Erin Pierce
Semester Project

Our world's governments and nations often assume that economic development is a solution to poverty, as it increases the production and consumption of commodities. A post-structural argument reacts that economic development, while producing more goods, is actually creating and supporting the very scarcities that it is intended to overcome. This idea of socially constructed scarcity can be seen in the use of chemical pesticides and fertilizers used in agriculture. Our modern development of vast monoculture cash crops produces the need for fertilizers as soils are depleted of critical nutrients. Monocrops also build up resistance to chemical pesticides and often require new chemical mixes regularly. All of these synthetic applications can come at a staggering cost for independent farmers in Third World nations, and even our small farmers in Pennsylvania.

While monoculture is collectively accepted as the tried-and-true method of food production, it should be noted that various other growing strategies can be employed to reach the same end-use of production without the financial commitment to synthetic fertilizers and pesticides. The following provides a brief look at polycultural methods of crop production and describes their chemical-free characteristics and ecological benefits.

The final portion of this project examines the discourse of agriculture through a vast nexus of relations, and incorporates my own agency in the issue through the academic node at Penn State. The university's participation in the conversation is analyzed through the courses and degree programs that it offers, the research centers that it funds, and through its historic actions regarding student farming.

Monoculture

The desire to reach maximum yields on cash crops, in conjunction with the vast mechanization that took place after the Industrial Revolution, has resulted in the common tendency to plant a single plant species over a wide area. While this method certainly arrives at crop productivity, as we see in the Corn Belt and the Kansas wheat region, it promotes insect pests, weeds and diseases which then require significant chemical in-put to control. Monocultures see a decreasing species mosaic at the individual field scale as well as in the larger aggregation of fields at a regional level. This lack of biodiversity and concentration of a single species opens the door for insect invasions whose entire life cycles can be fulfilled in such a suitable environment.[1] This quickly becomes a food security issue as well as a livelihood problem, since loss of entire crops due to pests and disease is a reality. Annual cultivation of the same crop is another aspect of monoculture which leads to the build-up of hearty, undesirable weeds which then require herbicide in-puts.[2] This also puts strain on the soil as each year's crop extracts nutrients which are often reintroduced as synthetic, inorganic fertilizers that provide nitrogen, phosphorus and potassium needs.

Chemical in-put has certain consequences on the individual farmer, who must purchase spraying equipment on top of the chemical costs, but it also has significant

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[1] Root 1973 as cited by Altieri page 273.

[2] Kiley-Worthington, Marthe. Eco-Agriculture: Food First Farming Theory and Practice. 1st ed. London: Souvenir P Ltd, 1993. 78-80.

ecological costs. Nitrogen-fixing fertilizers are presently derived from non-renewable fossil fuels and are intrinsically tied to issues of energy security and climate change. Other chemical fertilizers and pesticides are extremely soluble compounds, which render them an easy entry into the water table. Methemoglobinemia, commonly referred to as Blue Baby Syndrome, is one disorder that has been linked to agricultural nitrogen fertilizer. Run-off of fields leaches nitrogen into the groundwater, eventually enters drinking wells, and affects children and infant consumers. While the Environmental Protection Agency has placed a cap on the level of nitrogen in drinking water, the continued use of these fertilizers ensures that the threat is still possible.[3]

Polyculture

An alternative method of crop production utilized by many traditional farmers in the developing countries uses mixtures of crop species in the same field. This polyculture, or intercropping practice has largely been ignored by agricultural researchers in the developed nations. Not until the late 20th century did polyculture see an increase in interest surrounding its beneficial characteristics from the research community.[4] The agricultural community categorizes this type of production as being a "cultural" method, where management decisions and practices influence growth rather than chemical methods.[5]

Polyculture is an intrinsically flexible production system, as there are enormous varieties of compatible species as well as countless spatial organizational patterns and temporal planting differences. They can be used for production of food, fiber, fuel as well as forage and cash in all parts of the world thanks to this flexibility. While intercropping methods are prevalent in Africa and Latin America where farms are typically small and lack capital for chemical fertilizers, they are not restricted to these geographies. According to Miguel Altieri, "Polycultures can also be used on relatively large, highly mechanized capital-intensive farms in temperate areas."[6] He describes forage grasses and legumes mixed into a previously growing crop of corn, soybean, barley, oats or wheat as examples that could be easily incorporated into modern farming.

