal to the City of Claremont Architectural Commission, which was approved in early 2004. Peter Stanley, President of Pomona College at the time, generously allocated $10,000 for the Earth Dome and a donation from Mr. Fleming covered the rest of the cost for this larger scale, city-permitted project. Work on concrete and rebar foundation began in the summer of 2004 by students Joseph Prows and Geordie Schuurman and Professor Worthington. After period of limited student involvement at the Farm in the fall of 2004, the remainder of the Earth Dome was constructed during the spring of 2005 by students in Professor Worthington’s class, a class from Pitzer College, and dozens of volunteers from the colleges and the wider community. Work on filling and stacking long bags with dirt began on February 16th, and this step was finished in just under three months on the day before graduation. Over the summer of 2005, wire mesh and rebar was installed around the stacked bags and a first layer of gunite was applied. Later that fall, a final gunite was added to finish the Earth Dome in accordance with building codes. Later improvements such as surface plastering, drainage trenches, a hand-carved door, hand-painted interior art, and a concrete floor were developed and implemented over the course of many years and not finally completed until 2011.

From the Earth Dome, turn around and head back to the chicken coop, which you probably passed on your way in.

Chickens

There have been chickens at the Farm since 2008, when a group of students called “The Order of the Sagehen” began raising chickens to learn about sustainable animal husbandry. The current chickens have only been at the Farm since spring 2013. The current coop was constructed with lots of student assistance in fall 2012 and spring 2013 after the previous structure failed to protect the resident chickens from an assumed aerial predator. Like much of the rest of the Farm, the chickens are under the oversight of the EA department, but any vertebrate animals on campus, they are subject to additional regulations. Their welfare is ensured by the strict standards of the Animal Care Committee, which conducts inspections and approves measures for their care. A group of students cares for the chickens' daily needs on a rotating basis.

The West Farm

The Pomona College Organic Farm has two distinct faces: the West Farm and the East Farm. These two sides embody two distinctly different approaches to organic farming, with the West Farm taking a smaller-scale permaculture/food forest approach and the East farm taking a more traditional row crop approach. They thus offer unique opportunities to explore two different sides of organic farming and gardening. The following excerpt is from the Farm website:

"The West Farm, the smaller and older Farm, was started a little over 10 years ago when four Pomona College students planted a small garden in an area known as the Wash, then being used as a gravel pit. Utilizing Dutch White Clover, a nitrogen-fixing plant species, the students fertilized the one-acre area of land and began cultivating small plots of herbs and vegetables. Since its birth, the West Farm has grown through the spontaneous and grassroots efforts of students, faculty and community members."[208]

The west side is currently home to student and faculty plots, available for checkout on a per-semester basis, and a variety of fruit trees. This side is more favorable for small-scale gardening and installations based on companion planting/the permaculture guild concept because it's divided into smaller parcels. The west side is also much shadier, so offers opportunities to explore gardening with shade-friendly plants. Events such as music festivals, harvest parties, and workshops are also often held on the west side.

Make your way through the student, faculty/staff, and community member plots as you head past the Earth Dome to the Hammer Throw Field.

The Hammer Throw Field/Experimental Field

Like the Earth Dome, this controversial piece of grass was central to the Farm's history. Another excerpt from Adam's thesis:

> *"Save the Farm" Movement*
>
> Although Pomona College was supportive of the second Earth Dome project, there were still numerous tensions between Farm supporters and the college's administrators in the mid-2000s. Some lingering concerns about the safety of activities conducted at the Farm were raised by the Dean of Students at

[208] From http://www.pomona.edu/about/pomoniana/organic-farm.aspx, 8/2/2013.

the time, Anne Quinley, who was not generally supportive of the Farm. Additionally, as the students responsible for the initial push to create the Farm began to graduate, volunteer student participation waned in what was still a largely student-run, guerilla operation. Wishing to expand and formalize the Farm's boundaries, a group of professors met with President David Oxtoby and other college administrators and grounds supervisors at the Farm in December 2005. To their surprise, the administrators indicated that the master plan of the college had actually designated parts of the Farm for other uses, but they agreed to postpone any final decisions until students returned in the spring.

This group of professors also proposed allocating a new space for Professor Hazlett's first Farms and Gardens class which was being offered during the upcoming spring semester. This new space, originally known as the "Experimental Field" or the "Academic Field," was a mostly empty plot of land on the far side of a hammer throw field to the east of the original Farm site, amongst a few oak and sycamore trees and a fruit grove surreptitiously planted by students in 2004. Additionally, current Vice President and Dean of the College Gary Kates, agreed to provide temporary funding, at Professor Hazlett's request, for a part-time Farm technician to manage the Experimental Field and assist in the instruction of the Farms and Gardens class. Juan Araya was hired for this position in January and rehired on the official payroll at the start of the new budget cycle in July of 2006.

A meeting with students, faculty, and administrators in January 2006 ended with the understanding that the original Farm boundaries would be maintained and space would be allocated for Professor Hazlett's course. To confirm, professor Worthington sent a follow-up e-mail to President Oxtoby in mid-February but was surprised hear that a differing proposal was soon to be submitted to the Board of Trustees. This alternate proposal would have demolished everything except for what was within a 20 foot radius of the new Earth Dome. It was even rumored that the physical relocation of the Earth Dome and fruit trees was at one point an option on the table as well.

When students learned of this plan, they were understandably upset, and the "Save the Farm" movement was born. Students quickly organized a meeting with President Oxtoby to request that the Board of Trustees postpone a vote on the alternate proposal until their next meeting in May 2006, and the President agreed. After this accomplishment, Farm students mobilized to design a flyer, contact alumni, paint Walker Wall, make posters, get petition signatures, and do anything they could to teach others about the value of the Farm and get support to save it from development. The efforts of the first Farms and Gardens class, consisting of 43 students who received cultivation instruction at the original Farm site, tilled the first plots in Experimental Field, and installed a new shed, also played an important role in showing the administration the importance of the Farm. A core group of Farm students, as well as many in Professor Worthington's "Politics of Community Design" class, also began work on a proposal that President Oxtoby had requested as a way to begin official dialogue between students and faculty about the future of the Farm. Hundreds of students, community members, staff, and faculty came out in support of the Farm, with dozens writing the administration with letters of support and almost 900 signing a petition.

Finally, in response to student pressure and a faculty letter of support, President Oxtoby formally agreed to support the preservation of the Farm in early April. The students' proposal, which hoped to formalize the Farm's original boundaries and management protocol, was submitted to President Oxtoby on April 11th, 2006 and mistakenly rejected as an attempt to enlarge the original Farm site. Soon after, however, a faculty and staff committee was formed to incorporate suggestions from the student proposal into a unified proposal submitted to the Board of Trustees on May 13th. This proposal was accepted and the boundaries set remain in place today. Although the Environmental Analysis (EA) program was never formally appointed to oversee the Farm, because of the Farm's inherent connection with the, EA faculty's support for the Save the Farm movement, and the new Farms and Gardens class, EA began to provide financial and operational support for the Farm at this time as well. This top-down support was intended to be solely for class operations in the Experimental Field, but oversight often spread to the original Farm site as well. Even today, the role of student versus EA oversight of the Farm continues to evolve.

Overall, the Save the Farm movement was a key turning point in the history of the Farm, a significant and "very diplomatic"2 effort by students, faculty, and others to save a valuable and unique educational resource at Pomona College. While this effort to formalize boundaries and rules for the Farm was necessary to save it from development, this recognition ironically changed the very nature of the Farm, as it was no longer a purely student-run, grassroots operation. However, as was eloquently put by an anonymous author who contributed to a 2006 Farm Anthology, "What matters most is that the Farm continues to serve as an example of sustainable agriculture, spark new ideas and ways of thinking, foster creative energy, inspire people to seek alternative solution, and be a reminder of hope."

More recently, the Hammer Throw field has been a source of slight friction between those who disagree with maintaining a lawn in this location, seeing it as a perfect place for the Farm to expand its compost program or other activities, and those who emphasize the importance of continuing to offer a facility for hammer throw at track and field competitions. The latter group continues to hold sway, and hammer throw athletes can compete here when Pomona hosts competitions. Keep going across the field and past the large toolshed into the East Farm.

The East Farm

The East Farm shows an entirely different approach to organic farming, one that's more traditional and a little larger-scale. It is home to the incredibly popular EA course Food, Land, and the Environment each spring, and is maintained year-round by the Farm Manager, student workers, and Farm Club. Produce from this side is also sold at Farm Stand to raise money to buy seeds and supplies or equipment needed to keep the Farm running. This side also has a fruit orchard, greenhouse, extensive compost program, and beehive. The compost program processes all the food waste from Pomona's dining halls and turns it into a soil amendment that can be used on the Farm or elsewhere on campus; this is a good example of how organic farming tries to minimize external inputs wherever possible and recycle nutrients. The bees are maintained by an outside beekeeper, who may lead workshops in the spring.

Another excerpt from the Farm website:

"The East Farm, or Academic Field, was sanctioned from the top-down as a 1.5-acre facility [note: the current East Farm is actually around 0.45 acres] for the Environmental Analysis Program. Unlike the West Farm, which has garden-like feel with paths, nooks and small idiosyncratic crop plantings, the Academic Field focuses on larger-scale, higher output agricultural methods. In spring 2006, the inaugural Farms and Gardens class broke ground in the Academic Field, setting up a greenhouse and tool shed. In spring 2007, the second Farms and Gardens class started a berry patch filed with blackberries, raspberries and boysenberries."[209]

Greenhouse

The current greenhouse was built in fall 2013, replacing its somewhat flimsier predecessor and offering more space for seedlings. Although you may associate greenhouses with cooler climates, the greenhouse here is vital to help seedlings survive the cool nights here until they are large enough to transplant. The greenhouse also offers some measure of protection against the many hungry animals at the Farm.

