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Raising organic: An agro-ecological assessment of grower practices in California

Julie Guthman
Department of Geography, University of California, Berkeley, California, USA

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Abstract. As the organic food sector has grown and changed to become more mainstream, large-scale conventional growers have entered into organic production. While it is increasingly clear that not all organic farms are self-sufficient small scale units that practice poly-cultural agronomy and sell in local marketing venues, there still exists a presumption that there are clear lines between the small scale "movement" farmers who follow agro-ecological agronomic ideals and the relatively larger and partly conventional newcomers who do not. This paper addresses a specific empirical issue, which is the extent to which California organic farmers practice the techniques of ecological farming. It illustrates that while there are some distinct differences in practices between larger and/or part-conventional (i.e., mixed) growers and smaller and/or all-organic growers, it also shows that in almost all cases, practices fall quite short of agro-ecological ideals. By examining in more depth how growers follow particular agro-ecological principles, the paper also demonstrates that key variations are related to variables separate from scale. Some of these variables are geographic, ranging from biophysical and climatic opportunities and constraints, to regional norms and institutional support. Mostly, however, variation is related to crop specificities and the availability of efficacious technologies to deal with crop-specific problems. This so-called technology barrier crucially depends on how organic is defined, and thus suggests the importance of organic rules and regulations in shaping the practices of organic production.

Key words: Agro-ecology, Agriculture-California, Organic agriculture, Sustainable agriculture

Julie Guthman *recently received her Ph.D from the Department of Geography at the University of California at Berkeley. Her dissertation focused on the political economy of organic agriculture in California. Her previous publications include articles on environment and development in the Nepal Himalaya (her M.A. thesis) and earlier works on her dissertation topic. She is also involved in projects addressing the political economy of agricultural biotechnology.*

In the last fifteen years, the organic food sector has grown and changed dramatically. Along with widely cited estimates of continuing 20% per annum growth in sales, organic food delivery has become decidedly more mainstream and the range of products available has broadened considerably. Supermarkets almost entirely dedicated to organic lines have become the darlings of Wall Street investors and industry representatives boast that soon even Twinkies® may be produced organically (anonymous personal communication). Primarily in response to these new market opportunities, large-scale "agribusiness" growers have entered into organic production (Buck et al., 1997; Guthman, forthcoming 2000). These days, it is hardly a leap to say that not all organic farms are self-sufficient small-scale units that practice poly-cultural agronomy and sell in local marketing venues. Yet, there still exists a presumption that there are clear lines to be drawn between the small scale "movement" farmers who follow such an ideal and the relatively larger and part conventional newcomers who do not. It bears closer examination as to whether there is such close correlation.

This paper comes out of a much larger study that looks at both the origins and contemporary character of the California organic sector (Guthman, 2000 forthcoming).[1] The study is a detailed examination of the political economy of organic production, focusing on producers' agronomic and marketing practices in relation to variables such as scale, location, tenure, farming history, and crop mix. It demonstrates how existing and proposed regulatory structures influence both the overall structure of the sector and the ways in which production is individually managed. It also shows that a fundamental axis of differentiation within the California organic sector is geographic, reflecting the unique historical development of various agricultural regions and the cropping patterns that came to define them, layered with the more recent history of organic's genesis. The purpose of this paper, however, is to address a specific empirical issue, which is the extent to which California organic farmers practice the techniques of agro-ecology, organic farming's most central and widely accepted claim.[2] While this topic clearly links to a broader set of arguments, by narrowing it so, it allows a focus on much-needed empirical evidence that has been heretofore only presumed.

Therefore, the central theme of this paper is a description of grower practices. These descriptions are based on interviews and site observations with 150 of the 2,204 organic growers that were registered with the state of California in 1997, both certified and noncertified.[3] Interviews were conducted between December of 1997 and March of 1999. Because the median farm size of organic operations is quite small – 4.4 acres in 1994–1995 (Klonsky and Tourte, 1998), the research sample was stratified to capture a statistically significant group of large growers as well as those with mixed conventional and organic operations. In other words, it was deliberately skewed in order to see if taxonomic patterns exist in how organic agriculture is practiced. So while not proportionately representative of the California organic sector in grower numbers, the study easily captures most of the sales and acreage in the sector.