It should be noted that while polycultures in developing nations are often what we would consider "organic" crops due to the lack of chemicals, this method of production can still involve chemicals, but typically at a much lower rate of application thanks to numerous benefits of the intercropping structure. These benefits include yield advantages, increased yield stability, greater resource capture as well as insect and disease management.

Land equivalent ratios (LERs) of polycultures are often much higher on a plot of land, than what would be found if that same plot was planted with a monocrop. Altieri cites an Indian study which discovered 0.94 hectares of sorghum and 0.68 hectares of pigeon pea monocultures were needed to mimic the same amount produced from 1

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[3] "NewNotes National Scene Issue 44." EPA Nonpoint Source News. Jan.-Feb. 1996. Environmental Protection Agency. 11 Dec. 2007 < http://www.epa.gov/owow/info/NewsNotes/issue44/natscn2.html >.
[4] Altieri, Miguel A. Agroecology. 1st ed. London: Westview P, Inc., 1987. 205-206.
[5] Mullen, R. E. Crop Science: Principles and Practice. 5th ed. Boston: Pearson Custom, 2005. 236-240.
[6] Altieri, Miguel A. 206.

hectare of the plants in polyculture.[7] While the polyculture produced less quantity of each species, it had 62% greater total yield for an LER of 1.62.

Particularly in small, subsistence farms mitigating the risk of crop failure is an obvious goal and polycultures rise to the task of increasing yield stability. Thanks to the biodiversity of crop species present in polyculture there remains another agricultural product even if one species fails. Greater resource capture of polycultures is defined by these species better ability to capture light, water and nutrients (which ties to increased yields). Essentially competition between plants of the same species is minimized by having complementary relationships with the surrounding species. Some crops make their resource demands at different times, at different canopy or root levels, or share a symbiosis through chemical differences (ex. legumes functioning as nitrogen producers and non-legume species meeting their needs from the chemical transfer).[8]

Increasing plant species in a given area also serves to increase insect biodiversity, as more food sources are available. While this might suggest a greater risk of insect attack on crops, it should be noted that more natural enemies of pests are also more abundant. The resource concentration hypothesis also suggests that in polyculture pests are not as able to easily locate their desired crop host, and therefore are unable to uniformly infect a crop.[9] Similarities exist for plant pathogens as well, as resistant plants might intercept a disease, sparing susceptible plants in what is called a natural "fly-paper" effect.[10] In essence, the intrinsic diversity of polycultures does not create an environment suitable for widespread disease or pests. Polycultures can be supportive for weed control, as specific species can be sown as smother crops, as seen with squash, beans, and sweet potatoes in East Africa.[11]

Due to the wide varieties of polycultures this agricultural method is amazingly flexible and can be adapted in many different geographic areas. Because of its wide range of beneficial properties including yield increases, and pest control without the need for additional chemical in-puts, polycultures are indeed a possible step towards greater agricultural sustainability.

The Penn State Discourse

With roots as the "Farmer's High School of Pennsylvania," it was the university's founding mission to apply scientific research methods to farming. With the College of Agricultural Sciences currently recognized as one of the best agricultural research and education programs in the country, their role in modern agricultural discourse is significant. The following investigates that academic node of the larger agricultural discourse, and explores the participation of the university in that discourse. I hope to determine if Penn State ascribes to chemical methods of crop care and their inherent social of scarcities, or if recognizes that the end-uses of fertilization and pest control can be satisfied by alternative methods like polyculture.