Compost Pile

Pomona currently composts both pre-consumer (i.e. kitchen scraps) and post-consumer (i.e. non-meat, non-dairy food scraps, used napkins) organic waste. A student Compost Driver picks up the bins of waste from the Pomona dining halls every day and brings them to the Farm, where student Farm employees layer them with mulch to form giant compost piles. As the piles heat up, specialized microbes turn the organic waste into compost, which is ready to use after a number of weeks. Because these microbes require air to thrive, the piles will be turned by hand and/or with the tractor a few times over the course of the composting process. When the compost is complete (no identifiable food scraps remain, the pile has cooled down, and it smells like good dirt instead of fermenting food), it can be sifted to remove rocks and applied to beds at the Farm

[209] From http://www.pomona.edu/about/pomoniana/organic-farm.aspx, 8/2/2013.

or around the college. A waste audit in spring 2011 showed that over 1.5 tons of food waste per week is turned into compost at the Farm!

Fruit Trees

The orchard on the East side does produce fruit, but could use some expert care. Some of the peach trees, for example, were originally root stocks intended to have the branches of tastier peach trees grafted to them. Instead, they continued to grow and produce peaches of their own, which are certainly edible if not the best peaches you may have tasted. Feel free to explore the orchard and see how many different kinds of fruit trees you can identify.

1B: Seedling Planting

Materials

- Greenhouse space for seedling trays for roughly 4 weeks
- Seeds of fall (cool-weather) crops for seedling starts
    - Seedling starts: broccoli, cauliflower, kale, onions, Swiss chard, cabbage
- Seed trays for seedling starts
- Potting mix for seedlings
- Functioning irrigation system in greenhouse

Fall is the time to plant cool-season crops in Claremont. These include all the crops listed above, as well as others better-suited to direct seeding[210]. Root crops and some other vegetables are better-suited to direct seeding, whereas brassicas usually need to be started as seedlings in the greenhouse.

Objectives

- Learn how to start seedlings in a greenhouse and understand why a greenhouse is necessary for some plants in this climate

Seedling Starts

Certain crops need to be started as seedlings and transplanted after around 4 weeks. This gives them a chance to germinate and grow a little bit under the more controlled conditions of the greenhouse, without exposure to the full range of temperature shifts and animal predators that they would experience in the beds.

Seedlings can be started according to the following directions[211]:

> *"Starting Transplants*
>
> Any non-root crops can be started by planting seeds in a seedling tray in the greenhouse on the East Farm. The greenhouse keeps the seedlings warm and moist and diffuses incoming sunlight, which can help sensitive young plants grow during their first few weeks. Warm weather crops can also be started in the greenhouse as early as mid-February, four to six weeks before the warm season begins, which means you will have healthy summer seedlings to plant as soon as it begins to warm in the spring. Because greenhouse space is limited and prone to becoming disorganized, it is best coordinate with Farm Staff and other Farm users when planting in the greenhouse so that you can plant a full tray of each crop and everyone can use a portion of the seedlings.

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[210] For another resource, see "Digital Gardener's Southern California Vegetable Planting Schedule". 1999. Digital Visions Consulting. 8/16/2013. <http://www.digitalseed.com/gardener/schedule/vegetable.html>. Start seedlings around 4 weeks before the suggested planting time in order to be able to transplant them then.

[211] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013.

> To plant in the greenhouse, start by getting an empty black seed tray from the shelf to the west of the greenhouse on the East Farm. For most plants, the large, black trays with many small 1.5 inch square cells are big enough to accommodate the young plant, but small enough that you can make efficient use of greenhouse space. Most of the trays at the Farm are around 6 cells wide and 12 cells long. For plants like squashes and beans which have larger seeds (and thus larger seedlings), it may be necessary to use seedling trays with larger cells. Next, fill each cell in the tray with a light and airy store-bought potting soil, commercial seed-starting mix, or a self-made mix. The mix recommended by April Johnson of the Rodale Institute in Pennsylvania is a blend of 4 parts screened compost, 2 parts coconut coir, 1 part perlite or sand, and 1 part vermiculite.
>
> It is important that a seed-starting medium strikes a balance between water retention (vermiculite and compost) and good drainage (perlite or sand) so that seeds and young plant roots can have oxygen and space to grow, but also ample access to water. Then, like with direct seeding, create a small depression in each cell that is approximately twice as deep as the seed is long, place 2 to 3 seeds in the hole, gently nudge the surrounding soil over the seeds, and lightly tamp the soil in place. The crops most commonly started in the greenhouse include broccoli, cauliflower, cabbage, kale, Swiss chard, and onions for the winter and tomato, eggplant, pepper, squash, cucumber, and basil for the summer. Keep in mind that it is also usually best to thin greenhouse seedlings down to one plant per cell, and that can be challenging if there are 20 little plants sprouting in one small cell. Once the seedlings are 3 to 4 inches tall, which takes anywhere from 4 to 8 weeks, it is time to transplant them. Seedlings that are allowed to grow any taller will start to outgrow the small cells and their growth could be permanently stunted."

It is suggested to transplant the seedlings during the Soil Science unit (week 5), although that can be adjusted depending on your particular seedlings. Make sure to check on your seedlings and keep the soil moist, especially in the crucial window before germination!

Additional Resources

"Appendix 2: Soil Temperature Conditions for Vegetable Seed Germination." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 42. Print.

A useful table of optimal soil temperature conditions for vegetable seed germination.

"Appendix 4: Days Required for Seedling Emergence at Various Soil Temperatures from Seed Planted 1/2 Inch Deep." *Teaching Organic Farming and Gardening: Resources for*

Instructors. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 44. Print.

A table of time to emergence at various temperatures for a variety of vegetable seeds.

"Appendix 5: Approximate Monthly Temperatures for Best Growth and Quality of Vegetable Crops." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 45. Print.

A table of optimum growing temperatures for various vegetables.

"Seed Lecture 1 Outline: Seed and Seedling Biology and Cultural Requirements." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Farming Systems, 2005. 7-10. Print.

A good overview of the conditions seeds require to germinate and the biology of germination, in outline form.

2A: Tillage

Tillage prepares soil for planting by breaking up compacted soil and improving soil structure for plant roots. However, it's also somewhat controversial, as it can increase soil erosion and compaction (the Dust Bowl, for example, has been blamed to a great extent on over-tillage). Tillage exposes the organic material in soil to air, causing the aerobic microorganisms that break it down to go into action and turning all that carbon-containing plant matter into carbon dioxide that is released into the air. Since organic matter also helps hold the soil together, the rapid degradation of organic matter means that the remaining soil is more likely to erode and wash or blow away. Plowing can also compact the soil deep below the surface, creating a "plow pan" that plant roots can't break through. For more about different types of tillage, check out this week's reading:

"Detailed Lecture Outline: Soil Tillage and Cultivation." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 9-18. Print.

Read pages 9-17 and 43 for a great introduction to tillage, with a section focusing on the French-intensive style of tillage used at the Farm.

Additional Resources

Altieri, Miguel A. "Crop Rotation and Minimum Tillage." *Agroecology: The Science of Sustainable Agriculture*. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 233-46. Print.

Pages 239-246 address minimum-tillage systems, which are touted as a soil-conserving alternative to conventional tillage.

Hazlett, Richard. "Lecture Notes, EA85, March 11, 2013." Claremont, CA. Print.

Fungi are incredibly important to soils, and their survival depends on how heavily the soil is tilled. This is an entire lecture devoted to fungi, touching on bioremediation and no-till agriculture.

Jackson, Wes. *New Roots for Agriculture*. 2nd Edition ed. Lincoln, NE: University of Nebraska Press, 1980. Print.

Jackson's treatise on sustainable agriculture takes the perspective that we need to develop agroecosystems based on perennial grains to preserve the soil. His focus is soil conservation, and he emphasizes the unsustainable ways we have treated our soil in the past before outlining his philosophy for the future of agriculture. Most relevant are the short Preface and Chapter 5 ("Agriculture: Tragedy - or Problem with a Solution?"), and the somewhat longer Chapter 8, "New Roots for Agriculture," lays out the specific details of his vision.

2B: Tillage Workshop and Discussion

Materials

- Two beds (or two halves of the same bed) to be prepared
- Mature compost, sifter, and wheelbarrow
- Digging forks
- Shovels

Objectives

- Learn the basics of two tillage techniques: primary cultivation and French-intensive. Understand how the techniques are different and the relative advantages of each.
- Understand why we till the soil.
- Think critically about the conditions under which tilling is appropriate and be able to choose appropriate methods.
- Design an experiment to test differences between tillage methods.

Discussion Questions

- Why do we till the soil?
- What are some potential disadvantages of tilling? What conditions are best for tilling, and when should tilling be avoided?
- What were the main steps in the primary cultivation process? Why do we do each step?
- What do you think the benefits of the French-intensive method would be? Are there any drawbacks?
- Do you think the French-intensive method and primary cultivation method would lead to different results in plant growth? How could we test this?
- Minimum tillage, conservation tillage, and no-till systems are increasingly common. What are some advantages of these systems? What are the special characteristics of those systems (for example, why couldn't we just plant seeds into untilled soil every year and have a successful no-till system)?

Demonstration: Primary Cultivation (improved soil) vs. French-intensive

We'll compare two tillage techniques today: primary cultivation and French-intensive, also called double-digging. Primary cultivation is generally used for soil that has already been improved, so it requires less work. French-intensive bed preparation works more organic matter into the soil at greater depth, so it can help increase the amount of productive topsoil for unimproved soils.