The paper proceeds in the following way: First, it looks at the claims of ecological farming, derived from agro-ecology but which have been further codified by California Certified Organic Farmers (CCOF)[4] and briefly discusses how these principles were used as the basis of an agro-ecological assessment within the study. Next, it introduces the results of this assessment, which indicates the degree to which California farmers practice agro-ecology, both in the aggregate and within broad taxonomies. Then, it turns to a detailed description of how organic farming is practiced in California, referring to each of the principles on which the assessment was based, both to note the patterns in how specific agro-ecological principles are followed and to note differentiation by factors other than scale-based taxonomies. It concludes by suggesting some of the ways in which the very act of codifying agro-ecological principles affects how they are practiced.

Defining the agro-ecological criteria

As a general rule, sustainable agricultural systems are supposed to minimize energy and resource use, by recycling resources within the farming system, or at least by using resources found near the farm. From a technical viewpoint, the basic components of such a system are (1) use of cover crops, mulches, and no-till practices as effective soil and water-conserving measures; (2) promotion of soil biotic activity through the regular addition of organic matter such as manure and compost; (3) use of crop rotations, crop/livestock mixed systems, agro-forestry, and legume-based intercropping for nutrient recycling; and (4) encouragement of biological pest control agents through biodiversity manipulations and introduction and/or conservation of natural enemies (Altieri, 1995: 92).

In this study, growers were assessed on the degree of their adoption of the above sorts of practices (on organic fields only), according to criteria developed both to discern taxonomic difference and to determine how regulation itself affects organic practices. Most of the assessment was based on comprehensive interviews with each grower studied, and thus captured practices as growers themselves describe them. These assessments, however, were often supplemented by the visual cues of on-site observations, which in no case contradicted descriptions as given by growers, but only enriched them.

The criteria on which growers were assessed include

- degree and extent of on-farm fertility management through composting and cover cropping;
- degree of on-farm biological pest management;
- avoidance of legally restricted or controversial materials (explained below);
- employment of innovative weed control practices such as mulching;
- bio-diversified cropping patterns, including intercropping and integrated livestock; and
- evidence of intensive management (as opposed to "organic by neglect").[5]

Growers were given one point for each criterion substantially met, except for the first two criteria, which were given double weight since there is a much wider spectrum in these areas. This allowed growers to earn a middle rating for these two criteria. For example, a grower who cover crops a portion of the farm every year and purchases compost from a supplier would earn one point, one less than a grower who provides all the farm's fertility needs through on farm recycling and cover crops, but one more than a grower who purchases all fertility needs. Points were added and then calibrated to a one through five aggregate rating, one being assigned to growers who took none of these affirmative steps, and five going to those who did all. In addition, a rating of zero was assigned to growers if they were in obvious violation of organic codes and practices. When rounding was required, additional factors were considered, such as attention to water conservation or on-farm seed and transplant development,

Table 1. Agroecological ratings by grower type.

Rating	Mixed growers		All-organic growers		All growers	
0 (lowest)	1	1.5%	0	0.0%	1	0.7%
1	10	14.9%	1	1.3%	11	7.6%
2	40	59.7%	20	26.0%	60	41.7%
3	14	20.9%	29	37.7%	43	29.9%
4	2	3.0%	23	29.9%	25	17.4%
5	0	0.0%	4	5.2%	4	2.8%
Total observed	67	100.0%	77	100.0%	144	100.0%

Table 2. Agroecological ratings by grower sales.