First, it should be recognized that the state of Pennsylvania, served directly by the university, sees an average farm size of 133 acres by 2002 data (Appendix 1).

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[7] Natarajan and Willey, 1981. As cited by Altieri. 206-207.
[8] Altieri 209-211.
[9] Root, R.B. 1973. As cited by Altieri. 212.
[10] Altieri. 213.
[11] Kiley-Worthington, Marthe. 80.

Independent, family farms also account for 91.6% of all farms in the state (Appendix 2.). From this census data it can generally be understood that the receptive audience for the College of Agricultural Sciences research and education knowledge is comprised of small, family farmers on very modest holdings.

The university's participation in the agricultural conversation can be analyzed through the courses and degree programs that it offers, as well as through the research centers that it funds. With 12 academic units, the college offers 20 majors and 22 minors in agricultural studies. It functions off of a staggering $165 million dollar budget sourced from general tuition, general state funds, and specific agricultural funds from the federal government. With 23 Research Centers/Institutes and Extension centers to boot, it is not hard to imagine that the college is a powerful authority for agricultural knowledge.

Seeking out information about its role in polycultural research or education, I contacted a good many agricultural faculty and student members. What I discovered was the Agroecology major. It was described by one of the discipline's most famous authors, Miguel Altieri, during an interview:

> The science of agroecology is based on the science of ecology, but also the science of anthropology and sociology and the basic agronomic sciences. That allows us to study agricultural systems in a holistic way; that is trying to understand agriculture as the result of the interaction between humans and nature and also to design systems that are going to be are going to be sustainable. That is that they are going to be socially just, economically viable, environmentally safe, and culturally diverse.[12]

I felt that if I were ever to find polyculture in Penn State lessons, it would surely be within this sustainably and environmentally-minded discipline. Of the faculty I was able to contact Dr. Heather Karsten, associate professor of Crop and Soil Sciences, maintained that she teaches about forage intercrops for livestock grazing, as well as mentions the Three Sister crop of corn, beans and squash to her Agronomy 28 Principles of Crop Management class. As communication with faculty is often frustrating, particularly when you are not a student in the major, I decided to track down and Agro 28 student with the hopes for more open communication.

Undergraduate Marissa Evankovich provided me with insights into her Agro 28 topics as well as her experience in her Agroecology major. Agro 28 does indeed touch upon aspects of polyculture for forage crops, but does not dive deeper into the benefits of the method. On the opposite end, neither does it push much of the chemical discourse that I was also looking for (Appendix 3). She provided me with a copy of the text for the course, and from my brief examination it seems devoid of much mention of polyculture, but does spend significant time discussing other means of "cultural" methods of crop management, like tillage types, cover crops, and varieties of crop rotations.

Dr. Stephen Smith, head of the department of Agricultural Economics and Rural Sociology was one of the few faculty contacts to enthusiastically respond to my request for materials and an interview. His background includes decades of research in Latin American traditional farming methods, and he teaches of these polycultural methods in

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[12] Altieri, Miguel A. Interview. Earth and Sky. 11 Dec. 2007 <http://www.earthsky.org/article/miguel-altieri-interview>.

his Introduction to International Agriculture course. He maintained a positive view of traditional methods when he said, "We can learn a lot from traditional farmers. They've been surviving for thousands of years and there is a reason why." I was thrilled to encounter this perception and was encouraged to believe that I found a source of alternate discourse in his work.. While his syllabi revealed the common Problem/Non-problem conceptualization ("One of the greatest challenges facing the world is to find solutions to problems of hunger and poverty in less-developed countries" Appendix 4), he was at least *engaging* polycultures more deeply than in Dr. Karsten's work.