Primary Cultivation

1. Move the irrigation lines off of the bed you plan to prepare.

2. Fracture the soil to a depth of around 6 inches all the way to the borders of a bed using a digging fork.
3. Sift compost into a wheelbarrow using the screen.
4. Spread compost onto the soil to a depth of around 3 inches (more, if you'd like), and work it in with the digging fork.
5. Shape the bed so that it's level, and replace the irrigation lines.

French-intensive

1. Move the irrigation lines off the bed you plan to prepare.
2. Sift compost into a wheelbarrow using the screen. You will need much more compost than with the primary cultivation method, so you may want to have some members of the group sift compost as others work on the bed.
3. Using shovels, dig a trench at one end of the bed that's about 1 foot deep and two feet wide. Pile the soil to the side to fill in later.
4. Fill the trench half-full with compost.
5. Remove the adjacent 2-foot-wide, 1-foot deep section of soil, and put that soil on top of the compost. Use the shovel to mix in the compost.
6. Continue down the bed in the same way, using the soil you removed at the beginning to fill in the very end.
7. Level off the bed and replace the irrigation lines.

Testing Differences between the Two Methods

Is French-intensive worth the extra work at the Farm, where most of the beds have been used relatively recently, so the soil is already somewhat improved? Next week, we'll be planting these beds, so we can test this out. Design an experiment to test the differences between the two methods. Things to consider:

- What differences would be important to measure? Are you more interested in physical parameters of the soil (moisture content, structure, etc.) or plant growth?
- Will different types of crops (for example, root crops and leaf crops) respond differently to different tillage methods? Do you need to plant the same crops in both beds?

3A: Plant Growth

To understand agriculture, it's important to understand what plants need in order to grow and thrive. There are two relatively short readings this week, focusing especially on the role of light:

1. Gliessman, Stephen R. "The Plant." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 35-42. Print.

   Read pages 35-42. A fairly short text on plant metabolism and nutritional needs, including photosynthesis, carbon partitioning, transpiration, major nutrients, and interactions with the environment.

2. Gliessman, Stephen R. "Light." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 43-57. Print.

   Read pages 47-55. These sections outline factors contributing to variation in the light environment and describe how that variability affects photosynthetic rate and other aspects of plant physiology.

Additional Optional Resources

Hazlett, Richard. "Lecture Notes, Ea 85, January 28, 2013." Claremont, CA. Print.

An introduction to agriculture as a whole, including botanical classifications of the types of plants we eat and various types of agriculture. Includes an interesting section on the "farm of the future".

Hartmann, Hudson T., and Dale E. Kester. *Plant Propagation: Principles and Practices*. 4th Edition ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983. Print.

This text is extremely detailed, but does have some potentially helpful sections. For this week, pp. 29-33 ("Media for Propagating and Growing Nursery Plants") and pp. 59-74 ("The Development of Seeds and Spores") would be most relevant.

Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013.

Read pages 58-66, a detailed overview of some of the cool-weather crops that have been grown in the past at the Farm.

3B: Planning a Garden Bed

Materials

- Vegetable Temperature Table[212]
- Seedling Emergence Table[213]
- List of cold-weather crops[214]
- Companion Planting Table[215]
- Seed packets for cool-weather crops
- Light meter to measure lux
- Soil temperature probe, if available
- Paper and pencil

Objectives

- Understand why light is important for plant growth and learn how to measure it
- Think about how the light environment is affected by other plants and physical location
- Think critically about the needs of different plants at different times (light, carbon dioxide, root space, leaf space) and use that knowledge to plan a garden bed
- Learn about companion planting and factor that into the bed plan, if desired

Discussion Questions

- The Gliessman reading this week (pp. 35-42) talked about photosynthesis. What is photosynthesis? Can you explain briefly how it works? How do the two kinds of photosynthesis differ?
- What do plants need to grow? Can there be too much of a good thing (light, warmth, moisture, etc.)?
- How does light affect other environmental conditions (soil temperature, moisture, etc.)?
- If, as Gliessman notes on p. 48, only 10% of incident light passes through a leaf, what does that mean for how you plan a garden? Do all plants need the same amount of light?

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[212] "Appendix 5: Approximate Monthly Temperatures for Best Growth and Quality of Vegetable Crops." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 45. Print.

[213] "Appendix 4: Days Required for Seedling Emergence at Various Soil Temperatures from Seed Planted 1/2 Inch Deep." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 44. Print.

[214] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013. 58-66. Print.

[215] http://farmtopreschool.org/pdf/2.3_CompanionPlanting_Chart.pdf.

Part 1: Measuring Light (30 minutes)

A. Incident Light (lux)
    a. Using the light meter, measure lux (essentially, light intensity) at different sites on the Farm. Try measuring along east-west as well as north-south gradients in different beds. Looking at the layout of the beds, how do you think these measurements would change at different times of day?
    b. The Gliessman reading suggested that only 10% of light passes through a leaf (p. 48). Is this true? How would you measure this? Does that rate depend on leaf type?
    c. How much do you think sunlight affects soil temperature? How would you test this? If a soil temperature probe is available, use it to test your hypotheses!
B. Review: Types of Photosynthesis
    a. Make sure to look at amaranth plants (C4 photosynthesis) and squash or tomato plants (C3 photosynthesis). Under what conditions is each type of photosynthesis most advantageous? How would this affect relative rates of growth of these two kinds of plants in summer versus in winter in Claremont? Do you notice any visible differences between the plants?

Part 2: Planning a Bed (1 hour)

Now that you've measured incident light, think about how you need to lay out the plants you want to grow to provide them with the appropriate amounts of light.

- Looking at the list of cold-weather crops for this area, identify some that you'd like to grow.
- Read the backs of the seed packets: what are the light requirements of these plants? How long do they take to mature?
- What are the space requirements of each plant in terms of roots and leaves?
- Looking at the companion planting guide, are there any plants you want to put particularly close together or far apart?
- How can you maximize your use of the space? Are there shade-tolerant crops that could grow underneath taller sun-loving crops? What parts of the bed receive more light than others?
- Taking all these factors into account, lay out a plan for the bed. Include which crops you want to grow, how much space in the bed each will get, whether you'll start them as seeds or direct sow them, and time to maturity.

4A: Weeds

Ralph Waldo Emerson famously wrote, “What is a weed? A plant whose virtues have not yet been discovered.” On the other hand, anyone who has done any farming or gardening knows how frustrating weeds can be. Weed management poses an even greater challenge to organic farmers, who avoid most herbicides and must use innovative strategies to keep unwanted plants from reducing their harvest. This week’s readings highlight weed biology, management strategies, and some of the most common weeds found at the Farm.

Readings:

1. "Detailed Lecture 1 Outline: Weed Biology." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 7-9. Print.

2. "Detailed Lecture 2 Outline: Cultural Weed Management Practices." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 15-17. Print.

3. Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm’s History and Basic Gardening Skills and Techniques ". Pomona College, 2013. 89-100. Print.

   Pages 89-100 have a list of common weeds at the Farm.

Additional Resources:

Altieri, Miguel A. "Weed Ecology and Management." *Agroecology: The Science of Sustainable Agriculture*. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 283-305. Print.

A great introduction to weeds, including some studies on timing of weed interactions with crops. Also addresses various management options. If you prefer traditional textbooks to the outline format of the first two readings above, this would be a good alternative.

Baker, Allen V. "Chapter 10." *Science and Technology of Organic Farming*. CRC Press, 2010. Print.

This chapter outlines various strategies for weed control; Professor Hazlett used it as a text for the EA85 course.

Gliessman, Stephen R. "Allelopathic Modification of the Environment." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 156-60. Print.

These four pages have a great overview of allelopathy (chemical interactions between plants). Read "Allelopathic Effects of Weeds" (pp. 156-8) and "Allelopathic Effects of Crops" (pp. 158-160).

Gliessman, Stephen R. "Beneficial Interferences of Weeds." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 209-11. Print.

Pollan, Michael. "Weeds Are Us." *The New York Times Magazine* 1989. Print.

Pollan's reflections on weeds as a central battlefront between nature and culture are extremely articulate and thought-provoking. He writes as a hobby gardener, but his observations are relevant to farmers and gardeners of all persuasions.

Vandermeer, John H. "Herbicides: "Chemical Mechanization" Of Weed Control." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 95-97. Print.

While most of this chapter is a too-detailed analysis of weeds, these three pages have a great overview of the development of chemical herbicides.

Vandermeer, John H. "Competition and Facilitation Among Plants: Intercropping, Weeds, Fire, and the Plow." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 63-116. Print.

If you want more details from the ecological theory perspective, check out this chapter by Vandermeer.

4B: Weed Lab Week 1

How well does hand cultivation actually control weeds? What weeds grow most vigorously at the Farm at this time of year? To answer these questions, you'll do a multiple-week activity and measure weed growth.

Materials

- A bed that hasn't been weeded for a while (or multiple beds, if you want to test different weed control strategies)
- Weeding tools
- Clippers
- Accurate, precise scale
- Dry area (such as the inside of the Dome) where you can set aside weeds to dry
- Paper bags
- Sharpie
- List of common weeds at the Farm[216]

Objectives

- Become familiar with the different weeds that are present locally
- Conduct an experiment to analyze the effectiveness of hand cultivation and determine which weeds grow fastest at this time of year

Overview

Week 1: Record different types of weeds present and number of each, weed the bed, and set aside weed biomass to dry.

Week 3: Weigh dry biomass from week 1, record different types of weeds present and number of each, weed the bed, and set aside the biomass to dry.

Week 4: Weigh dry biomass from week 3.

Procedure

You may want to set up a data sheet for this experiment that looks somewhat like the example below. You'll count the number of weeds of each type on weeks 1 and 3, and fill in the corresponding biomass after it has been dried on weeks 3 and 4.