Rating	Sales: <$100,000		Sales: $100,000–999,999		Sales: $1,000,000–9,999,999		Sales: >$10,000,000	
0	0	0.0%	1	2.6%	0	0.0%	0	0.0%
1	1	2.3%	2	5.3%	6	13.3%	2	11.1%
2	14	32.6%	13	34.2%	19	42.2%	14	77.8%
3	17	39.5%	10	26.3%	14	31.1%	2	11.1%
4	9	20.9%	10	26.3%	6	13.3%	0	0.0%
5	2	4.7%	2	5.3%	0	0.0%	0	0.0%
Total observed	43	100.0%	38	100.0%	45	100.0%	18	100.0%

Note: Sales include all aspects of operation, not just crop value.

although neither is considered in the construction of organic rules.[6]

Aggregate analysis

Table 1 is the distribution of ratings according to whether growers are all-organic or mixed conventional and organic; Table 2 is the distribution of ratings according to sales class, as a proxy for scale. As Table 1 shows, the modal point for all growers interviewed was a "2," assigned to 60 out of 144 growers, or 42%.[7] In effect, this rating means that growers are following the letter of the law, but are relying heavily on an "input-substitution" strategy to manage their organic program (Rosset and Altieri, 1997), where disallowed inputs have been replaced by allowable organic inputs. In other words, most growers have not reached what Hill (1985) calls the "design phase," where external inputs are minimized and the farm operates in a "balanced" and "self-regulating" manner.

This modal point in part reflects the skewness of the sample towards large and mixed growers. Mixed growers disproportionately achieved a 1 to 3 rating (97% of those interviewed) with a modal rating of 2, whereas all-organic growers mainly achieved a 2 to 4 rating (94% of those interviewed) with a modal rating of 3. (When further dis-aggregated to those who have always been organic, the modal rating goes up to 4, or 41% in that category.) Likewise, as can be calculated from Table 2, 90% of growers in the two largest scale categories met criteria for 1 to 3 ratings, with no one in the top category higher than a 3, even those that are all-organic, while 90% in the two smallest scale categories received 2 to 4 ratings. Some of the scale-based difference has to do with the inevitable imputation of scale-based criteria in the rating system itself. The fact is that if on-farm compost-making is taken as evidence of a higher degree of agro-ecology, it constrains large scale operations from living up to that standard, a limitation that is the normative basis of agro-ecology (Altieri, 1995). But it is also true that larger, or more well capitalized growers are more dependent on external inputs, because they can afford to be. In other words, it may be less the ideological commitment and more the inability to pay for the "silver bullet" that constrains smaller growers from seeking such solutions. These problems are endemic to correlation-based reasoning, but such speculation should not blur the basic finding that growers with mixed and/or larger operations more often do the minimum in meeting agro-ecological ideals than those who are fully organic and/or smaller.

Yet, it is striking how few growers of any type actually approach the agro-ecological ideal. Only four growers interviewed came close to having the sort of integrated systems warranting a 5 rating, that, given the criteria, had to be evidenced by integrated livestock, inter-cropping, and/or intense mosaic cropping designs combined with a high degree of on-farm input development. Twenty-five growers were assigned a less stringent 4 rating. Growers attained this rating in all but the very largest scale category, and almost all who did were all-organic growers. Here the exception proves the rule: of the two fairly large mixed operations that warranted a 4, one had hired a long time organic farmer and consultant to instigate its fresh vegetable operation, who in turn convinced the company to attempt organic production. It is most striking, however, that the largest all-organic growers, the industry leaders, mainly achieved ratings of 2 and 3. This is a remarkable finding, as they are the ones who are presumably quite committed to organic practice, but fall short in the context of these particular agronomic definitions.

Analysis by agro-ecological principle

As stated above, ratings were designed with the specific purpose of discerning difference among growers. In some areas of farming practice, however, almost all organic growers do the same thing, whereas in other areas, there is marked differentiation. Either way, differences and similarities are glossed over in aggregate ratings. Moreover, aggregate ratings miss the ways in which variations are related to factors other than scale, including ideological predispositions borne by growers themselves, in addition to those of geography and crop specificity. The following discussion examines in greater detail each of the specific agro-ecological principles and how growers approach them.