We discussed role of the International Potato Center of Lima in the current agricultural discourse in Peru, and much to my surprise they seem to be moving in very different directions from their research of the 1970's. Dr. Smith agreed with our common course discussion that the push for one breed of potato was misguided. While he agreed with the popular criticisms of the past, he said that his visit to the Center the previous week had given him new insight into their research directions. He produced a bag of olluco[13], a native tuber (seen in folder) and pointed out the mold on a few specimens. He learned that more than 50% of the native farmer's harvest is lost molds like this one due to storage conditions. The Center is attempting to focus on these small crops and find better way to preserve them in an attempt to strengthen native food securities and allow for additional harvest to possibly be sold at markets for additional income. While my time with Dr. Smith was an enjoyable look at agriculture and the use of polyculture in Latin America, it was a far cry from the solid support for traditional methods in modern agriculture that I was seeking. Our interview proved that portions of the academic node are discussing these sustainable methods, but was anyone making the final connections and bringing the lessons home to apply in our own fields?

Student Agriculture

My examinations of this discourse lead me to a few Penn State organizations which help to illustrate the university agricultural environment. The first is a brief look at the Circleville student farm and the reasons behind its dissolution. The second is a summary of the Sustainable Agriculture Club and their participation in the university conversation.

Circleville farm and I began life in State College in the same year of 1984. According to Dr. Dorothy Blair, one of the farm's faculty instructors, the student farm was designed to offer hands-on experience in small-scale farming for the majority of Agriculture students who did not have working farm experience. The entire endeavor was made possible by funding from the university, the state legislature, and the Kellogg Foundation. The path to Circleville was in part paved by the dean of the time, Dr. Lamartine Hood. According to Dr. Blair, Dr. Hood had both a favorable attitude towards a student farm, and the legislative connections to fund the endeavor with a budget of about $75,000 per year. Student farm managers were hired to oversee and market their harvests from the 176 acre farm, causing farm economics to join the list of instructional topics including holistic farm management, biological, cultural, and mechanical methods

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[13] Also called ulluco. When I questioned Dr. Smith on the legality of importing raw vegetables like this for his research purposes he smiled and acknowledged that it was "perfectly illegal." His smuggling practices ensure that his students have specimens to pass around during lectures for "hands-on" learning, and I must admit there is a certain wholeness to his stories with the physicality of the potato.

of weed and pest control, soil quality and low-input practices. In its first five years in student hands, the farm grossed an average *gain* between $10,000 and $20,000 from sales of harvests and livestock.[14] The first courses in sustainable agriculture used Circleville as a working laboratory and were often focused on local farmers. Dr. Blair recalled the many outreach programs that took place at the farm, including agricultural film series, plays, and seminar series. "We taught women to wield chainsaws in some of our workshops," recalled Dr. Blair. "We were very successful in the eyes of the students, faculty, and community."

When prompted for a reason behind the termination of the farm, Dr. Blair referenced a larger transformation in the College of Agriculture catalyzed by a new dean in the 90s. According to College websites, Dean Robert D. Steele arrived at Penn State in 1997 from the University of Wisconsin-Madison.[15] She described the general change in attitude away from farming practice towards research grounded in science and the sterile laboratory. She saw an obvious change in College media, as images of tractors and farm life on publications were replaced with those of students in lab coats and test tubes. To Dr. Blair, the change of image was a death sentence to Circleville as she saw the funding for the farm redistributed. The sale of Circleville land was the final sentence to the student farm history, but some student, faculty, and community members did not let it go quietly. Laura Silver of the Center for Sustainability mentioned some of the proposed alternate uses for the farm, including a plan for a sustainable ecovillage from Dr. Richard Alden in the School of Architecture, as well as simple conservation for the important groundwater recharge, and bird migration area. Ultimately Penn State sold the land for $3 million to a developer who lately secured residential zoning for the area.