Week	Weed type	# Plants present	Dry biomass (g)
1	Mallow	3	10.1
	Lamb's Quarters	4	5.2

[216] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013. 89-100. Print.

- This week, begin by becoming familiar with all the weeds in the bed using the weed guide and any other resources as necessary.
- Record the name of each and how many plants of that type are present.
- Using the weeding tools, weed the bed, making sure to get the roots all the way out! Clip off the aboveground biomass (everything above the level of the soil) and separate the weeds by type into paper bags. Label the bags.
- Leave the bags (tops open) inside the Dome to dry until week 3.

Questions to Consider:

- Which weeds were present in high numbers? Looking at the size of each plant, do you think these will also be the weeds with the most total biomass? Why might some weeds put more energy into reproduction (higher numbers of seeds/new plants) while others put more energy into growth (more biomass)?
- Why are you measuring biomass? What will that tell you about the ability of these weeds to compete with crops?
- How fast do you expect the weeds to grow? How much confidence do you have in your weeding ability: do you think any weeds will return within two weeks? Which weeds do you think will return fastest?

4B: Weed Lab Week 3

(Note: this is the second week with an active part for this lab, but the third week in terms of time since you started the lab.) Two weeks after setting up your weed experiment, you'll measure weed regrowth to answer your original questions: how well does hand cultivation actually control weeds, and what weeds grow most vigorously at the Farm at this time of year?

Materials

- The bed you weeded in week 1
- The weeds you set aside in week 1
- Weeding tools
- Clippers
- Accurate, precise scale
- Dry area (such as the inside of the Dome) where you can set aside weeds to dry
- Paper bags
- Sharpie
- List of common weeds at the Farm[217]

Objectives

- Compare weed regrowth to the original weed population
- Draw preliminary conclusions about the effectiveness of hand cultivation and determine which weeds grow fastest at this time of year

Overview

Week 1: Record different types of weeds present and number of each, weed the bed, and set aside weed biomass to dry.

Week 3: Weigh dry biomass from week 1, record different types of weeds present and number of each, weed the bed, and set aside the biomass to dry.

Week 4: Weigh dry biomass from week 3.

Procedure

- First, weigh the dry weed biomass for each weed type from week 1. Record this on your data sheet.
- Next, return to the bed you weeded two weeks ago. As you did then, record the name of each weed you see and how many plants of that type are present.

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[217] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013. 89-100. Print.

- Using the weeding tools, weed the bed, making sure to get the roots all the way out! Clip off the aboveground biomass (everything above the level of the soil) and separate the weeds by type into paper bags. Label the bags.
- Leave the bags (tops open) inside the Dome to dry until week 4.

Questions to Consider:

- Did biomass correspond to number of plants for the weeds you harvested in week 1? What does this tell you about which weeds put more energy into reproduction (higher numbers of seeds/new plants) versus which ones put more energy into growth (more biomass)?
- Which weeds returned in greatest numbers? Does the weed population this week look like the initial weed population?

4B: Weed Lab Week 4

Three weeks after setting up your weed experiment, you'll measure biomass from the weeds you harvested in week 3 and answer your original questions: how well does hand cultivation actually control weeds, and what weeds grow most vigorously at the Farm at this time of year?

Materials

- The weeds you set aside in week 3
- Accurate, precise scale

Objectives

- Measure biomass of weeds, and compare that to number of plants to make inferences about weed life history strategies
- Draw conclusions about the effectiveness of hand cultivation and determine which weeds grow fastest at this time of year

Overview

Week 1: Record different types of weeds present and number of each, weed the bed, and set aside weed biomass to dry.

Week 3: Weigh dry biomass from week 1, record different types of weeds present and number of each, weed the bed, and set aside the biomass to dry.

Week 4: Weigh dry biomass from week 3.

Procedure

- Weigh the dry weed biomass for each weed type from week 3. Record this on your data sheet.

Questions to Consider:

- Did biomass correspond to number of plants for the weeds you harvested in week 3? What does this tell you about which weeds put more energy into reproduction (higher numbers of seeds/new plants) versus which ones put more energy into growth (more biomass)? Was the relationship the same as in week 1? Why might this be?
- What can you conclude about the effectiveness of hand cultivation? Which weeds grow fastest at this time of year?

4B: Weed Lab Report Guidelines

Due Date:

Format: Please structure your lab report like a traditional science lab report or journal article, with Introduction, Materials and Methods, Results, Discussion, and Literature Cited sections. Each section doesn't need to be long, but should be clear and complete. For example, you don't need to look up twenty journal articles for the introduction, but do explain what the purpose of the lab was and why it's an interesting/important question. In the results section, you should include the name of each plant we identified, as well as a picture if you can (it's fine to find this on the Internet, but make sure to cite your source). Final length will probably end up being around 3-4 pages double-spaced, depending how many images and/or figures you include, but there are no specific length requirements. If you need to refer back to the original handouts, they're in the Google Drive folder. If you have any questions about the format, please don't hesitate to ask!

Grading: This project counts for 10% of the course grade (half of the 20% that makes up written assignments not including the final project). It will be graded on a 50-point scale:

Format: 5 points (Are all required sections there?)

Introduction: 10 points (Is the context of the experiment given? Are your hypothesis and predictions present? Is your writing clear?)

Materials and Methods: 10 points (Did you state everything you did, clearly and concisely?)

Results: 10 points (Are all plants listed? Do you list results for each hypothesis you tested?)

Discussion: 10 points (Did you put the results in context? How is this relevant to the Farm or farming/gardening beyond this experiment?)

Literature Cited: 5 points (Did you cite every source you used? At a bare minimum, this should be the plant guide you used to identify the weeds.)

If you have any questions, don't hesitate to ask!

5A: Soil Science

Soil is literally the foundation of agriculture, and its importance can't be overestimated. There's enough material on soil science to fill an entire year, so for a week-long unit, we'll just scratch the surface. Feel free to explore the additional resources if you're interested.

First, a few definitions[218]:

Soil quality: "The capacity of a soil to function, within land use and ecosystem boundaries, to sustain biological productivity, maintain environmental quality, and promote plant, animal, and human health."

Soil fertility: "The capacity of a soil to provide nutrients required by plants for growth. This capacity to provide nutrients to crop plants is in part influenced by the physical properties of soils and is one component of soil fertility. Desirable soil physical properties and the capacity of the soil to provide nutrients for growing crops are both soil quality indicators."

Readings:

1. Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013. Print.

   Read the Soils section (pp.29-46), which is full of excellent local information about the Farm's soil.

2. Gliessman, Stephen R. "Soil." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 99-114. Print.

   This is an excellent overview of the most relevant soil characteristics and processes for sustainable agriculture. It's not too long, and the level is good for those who haven't necessarily had a geology background.

Additional Resources:

"1.11 Reading and Interpreting Soil Test Reports." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 7-10, 25-26. Print.

The lecture outline on pp. 7-10 (Using a Soil Test to Assess Soil Quality) and the demonstration on how to take representative soil samples (pp. 25-26) are particularly useful. The rest of the chapter deals with high-tech laboratory analyses and how to interpret them; while this would be fantastic activity, it would be expensive.

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[218] *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. Unit 1.1 p.9. Print.

"Demonstration 1: Garden-Scale Compost Production." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 21-26. Print.

Hands-on exercises with compost that are a little too time-intensive for a semester-long independent study, but that could be modified or used as an independent project.

"Detailed Lecture 1 Outline for Students." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 9-13. Print.

Useful as a review guide for soil fertility (in outline form).

"Detailed Lecture 2 Outline: Soil Fertility Management - Sustainable Agricultural Practices." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 19-22. Print.

This is a great overview of essential organic soil management practices, including tillage, cover cropping, compost/manure, soil amendments, and crop rotation. Outline format.

"Detailed Lecture Outline: Making and Using Compost." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2005. 9-16. Print.

A wonderful introduction to compost.

"Detailed Lecture Outline: Soil Biology and Ecology." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 9-20. Print.

An overview in outline form of soil biology and ecology.

"Detailed Lecture Outline: Soil Chemistry." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 9-30. Print.

A very detailed outline of soil chemistry, from basic chemistry concepts to soil nutrient cycling and micronutrients.

"Detailed Lecture Outline: Soils and Soil Physical Properties." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 9-24. Print.

For those interested in the physical properties of soil.

Hazlett, Richard. "Lecture Notes, Ea85, February 25, 2013." Print.

A very approachable introduction to some of the microorganisms that live in soil and their relationships with plants.

---. "Lecture Notes, February 18, 2013." Claremont, CA. Print.

A geology-oriented overview of the formation and classification of soils.

Magdoff, Fred. "Soil Quality and Management." *Agroecology: The Science of Sustainable Agriculture*. Ed. Altieri, Miguel A. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 349-64. Print.

A more in-depth approach to soil quality than other readings.

Pollan, Michael. *Second Nature*. New York: Grove Press, 1991. Print.

Pollan's creative reflections on gardening as a reflection of the interface between nature and culture are thought-provoking and enjoyable. The chapter "Compost and its Moral Imperatives" is especially appropriate for this unit and a refreshing alternative to the more scientific focus of the other readings.

Vandermeer, John H. "Soils and the Emergence of the Industrial Approach." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 117-60. Print.

For those with a strong interest in soil properties, but pages 148-152 have a great section on the development of chemical fertilizers.

---. "The Biology of the Soil and the Emergence of an Ecological Vision." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 161-208. Print.

Extremely detailed, but possibly of interest to some. Pages 162-168 cover the historical development of soil science, and the remainder of the chapter takes a more scientific approach to soil biology. Pages 168-196 cover nutrient cycling in the soil with a focus on the role of microorganisms.