1. *Fertility practices*

Organic systems attempt to encourage soil biotic activity as a route to improved fertility and tilth. While there are volumes written on issues related to soil, the two practices most commonly associated with organic farming in this regard are the use of cover crops and compost. Cover crops are annual or herbaceous plants that are not grown for harvest, but rather to fill gaps in either time or space when cash crops would leave the ground bare (Altieri, 1995). Planted between cash crops, they are supposed to restore fertility, increase biomass, and reduce soil compaction and erosion. Beyond the benefits they offer to soil, they also help in moisture retention, weed control, and if they are flowering, are useful for pest management by creating beneficial insect habitat. Depending on the need, many growers use a combination of species in their covers, ranging from the leguminous nitrogen fixers (e.g., bell beans, vetches), to the more bio-massive (e.g., sudan grass), to the more flowery. Cover crops are usually mowed and left as "green manure" or plowed in; rarely are legumes harvested.

For cover cropping to work in vegetable systems, any given piece of land must be without a cash crop for at least four months out of the year. Even the best intentioned growers have difficulty ensuring this sort of fallowing, hindered both by the complicatedness of rotating different blocks in and out of production and the economic costs of having land out of production. Thus, growers who most often reach the ideal of having every part of the farm in cover during one point in the year, either do only one cash crop per year, farm on cheap land (and can thus afford land out of production), and/or are extraordinarily conscientious about this particular concept. The rest see cover crops as a luxury, or claim that they cause more problems than they solve. Most of these latter growers either squeeze in as many cash crops as possible and/or farm in areas where water is expensive. Consequently, there is significant regional differentiation in the use of cover crops. Growers in the northern and rainier parts of California are more likely to use cover crops, especially when land is too saturated in the winter to cultivate anyway, while growers in the southland are more reluctant to do so, despite the fact that cover crops are supposed to aid in moisture retention. Note that many growers on the south and central coast can effectively produce crops year round, and simply don't want to take land out of production.

In orchard and vineyard systems, cover crops are said to be essential to maintain biological diversity, in addition to the other benefits mentioned above. Again, they are more often used in the northern and central parts of the state, but not only because of more favorable water costs and availability, but also because there is more institutional support for ecological farming practices in these areas, including the Biologically Integrated Orchard System program, based in the Davis area, the Center for Agroecology based at the University of California at Santa Cruz, and a number of private advisors. Meanwhile, there are growers who claim that the weedy so-called native grasses provide the same function as cover crops and will let them grow in lieu of planted covers. This strategy is particularly employed among citrus and avocado growers in southern California.

While almost all orchard cover crops and grasses are mowed or harrowed before harvest, the timing of these practices is highly variable. Growers attempting to maximize the use of covers to maintain beneficial insects will wait until just before harvest; others may harrow at budding. Oddly, there continue to be orchardists who attempt to keep their orchards "clean" year round, by mowing, weeding, and sweeping all vegetation – a clear carryover from conventional agriculture, but a highly controversial practice in sustainable systems. Nevertheless, the majority of orchardists see clear benefits from cover-cropping, and this is one of the elements of organic production that they are mostly likely to carry over into their conventional operations, if they exist.

While cover crops provide the broadest repertoire of benefits, compost gets all the attention, as the use of compost is most idiomatically associated with organic production. The purpose of compost, of course, is to recycle agricultural waste back into the system, so that a minimum of energy and nutrient transfer occurs away from the farm aside from the food produced. In an ideal system, compost is comprised of crop residues, livestock manure, and organic household waste. It is supposed to be "cooked" to a certain degree, to stabilize nutrients, neutralize pesticide residues, and kill weed seeds and pathogens (CCOF, 1998). In effect, few farms meet the ideal of on-farm composting. First, only a handful of farms integrate livestock into their production system; at best manure is purchased from nearby dairies or chicken farms, where livestock have been fed non-organic grain, treated with antibiotics, and so on. Even then, not all growers cook or properly age such manure; it is not uncommon to hear of tree crops treated with so-called raw manure, although this practice is apparently more prevalent in conventional systems that are, ironically, less regulated. But mainly, the ideal is extraordinarily difficult to meet, as composting is land extensive itself and requires brought in material to make sufficient compost. As one grower framed it, with the amount of land, water, and monitoring it takes, making compost is like growing another crop.