Many cite the work at Circleville for the generated interest in sustainable agriculture that lead to the formation of the Pennsylvania Association of Sustainable Agriculture (PASA), and organization of over 3,500 members.[16] While a proposal for a new teaching farm at the future Arboretum grounds north of campus was lead in the spring of 2007 by Dr. Heather Karsten and members of Penn State's Sustainable Agriculture Club, it was turned down by the administration. Clare Wagner, President of the club described the situation as a tumultuous interaction between administration and faculty that in her opinion ended due to lack of compromise and increased demands by Karsten. When asked for comment, Dr. Karsten acknowledged the proposal defeat and related that "…the administration did not support [the proposal]. So, I have not spent more time on it."

While the future for a student farm presently looks bleak Clare Wagner informed me of her group's work with the Center for Sustainability to establish student and community organic gardens in the coming year. While student gardens have existed on campus in the past through the Graduate Student Association, they were restricted to members and the project was eventually abandoned. This upcoming program will incorporate any member of campus and the surrounding community and will be located

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[14] "CAMPUS LIFE: Penn State; Students Protest Loss of Control Over Farm." The New York Times 6 Aug. 1989. 11 Dec. 2007

[15] "Penn State College of Agricultural Sciences." 2007. Pennsylvania State University. 11 Dec. 2007 <http://www.cas.psu.edu/Dean.htm>.

[16] Moist, Linda. "Reflections on Student Farming At Penn State." Penn State Sustainable Ag Working Group 3 (2006): 1+. 10 Dec. 2007 <http://sawg.cas.psu.edu/PDFs/April06.pdf>.

near the Center. Gardening workshops will be required for all participants at a small fee that will help to maintain the program and organic methods are also required. While these plans are still in their working stages, the future for these gardens appears solid.

Discourse and Agency

This whirlwind examination of the agricultural discourses at Penn State has been enlightening, uplifting, and discouraging. My attempt to discover the participatory role of the university in polyculture as an alternative path to the end-uses of increased crop yields and pest prevention quickly dead-ended with a few introductory courses in Agronomy and International Agriculture. The related practices of using cover crops, crop rotations, various till methods, and beneficial insects to reach these desired results with less chemical assistance seems to be a much larger focus in the Sustainability discourse based on my survey of students, faculty, teaching literature, and related groups like the PASA, Sustainable Ag Working Group, and the Sustainable Agriculture Club.

While the support for more sustainable farming research and outreach is present in groups like those mentioned, the funded university research in these areas hardly matches the support it gives to other agricultural areas of interest like biological engineering, dairy and animal science, crop sciences and genetic research. While Dr. Blair and her peers in sustainable agriculture maintain there is some support (like the Agroecology major), they frequently reference the suspension of Circleville as a metaphor for the overwhelming disconnection between the goals of sustainable agriculture and the goals of this research university.

Through this research I had hoped not only to discover the university participation in alternative monoculture practices, but *engage* the discourse through my own position as a Penn State student. My personal involvement was to be limited to a simple report of this discourse in a website format, where resources of polyculture would be politely showcased for interested browsers. Within the final weeks of this research when the bulk of my interviews occurred, I realized that this digital format would not allow me to participate to my fullest, but rather take a passive back seat in the discourse. While I still hope to compile this website in the future, featuring links to intercrop supporting centers like the Land Institute, or the ground breaking Rodale Institute here in our backyard of Emmaus, PA, the call of personal agency pulls me towards participation in *doing* sustainable agriculture and flexing my non-sovereign power in my hometown. This spring and summer I plan to test my newfound theories of polyculture on a communal plot in the Center for Sustainability's community gardens. While squash, corn and beans will be my first attempt at utilizing characteristics of polyculture and sustainable agriculture at a personal scale, I can now very clearly see opportunities for my participation at larger scales of agency. Discussing the matter with Dr. Deryck Holdsworth led to a possible Masters Thesis topic regarding the history and geographic nature of sustainable agriculture development here in central Pennsylvania in the very shadow of a university that seems to be heading in a different direction. Such intriguing study could surely lead me to that next step of agency in the academic node, and I am thrilled with this new avenue from which to participate in a topic that has captured my academic, ecological, and local Pennsylvanian consciousness.

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