5B: Direct Seeding and Transplanting Seedlings

***Note**: you may want to harden off seedlings by moving the trays outside the greenhouse for 3 days or so before you transplant. You'll need to plan ahead to do this, but it will help them adjust to real-world conditions before you transplant, increasing their odds of survival!

Materials Needed

- Bed space for anything you plan to direct seed and for your seedling transplants; the bed should be prepared (weeded, tilled, and shaped) at this point
- Seeds of fall (cool-weather) crops for direct seeding: carrots, beets, parsnips, radishes, lettuce, arugula, etc.
- Seedling starts (these should be a few inches tall: broccoli, cauliflower, kale, onions, Swiss chard, cabbage, etc.
- Functioning irrigation system on beds, hose
- Trowel
- Plan for bed layout from Plant Growth week

Objectives

- Learn how to direct-sow seeds and be able to explain which crops should be direct-sown and why
- Learn to transplant seedlings and understand why each step (hardening off, making a deep enough hole, untangling seedling roots, etc.) is necessary
- Follow the bed plan designed in earlier weeks using a combination of direct seeding and seedling transplants

Direct Seeding

Seeds can be planted directly in the beds according to the following directions[219]:

"Direct Seed

Although some crops benefit from the more controlled conditions in a greenhouse, many vegetable seeds can also be successfully started by planting seeds directly into the soil. Root crops like carrots, beets, parsnips, radishes, must be directly seeded. For the direct seed method, first you must rake or and smooth the very top layer of soil, called the *seed bed*, in a fully prepared planting area, making sure that it is level and free of any rocks, sticks, or other objects that could get in the way of a sprouting seed. For large plants like broccoli, kale, zucchini, peppers, eggplants, or corn, use the hole method: poke a single small depression or hole in the soil with a finger, place 2-3 seeds in the hole, and then gently cover with nearby soil. Space the planting holes in a hexagonal arrangement, allowing enough space for each

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[219] Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm's History and Basic Gardening Skills and Techniques ". Pomona College, 2013.

plant at maturity (according to plant spacing distances found in the Crop Maintenance section on page 57). For smaller crops like carrots, radishes, lettuce, spinach, it is usually easier to use the row method by creating shallow linear depression with a finger or a stick, placing or sprinkling the seeds closely together along this line, and then gently covering them with soil.

You can also plant smaller crops by selecting an area of the plot, sprinkling the seeds evenly across that area, and then covering the seeds with a thin layer of light soil or compost (the area method). As a general rule, plant seeds at a depth that is twice the size of the seed. Pumpkin seeds, for example, may be up to a half and inch long and thus should be planted at least 1 inch deep, while carrot seeds rarely exceed ⅛ of an inch in length and thus should be planted within ¼ inch of the soil surface. Additionally, because germination rates are never 100%, it is also advisable to plant more seeds than you wish to grow into fully developed crops. Soaking seeds in water for 24 hours before planting can also help increase germination rate and reduce germination time and, especially for seeds with thick or tough outer shells like squashes and beans.

Once planted, water the bed regularly but lightly, making sure to not wash away the soil and the seeds you just planted. You can press a finger into the water flow coming out of a plain hose, creating a light spray, or attach a conventional hose spray nozzle and use the "mist" or "shower" setting. Depending on the crop, the growing conditions, and any seed preparation steps taken, the seeds will germinate after two days to three weeks. When the young plants are about an inch tall, you will need to go through and thin out any that are growing too closely together. For the large plants, carefully remove seedlings until you are left with one plant per hole. For those plants in rows or areas, remove seedlings such that the plants are evenly spaced from each other according to the specific plant spacing distance guidelines found in the Crop Maintenance section. Some plants can tolerate closer spacing, but most will be too crowded and will not develop to their full potential."

Transplanting Seedlings

Your goal in transplanting seedlings is to help them survive in a new environment, which requires helping them acclimate to the tougher conditions outside the greenhouse. The hardening off process, in which the seedling trays are placed outside the greenhouse for 3 days or so before transplanting, is part of this acclimation.

In the bed where you're planning to transplant the seedlings, prepare a row of holes that are ¼" deeper than the soil/root ball of the seedlings. (For example, if you grew the seedlings in 2" deep trays, dig 2 ¼" deep holes.)

You may need to pinch off the bottom leaves from some seedlings before transplanting them, especially if they're already wilted. If the seedlings only have a few true leaves and they're all healthy, ignore that step.

Squeeze the bottom and sides of a cell to loosen the soil and roots of the seedling, then grasp the seedling firmly at the base and lift out the whole seedling with the clump of soil. If necessary, use your fingers to break up roots that are growing circularly. This is important: plants need to be able to send their roots out horizontally and vertically to obtain enough nutrients and water, and “rootbound” plants (those whose roots are growing in a circle as a result of a too-small container) won’t survive.

Place the seedling in the center of the first hole and fill in evenly around it with soil. Tamp down the soil lightly with your fingers, making sure that the surface around the seedling is level (or a little higher than) the rest of the bed.

Once you’ve finished transplanting seedlings, water them well. Check in on them fairly regularly over the next week or so to make sure they’re surviving the transplanting.

5B: Measuring Soil Physical Parameters

Materials

- Three different agroecosystems (beds planted with different cropping systems) that you can take soil samples from
- Soil texture flow chart[220]
- Soil temperature experiment guidelines[221]
- Soil moisture experiment guidelines[222]
- Temperature probe
- Accurate, precise scale
- Jars with lids (one for each soil sample you'll take for the soil moisture section)
- Trowels or spoons

Objectives

- Understand the importance of soil texture, temperature, and moisture to plant growth
- Learn how to measure each of the above parameters
- Make a hypothesis about soil temperature or moisture differences between three different agroecosystems and test your hypothesis by collecting data

Measuring Soil Parameters

C. Soil Texture

  a. Everyone will learn to characterize soil texture by feel, using a flow chart. Sample soil from each of the three agroecosystems according to the instructions on the flow chart and use the chart to characterize soil type in each one.

Next, half the group will measure soil moisture while the other half measures soil temperature. Split into two groups, and develop a hypothesis within each group for how soil moisture or temperature will differ among the three agroecosystems.

D. Soil Moisture

  a. Follow the instructions on Investigation 4 from *Field and Laboratory Investigations in Agroecology*, by Stephen R. Gliessman. This can be found in Professor Hazlett's office.

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[220] Gliessman, Stephen R. "Measuring Soil Texture." *Field and Laboratory Investigations in Agroecology*. New York: Lewis Publishers, 2000. 61-62. Print.

[221] ---. "Investigation 3: Soil Temperature." *Field and Laboratory Investigations in Agroecology*. New York: Lewis Publishers, 2000. 33-41. Print.

[222] ---. "Investigation 4: Soil Moisture." *Field and Laboratory Investigations in Agroecology*. New York: Lewis Publishers, 2000. 43-51. Print.

E. Soil Temperature
    a. Follow the instructions for Investigation 3 from *Field and Laboratory Investigations in Agroecology*, by Stephen R. Gliessman.

Write-up

For this week, instead of doing a reflection you'll submit a brief lab report. Include:

- an introduction paragraph briefly summarizing the importance of soil texture, moisture, and temperature
- your hypotheses: what differences did you expect to find in soil found in the three different agroecosystems, and why?
- a methods section (this can be very short)
- your results
- a discussion paragraph: how could your results apply to organic farming or gardening in general? How could you design an agroecosystem for optimal texture, moisture, and temperature conditions?

6A: Integrating Animals into Sustainable Agriculture

The term "organic farm" may conjure up mental images of row upon row of vegetables for some, but animals can be part of sustainable agriculture, too. Manure can be used as a fertilizer, reducing the need for external chemical inputs and creating a closed-loop nutrient cycle. Some grazing systems rotate clover-containing pasture with crops to restore nitrogen to the soil, since symbiotic bacteria that fix nitrogen from the atmosphere live in the roots of clover plants. One of the best-known examples of a mixed farm (one that produces both plants and animals) is Joel Salatin's Polyface Farms, which was featured in *The Omnivore's Dilemma*. This week's readings look at the benefits of raising animals on a mixed farm.

Readings

1. Gliessman, Stephen R. "Animals in Agroecosystems." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 269-85. This chapter has an excellent overview of the opportunities for integrating animals into sustainable agriculture.
2. Watch: Loewen, Paul. *Moving the Chicken Tractor*. 2010.
   A short 1-minute video showing a chicken tractor similar to that described by Joel Salatin. http://www.youtube.com/watch?v=n7mPvrcc0Es.

Additional Resources

"The Bee Plan."

This book was produced as a final project in EA85 in spring 2013. It describes the role of honeybees in agroecosystems, focusing on the Farm, and lists some native plants to attract bees.

Hazlett, Richard. "Lecture Notes, Ea85, April 15, 2013." Claremont, CA. 28-39. Print.

The section beginning with "Domestication" has some interesting background on animals in agriculture. Hazlett writes with a broad geographical and historical focus.

"New Frontier Family Farm". 8/17/13.

New Frontier Family Farm, a small farm in Chino, CA, is a great resource if you'd like to learn more about raising animals for eggs and meat. They don't grow vegetables, but have a meat CSA program with lamb, beef, and chicken. The owners, Dave and Heather, are very friendly and willing to talk about what they do.

Pollan, Michael. "Sustaining Vision." *Gourmet Magazine* 2002. Print.

Similar to the excerpt on Polyface Farms from The Omnivore's Dilemma, this article describes Joel Salatin's vision for integrating animals into a sustainable small farm.

6B: The Mobile Chicken Coop

The readings this week were about integrating animals into sustainable agriculture, and the Farm offers a few opportunities to do just that. A beehive on the East Farm offers one chance to see how animals are necessary for agriculture, providing the necessary service of pollination, but we'll be focusing on the chickens this week. How does the presence of chickens change a vegetable garden? You'll explore that question this week by observing the chickens in a bed and conducting an experiment on.

Materials

- Mobile chicken coop[223]
- Chickens
- A bed of your choice
- A control bed
- Soil test kit
- Pitfall traps to collect insects and pitfall trap ethanol/water solution (note: you may be able to borrow these from the Biology department)

Objectives

- Think critically about how an agroecosystem differs from natural ecosystems, and how the introduction of animals may change that comparison
- Observe chickens to become familiar with their behavior
- Make hypotheses about how the presence of chickens will change soil chemistry and arthropod populations, and design an experiment to measure these changes

Procedure

- Set up the mobile chicken coop in your experimental bed, and observe the chickens for 15 minutes or so. What do the chickens do when you first put them in the bed? Does their behavior change over time? What are they most interested in?
- Chickens could affect soil chemistry and arthropod populations in the experimental bed. Why is that? How would you expect these parameters to change? Although you may not have time to actually carry out the experiment, design an experiment to test the effect of chickens on one of these two parameters. How long do you think you would need to expose the bed to the chicken "treatment" to see effects?

[223] Note: this was under construction as of fall 2013. If no mobile chicken coop is available, you can construct your own: it requires only PVC pipe and a flexible material (netting, wire, or something similar) to prevent the chickens from getting out. Take a long strip of the material that's about a meter tall and divide PVC poles evenly along the length. Attach stakes to the bottom of the PVC poles so that you can put it in the ground, and it's ready to go!

7A: Compost

Compost has been called “the foundation of sustainable agriculture,” and for good reason. Where conventional agriculture depletes the soil and requires constant external inputs of chemicals to provide nutrients, organic agriculture recycles nutrients through compost. Compost is produced when organic matter (dead plants, food scraps, manure, and more) is broken down by different groups of aerobic (oxygen-requiring) microorganisms. The process takes a few weeks, depending on the size of the pile, and occurs at surprisingly high temperatures. (Take a walk down to the Farm on a cool morning and watch the pile steam!) This week’s readings focus on the practical side: how to make compost.

Readings

"Detailed Lecture Outline: Making and Using Compost." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2005. 9-16. Print.

Additional Resources

See the resources for the Soils unit: many of these have relevant information!

7B: Comparing Compost and Soil Chemistry

Compost is an extremely important soil amendment that adds organic matter to the soil, releasing nutrients slowly over time. The slow release of nutrients is one thing that makes compost a more sustainable alternative to chemical fertilizers. When chemical fertilizers are applied in excess, the nutrients that can't be retained in the soil are leached out into soil water and enter groundwater or surface water, causing pollution problems. (Nitrogen and phosphates from agricultural sources have both had a significant impact on water quality in a number of places.) Compost, on the other hand, releases nutrients gradually as the organic matter it contains decays. If the pH of compost is too high or too low, though, it can impede plant growth. How do the chemical qualities of compost produced at the Farm compare to soil in the beds, and to soil from under the oak trees? This week, you'll test pH and the three major plant nutrients to compare the relative nutrient availability between compost and soil from different sources.

Materials

- LaMotte soil test kit (kept in Professor Hazlett's office)
- LaMotte Soil Handbook (kept with the test kit)
- Beds that you can sample soil from on the East Farm and West Farm
- Mature compost pile
- pH meter and operating instructions (kept in Professor Hazlett's office) (http://www.eutechinst.com/manuals/english/wp_testers/ecotestr_ph2_ra.pdf)
- Deionized water in a squirt bottle
- Four buckets
- Shallow dishes to measure pH

Objectives

- Learn why pH, nitrogen, phosphorous, and potassium are important for plant growth
- Think critically about the differences between soil and compost and make hypotheses about how their chemistry will differ
- Measure and compare pH, N, P, and K for soil and compost

Procedure

- First, refresh your memory on the role of pH, nitrogen, phosphorous, and potassium. How does pH affect nutrient availability and plant growth? What does each of the three main nutrients do for plants? Refer to readings as necessary.
- Obtain soil samples: Using a trowel and avoiding touching the soil with your hands (sweat and other compounds on your hands can contain nitrogen or affect the pH of a soil sample), take samples of soil or compost from three or four different locations. Make sure to sample from the depth at which plant roots would grow in the soil. Sift each sample, and mix it thoroughly in a bucket. Take samples of a) finished compost, b) East Farm beds, c) West Farm beds, and d) soil underneath the oak trees by the hammer throw field.

- How do you expect these samples to differ in terms of nutrients and pH? (Oak trees are known for producing acidic leaf litter: how would that affect the pH as compared to Farm soils?)
- Calibrate the pH meter by pressing down the “CAL” button until it begins flashing, then holding it in the pH 10.0 buffer solution and pressing “Enter”. Rinse with deionized water and repeat with the pH 7.0 and pH 4.0 buffer solutions.
- Combine a fixed ratio of soil with water for each of your samples, and use it to measure pH with the pH meter. Rinse with deionized water between each sample, and record your results on a data sheet.
- Prepare a soil extraction for each of your samples according to the instructions in the LaMotte manual on p. 5. You will use these extractions for all the nutrient tests.
- Measure nitrate nitrogen (p.6), potassium (p.7-8), and phosphorous (p.9) for soil and compost using the LaMotte soil test kit and manual.

Questions to Consider

- Why is soil pH important to plants? (You may want to return to some of the readings on plant growth to answer this.)
- Why are N, P, and K important? Do the forms of these nutrients matter? What forms did you measure?
- Were soil and compost different chemically (in the parameters you measured)? Why might this be? From your measurements, would you conclude that adding compost is beneficial to the soil?
- What other benefits besides N, P, and K might compost provide?

8A: Insects

Insects have a mixed impact on farming: some pollinate crops, an essential service, but others attack plants at vulnerable stages, decreasing yields. In organic farming, which avoids using most chemical pesticides, many farmers rely on integrated pest management (IPM) to control insect damage, using innovative strategies to keep insects from eating all their crops. One example is biological control, where farmers introduce a natural predator or parasitoid of the insect causing the damage to reduce the pest population. (Think releasing ladybugs instead of spraying chemicals to deal with an aphid infestation.) This week's readings will address a few of the diverse roles played by insects in agriculture.

Readings

1. "Detailed Lecture 1 Outline: Managing Arthropod Pests." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 11-17. Print.

   Read pp.11-17 for a good overview of arthropod control strategies for organic agriculture.

2. Gliessman, Stephen R. "Using Flowering Plant Corridors to Increase Beneficial Insect Diversity in a Vineyard." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 233-34. Print.

   A short case study on using corridors of natural habitat to increase beneficial insect diversity.

3. Vandermeer, John H. "Biological Control - the Practical Side of Predator/Prey Interactions." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 224-36. Print.

   Skim this introduction to biological control. It's a little long, but has a good level of detail and a critical analysis of the politics of IPM.

4. ---. "The Chemicalization of Pest Management." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 219-24. Print.

   An interesting historical look at the development of pesticides.

Additional Resources

Altieri, Miguel A. "Integrated Pest Management." *Agroecology: The Science of Sustainable Agriculture*. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 267-81. Print.

An explanation of the theory behind Integrated Pest Management, with a discussion of techniques such as crop rotation, polycultures, and insect control.

Hartmann, Hudson T., and Dale E. Kester. *Plant Propagation: Principles and Practices*. 4th Edition ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983. Print.

Useful here: pp.85-90: Pollination Requirements of Plants.

Hazlett, Richard. "Lecture Notes, Ea85, March 25, 2013." Claremont, CA. 1-8. Print.

The first eight pages of these notes describe some of the most important insects at the Farm.

Vandermeer, John H. "The Ecology of Herbivory and Disease." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 213-19. Print.

This section on the ecology of herbivory and disease takes a very mathematical approach. It would be an interesting supplement for those with a strong interest in math or population dynamics.

8B: Herbivory Lab

***Note:** This lab requires a lot of advance planning, because you'll have to plant the beds a certain way in early fall in order to be able to compare herbivory between a control bed and an experimental bed.

Sustainable agriculture requires creative approaches to pest management, since most traditional pest control relies on chemicals that can have harmful effects on native pollinators and even human health. One method for controlling pests is to use a "trap crop": a plant that is more attractive to insects than your crops. Mustard has been tested as a trap crop for many vegetables in the Brassica family, and has had some success at controlling these. Since brassicas are important fall crops at the Farm, this is a great chance to test out how well trap crops actually work.

Materials

- Brassica seedlings and mustard seedlings (you will need to start these from seed in the greenhouse 3-4 weeks before you want to transplant them)
- Two identical beds
- Guide for estimating % cover (Can be found at http://jsedres.geoscienceworld.org/content/21/1/32.full.pdf+html)
- Tape or other materials to tag plants

Objectives

- *Understand what a trap crop is and why it is used*
- *Evaluate the effectiveness of trap crops as a pest control strategy*
- *Think critically about how this method of pest control could be improved*

Procedure

- In early fall, when you are transplanting brassica seedlings, lay them out in two beds that are identical except for a border of mustard seedlings around one of the beds. This will be your experimental bed. Depending on how large the beds are, you may need to just plant mustard at the ends of the rows and interspersed with the brassica seedlings instead of planting a full border.
- After the mustard and brassicas have been growing for a few weeks, measure the rates of herbivory in the experimental and control beds. You can do this by estimating the percent of each leaf that has been eaten, using the guide above. Assess insect damage on the same number of leaves in each bed, recording distance from the trap crop for each plant in the experimental bed.

- What differences, if any, do you see between the two beds? Does the presence of a trap crop appear to be an effective way of reducing herbivory?
- How would you improve the trap crop method if you were to use it again? Would you plant more mustard? A different plant? A full border, or just at the edges?
- Did you see any insects on the plants? If so, what kinds? Why might trap crops be more effective for certain kinds of insects (flying, crawling, etc.) than others?

9A: Fruit Trees and Agroforestry

Fruit orchards can add an entirely new dimension to a farm. The region around Claremont used to produce a significant amount of citrus, in fact, and the Farm has many fruit trees of its own. One reading this week touches on the more technical aspects of fruit tree cultivation; unlike vegetables, fruit trees must be propagated asexually by grafting branches from one tree to the trunk of another tree. Agroforestry, or the integration of trees into agricultural systems, is a fascinating topic, and the other reading provides a short introduction to the topic.

Readings

1. Farrell, John G., and Miguel A. Altieri. "Agroforestry Systems." *Agroecology: The Science of Sustainable Agriculture*. Ed. Altieri, Miguel A. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 247-63. Print.

   A good overview of agroforestry as a concept, with some international examples.

2. Hartmann, Hudson T., and Dale E. Kester. *Plant Propagation: Principles and Practices*. 4th Edition ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983. Print.

   Read pages 343-349, Theoretical Aspects of Grafting and Budding.

Additional Resources

Tom Spellman is a wonderful local resource, and has taught pruning for 40 years! If you can coordinate a time for him to come and lead a pruning workshop (as early as possible in the fall semester), his advice is invaluable. Contact tom@davewilson.com. If you can't get him to come in person, check out his videos on the Dave Wilson website!

Hartmann, Hudson T., and Dale E. Kester. *Plant Propagation: Principles and Practices*. 4th Edition ed. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1983. Print.

Relevant sections include pp. 199-215: General Aspects of Asexual Propagation, pp. 235-297 Anatomical and Physiological Basis of Propagation by Cuttings (extremely detailed), and pp. 377-388 Scion-Stock (Shoot-Root) Relationships. This can be found in the Dome library.

Spellman, Tom. *Backyard Fruit Tree Basics*. *Fruit Tube.* Dave Wilson Nursery, 2011. http://www.davewilson.com/community-and-resources/videos/backyard-fruit-tree-basics.

A video introduction to fruit tree basics by Tom Spellman, a local expert who works at Dave Wilson.

10A: Cover Crops

In the absence of chemical fertilizers, organic farmers have to find other ways to maintain soil fertility. Rotating crops with legumes, which add nitrogen to the soil thanks to symbiotic bacteria that live in their roots, is one way of doing this. Many farmers plant cover crops in late fall, so that they don't compete with profitable agricultural crops, and turn them under in early spring to allow the nutrients to return to the soil. (In no-till systems, sometimes farmers simply mow the cover crop and plant seeds into the stubble, in order to avoid the negative consequences of tillage as discussed in previous weeks.)

Readings

1. "Detailed Lecture 2 Outline: Soil Fertility Management - Sustainable Agricultural Practices." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology & Sustainable Food Systems, 2005. 19-22. Print.

   This is a great overview of essential organic soil management practices, including tillage, cover cropping, compost/manure, soil amendments, and crop rotation. Outline format.

2. "Detailed Lecture Outline: Selecting and Using Cover Crops." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2005. 7-10. Print.

   A short but comprehensive guide to cover crops. Takes a more practical approach than some other texts, with sections called "Why Use Cover Crops?" and "How to Choose a Cover Crop".

Additional Resources

Altieri, Miguel A. "Cover Cropping and Mulching." *Agroecology: The Science of Sustainable Agriculture*. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 219-32. Print.

A good overview of different kinds of cover cropping and mulching, with a focus on orchards. Also contains a section on green and living mulches.

---. "Crop Rotation and Minimum Tillage." *Agroecology: The Science of Sustainable Agriculture*. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 233-46. Print.

Pages 233-239 cover crop rotation and could be a good supplement.

Gliessman, Stephen R. "Beneficial Interferences of Weeds." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 209-11. Print.

Page 210 has a great table for the Cover Crops unit, called "Potential Benefits of Cover Crops".

Vandermeer, John H. "Soils and the Emergence of the Industrial Approach." *The Ecology of Agroecosystems*. Sudbury, MA: Jones and Bartlett Publishers, 2011. 117-60. Print.

While the majority of this chapter will be useful mostly to those with a strong interest in soil properties, pages 148-152 have a great section on the development of chemical fertilizers.

10B: Planting Cover Crops

In the fall, growth naturally slows down as the days get shorter and the temperatures drop. In sustainable agriculture, farmers often take advantage of the winter season to restore fertility to their soils with cover crops. These crops are planted in the late fall and can be tilled under in the spring. Fava beans and clover work particularly well as a cover crop at the Farm, restoring nitrogen to the soil thanks to the bacteria that live in their roots; fava beans also provide a delicious crop of seeds that can be eaten or saved for replanting. However, not all crops benefit from the extra nitrogen: beans and peas, for example, don't do as well in high-nitrogen soils, whereas potatoes and many other crops need high nitrogen to thrive. This week, you'll assess what crops are where at the Farm and determine where to plant a fava bean or clover cover crop for best effect.

Materials

- Fava bean seeds
- Clover seeds
- Beds planted with the remains of fall crops
- Hand tools for digging out crops, as needed

Objectives

- Understand why cover crops are used
- Plan a bed layout for the spring, using cover cropping and crop rotation to best effect

Procedure

- Draw out a map of the beds on the East side as they are currently planted. In order to reduce disease and insect damage, it's best to rotate crops of different families. You may want to look up which family each crop that you see belongs to if you aren't familiar with them. (A great resource: http://www.growveg.com/growguides/crop-rotation.aspx).
- Think about what crops you will want to plant in the spring, and the nitrogen needs of each. (A resource that may be helpful is this website on varying nitrogen requirements of certain vegetables, although it's written more for someone planning to apply chemical fertilizers: http://www.ext.colostate.edu/pubs/garden/07247.html).
- Draw up a plan for the beds in the spring, noting the location of any crops that will need extra nitrogen and the location of crops that shouldn't receive too much nitrogen.
- Remove dead plants from the beds, amend the soil with compost as needed, and plant fava beans or clover. Review the Direct Seeding handout as needed.
- In beds where you aren't planting a cover crop, adding extra compost is a good idea: it will break down slowly over the winter, restoring organic matter and nutrients to the soil.

11A: Irrigation

Especially in a climate as dry as Southern California's, irrigation is vital to agricultural production. (Dryland farming is one exception, but suited to particular specialized crops.) Irrigation is also one of the more controversial areas of farming, however, as drawing on groundwater to irrigate crops can deplete aquifers; demand for water in Southern California contributed historically to political crises such as the Owens Valley affair as well. Understanding how much water crops actually need and choosing water-efficient irrigation methods can therefore help minimize conflict and make the best use of limited resources.

Readings

1. "Detailed Lecture Outline: Irrigation." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2005. 9-12. Print.

   Detailed outline of irrigation: the role of water in agricultural systems, water cycling, and frequency/volume of irrigation.

2. "Appendix 1: Estimating Soil Moisture by Feel." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2005. 38. Print.

   A useful table for estimating soil moisture. This may come in handy for the hands-on exercises this week, too.

3. Gliessman, Stephen R. "Water in the Soil." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 115-30. Print.

   This chapter has an excellent overview of water in the soil, including movement of water into and out of the soil, availability to plants, and irrigation.

Additional Resources

"Hands-on Exercises 1-6." *Teaching Organic Farming and Gardening: Resources for Instructors*. Ed. Brown, Albie Miles and Martha. Santa Cruz, CA: Center for Agroecology and Sustainable Food Systems, 2005. 17-22. Print.

(Note: this may be part of the hands-on activities this week.) These sample calculations and other mathematical exercises take you through figuring out how to replace water lost through evapotranspiration and water budgets.

Conrad, Rachel, and Lila Mendoza. "Exploring Irrigation at the Pomona Farm: Final Project." Claremont, CA: Pitzer College, 2012. Print.

Two students from the Food, Land, and the Environment course did a final project mapping and fixing the irrigation system at the Farm. Although slightly outdated now (the maps have been updated, too), it can introduce you to how irrigation works at the Farm and has some practical tips for fixing drip lines.

Gliessman, Stephen R. "Humidity and Rainfall." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 73-85. Print.

This chapter deals with natural patterns of rainfall and examples of agroecoystems based on those patterns (rainfed agroecosystems, dryland farming, and grazing systems).

12A: Classic Readings in Sustainable Agriculture

While most of this course focuses on the practical elements of organic farming, understanding the theoretical and historical framework behind these practices is important as well. This week, read the outline and then choose one of the following readings. As you read, consider some of the questions at the bottom. These can serve as the basis for a discussion with others in this week's meeting, since you may have chosen different readings.

Note: the readings aren't available on Google Drive: you may need to seek them out. Where possible, I've noted the location of the text.

Readings

Bailey, Liberty Hyde. *The Holy Earth* (1916). Online. http://www.gutenberg.org/files/33178/33178-h/33178-h.htm#First_the_Statement.

Liberty Hyde Bailey wrote in the early twentieth century from a more religious perspective than some of the later sustainable agriculture writers. Read "First, the statement" and "The farmer's relation". You could also check out *The Country-life movement* from Honnold Library.

Balfour, Eve. "Towards a Sustainable Agriculture." Canberra Organic Growers' Society, Inc., 1977. Online. http://www.soilandhealth.org/01aglibrary/010116balfourspeech.html

Lady Eve Balfour was another important voice early on in the sustainable agriculture movement. This is the text of an address she gave in Switzerland in 1977.

Berry, Wendell. *The Unsettling of America*. San Francisco: Sierra Club Books, 1997. Print. Professor Hazlett's office.

Berry is one of the most famous voices in the American sustainable agriculture movement. Read Chapter Three: The Ecological Crisis as a Crisis of Agriculture, or another work by Berry.

Fukuoka, Masanobu. *The Natural Way of Farming*. 1st Indian Edition ed. T. Nagar, Madras, India: Bookventure, 1985. Print. Professor Hazlett's office.

Fukuoka was a pioneer in the sustainable agriculture movement in Japan, starting his own farm based on "do-nothing farming" and natural methods. He takes a very philosophical approach. Read: Introduction (pp.15-20), The Relative Merits of Natural Farming and Scientific Agriculture (pp. 93-102), The Four Principles of Natural Farming (pp.103-118).

---. *The One-Straw Revolution*. New York: New York Review of Books, 1978. Print. Dome library.

More a philosophical treatise than a how-to gardening manual, Fukuoka's One-Straw Revolution is a classic in the literature of organic farming. He promotes "do-nothing" natural farming, avoiding tillage, chemicals, fertilizers, and prepared compost and sowing seeds into an unstructured polyculture. Read pp. 1-40.

Howard, Albert. *An Agricultural Testament*. New York: Oxford University Press, 1940. Online. http://www.zetatalk3.com/docs/Agriculture/An_Agricultural_Testament_1943.pdf.

Sir Albert Howard was a British soil scientist and one of the first advocates of organic soil management to preserve fertility. He has an interesting perspective on the differences between Western agriculture and traditional Eastern agriculture, which comes in part from his work in India. Read pp. 1-26.

Jackson, Wes. *Consulting the Genius of the Place*. Berkeley, CA: Counterpoint Press, 2010. Print. Professor Hazlett’s office.

Wes Jackson started The Land Institute in Salina, KS and works to develop perennial grains based on the natural prairie ecosystem. He has a unique perspective, and this is a more recent book than some of the others. Read Chapter 2: One Man's Education (pp. 19-65).

---. *New Roots for Agriculture*. 2nd Edition ed. Lincoln, NE: University of Nebraska Press, 1980. Print. Professor Hazlett’s office.

An interesting argument that we need to develop agroecosystems based on perennial grains. Jackson's focus is soil conservation, and he emphasizes the unsustainable ways we have treated our soil in the past before outlining his philosophy for the future of agriculture. Read: Preface and Chapter 5 ("Agriculture: Tragedy - or Problem with a Solution?"), or Chapter 8, "New Roots for Agriculture," which lays out the specific details of his vision for the future.

Leopold, Aldo. "The Land Ethic." 1948. Online. http://home.btconnect.com/tipiglen/landethic.html.

Aldo Leopold is one of the quintessential voices in American environmentalism, and this essay comes from his seminal work *Sand County Almanac.* Although it's not as specifically devoted to agriculture as some of the other readings, he has good ideas about the ethical underpinnings for the way we grow food and manage the land. Read the whole essay.

Pollan, Michael. *Second Nature*. New York: Grove Press, 1991. Print. Professor Hazlett’s office.

Pollan's creative reflections on gardening as a reflection of the interface between nature and culture are thought-provoking and enjoyable. Read "The Idea of a Garden".

Questions for Consideration and Discussion

- Who was the author whose work you read? Where and when were they writing? Did they have farming experience personally? How did the answers to these questions influence their writing?
- Whose ideas were they influenced by? Do they name people who inspired their work?
- How would your author define “sustainable agriculture”?
  - What are their views on nature? Agriculture? The role of humankind?
  - What specific views do they hold towards technology? The types of crops that should be grown?
- Eleanor Perényi, a gardener and essayist, commented, "I object to the idea that only a replica of the wilderness can qualify as an ecologically sound environment" (in Pollan, *Second Nature*, pp. 245). Based on what you read for this week, do you agree or disagree?
- As a group, see if you can make a timeline of the authors you read from. Does this tell you anything about how ideas evolved over time? Or do the different geographic and cultural contexts make comparisons impossible?

13A: Current Research in Sustainable Agriculture

The discussion on classic voices in sustainable agriculture focused on the past, but what about the future? Research in sustainable agriculture is a growing field, as scientists seek to perfect their methods and justify the use of sustainable techniques. This week, explore some of the research that's being done right now: find a recent journal article (something from the last 5 years) and bring it to the meeting to discuss with others.

First, read Gliessman, Stephen R. "Research on Sustainability." *Agroecology: The Ecology of Sustainable Food Systems*. 2nd Edition ed. Boca Raton, FL: CRC Press, 2007. 306-10. Print.

This reading gives a brief introduction to research in sustainable agriculture, especially focused on how to evaluate sustainability in an agroecosystem.

Finding a Journal Article

After reading the text above, find an article that interests you about research being done in sustainable agriculture. Possible topics include conservation tillage, integrated pest management, water-saving irrigation, biochar, beneficial microorganisms, etc. Good places to start include the databases subscribed to by Honnold-Mudd (Web of Science, JSTOR, ScienceDirect, etc.) and the Journal of Sustainable Agriculture. At time of writing, Farm Club has a subscription to the Journal of Sustainable Agriculture and stores the issues in the Dome library for public access.

Questions for Discussion

- What area of research does your article fall into? How new is this area of research? Can you tell (perhaps by looking at citations) how much impact this article has had?
- Who would benefit from the research done in your article? Organic farmers? Conventional farmers looking to convert their management techniques? Does the research apply to a broad geographic area or a narrow one?
- Where did you find your article? Was it difficult to find research being done in sustainable agriculture? Could you tell from the search process what some of the biggest journals in sustainable agriculture are?

14A: Polyculture and Companion Planting

Unlike conventional agriculture in the United States, which relies heavily on monocultures (growing a single crop exclusively), organic agriculture often makes use of polycultures. Planting a diverse mix of crops has many benefits for the farmer, from insurance against a single crop failure to the reduction of disease. Some plants even have beneficial actions for certain other plants, called "neighbor effects"; organizing a farm or garden around these interactions is called "companion planting". This week's readings will explain these concepts in more detail.

Readings

1. Liebman, Matt. "Polyculture Cropping Systems." *Agroecology: The Science of Sustainable Agriculture*. Ed. Altieri, Miguel A. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 205-18. Print.

   An introduction to polyculture cropping systems, with theoretical explanations and practical examples.

2. Mollison, Bill. *Permaculture: A Designer's Manual*. 2nd Edition ed. Tyalgum, Australia: Tagari Publications, 2004. Print.

   Permaculture is a version of polyculture that's designed to last rather than being harvested and replanted. Especially useful here are pp. 58-69, which address in somewhat more concrete terms how to design a guild-based polyculture system.

Additional Resources

Altieri, Miguel A. "Designing Sustainable Agroecosystems." *Agroecology: The Science of Sustainable Agriculture*. 2nd Edition ed. Boulder, CO: Westview Press, 1995. 89-106. Print.

A section on designing an agroecosystem.

Jackson, Wes. *New Roots for Agriculture*. 2nd Edition ed. Lincoln, NE: University of Nebraska Press, 1980. Print.

An interesting treatise on sustainable agriculture from the perspective that we need to develop agroecosystems based on perennial grains, a different kind of polyculture. Jackson's focus is soil conservation, and he emphasizes the unsustainable ways we have treated our soil in the past before outlining his philosophy for the future of agriculture. The Preface and Chapter 5 ("Agriculture: Tragedy - or Problem with a Solution?") are more theoretical, and Chapter 8, "New Roots for Agriculture," lays out the specific details of his vision for the future.

Long, Adam. "A Guide to the Pomona College Organic Farm: An Introduction to the Farm’s History and Basic Gardening Skills and Techniques ". Pomona College, 2013. Print.

Check out the table of companion planting interactions on p. 86.

Mollison, Bill. *Permaculture: A Designer's Manual*. 2nd Edition ed. Tyalgum, Australia: Tagari Publications, 2004. Print.

If you enjoyed the reading by Mollison above, you might find the rest of his book interesting: he writes with a very unique voice. Some of the best sections are: pp. 1-9, “Introduction”, which outlines Mollison's philosophy and theories of permaculture design and pp. 10-35, “Chapter 2: Concepts and Themes in Design”.

Independent Project Guidelines

Due Date:

Format: This project should be something you're excited about! Find something you're interested in doing at the Farm, and make it happen. The independent project has three parts: the physical project, a short oral presentation to the class, and a written description that will be kept in the Farm library. Some projects will be structured as a scientific investigation (i.e. How do different potting soils affect plant growth? Are organic fertilizers as effective as their conventional counterparts?), whereas others will be more of a construction project and report combination (i.e. What medicinal plants are native to this area? What season extension technologies are effective in this climate?).

Choose a topic you're interested in and develop a plan for how you're going to approach it, including a detailed itemized budget and timeline. Check the syllabus to determine time constraints: you'll have the majority of the time during some class periods to work on your project, but some projects may require work outside of the scheduled meeting time, too.

The oral presentation will be fairly informal: just explain what you did and show us your results!

The written project is a little more in-depth. If your project is a research investigation, it should be structured like a lab report. Otherwise, the structure is a little more flexible, but should clearly explain what you did and why it's relevant. Your target audience is all future Farm users. Final length will probably be around 10 pages, although this may vary depending on what type of project you have and how many images and figures you include. Completeness is more important than length.

Grading: The independent project is worth 30% of your grade in this course. It will be graded on a 50-point scale:

Project design: 10 points. Does your project have a clear question or focus? Is it well-designed to answer that question?

Oral presentation: 10 points. Did you explain your project well and have appropriate visuals?

Written report: 20 points. Is your report complete and well-written? Does it explain what you did and why it's important or relevant?

Overall effort: 10 points. Did you put in the time to make this a successful project?

If you have any questions, don't hesitate to ask!