Farms that rely primarily on in-house composting are either extremely small, or they work hard to bring *in* materials for composting, using not only nearby livestock producers, but cotton gin trash, rice hulls, and municipal clippings. Thus, of the larger farms that make their own compost, and there are several, they are located in proximity to areas where the appropriate waste exists and they have easy access to it (e.g., owning the cotton gin). Since these growers also dedicate substantial land to composting and may even sell their compost, they generally farm on relatively cheap land. There are exceptions, however, as compost is also the subject of much proselytizing. In the San Juan Bautista area, for instance, one erstwhile conventional grower has become a composting "guru;" he now leads composting seminars and provides on-farm advice, and consequently, many growers in that area, both conventional and organic, now make their own compost. Land is not particularly cheap in this area, however, and because of this new-found demand, municipal clippings are an increasingly scarce resource.

In most cases, compost users purchase compost from others. Some of these arrangements are local, but major growers increasingly go to the handful of highly reputable and specialized organic suppliers. As part of their service, these suppliers provide soil testing and analysis, and then develop a custom blend of compost. The shipping charges involved, when compost is trucked half way across state, makes custom compost a very expensive proposition indeed. Meanwhile, there are growers who purchase compost that appears not even to be allowable (e.g., mushroom compost is a restricted material as it may contain substantial pesticide residues), a practice that is more prevalent in the southern part of the state (where standard-setting CCOF is less influential).

Theoretically, cover crops and compost should provide all necessary nutrients, although growers tend to favor one over the other. In practice, most organic *produce* farmers purchase additional soil amendments, such as minerals (e.g., sources of calcium, magnesium, and sulphur), microbial inoculants, or micronutrients. Many growers spurn the use of compost and cover crops altogether and rely on various fertility enhancements, most commonly derived from bone and blood meal, fish products, seabird guano, and poultry products – often pelletized or liquified for drip irrigation. These range from the allowable and popular Phytamin 800, a blended fertilizer, to liquid foliar sprays (which defy the oft-cited dogma of "feed the soil, not the plant" but are otherwise allowed), to a popular southern California fertilizer called Easy Green, which is not on the CCOF list of allowable materials (CCOF, 1998). Most growers, therefore, do not meet the goal of on-farm nutrient recycling.

2. *Pest and disease management*

It is in the area of pest and disease management that organic agriculture can be most readily distinguished from conventional agriculture. Insofar as many organic growers base their pest control strategies on merely substituting disallowed products with allowed ones, this is also the basis of the most differentiation within organic production. With regard to controlling insect pests, the nature of controls range from the use of allowable insecticides to the absence of any pest management inputs, and instead, the maintenance of beneficial habitat for pest predators. The application of controls range from prophylactic use, to the wait-and-see approach most closely associated with Integrated

Pest Management, to farming by neglect. This last strategy makes for either extraordinarily high cull rates or poor market prospects.

Agroecology privileges controls that work with biological cycles over pesticides. So at the same time that the market is blossoming in botanical insecticides, organic growers are ideally supposed to focus on "bio-rational" and preventative pest management such as the use of resistant varietals, timing to avoid cycles of pest emergence, diversified cropping, and balanced nutrition (*design* controls), along with the more focused tools of natural predator release, habitat enhancement, and mating disruption (CCOF, 1998). Mechanical tools such as sticky tape, bug vacuums, and netting, are equally encouraged, although, arguably, they might also be viewed as characterizing a system that is out of balance. Generally speaking, growers new to organic tend to adopt *applied* pest controls, especially sprays, whether or not they are necessarily pesticides. These would include the more restricted botanical pesticides such as pyrethrum and neem-based products, as well as soaps, oils, pepper and garlic sprays, and even Bt.[8] Except for Bt, most growers end up disappointed with the effectiveness of any of these substances. Thus, growers more familiar with organic tend towards design components to mitigate pests.

Larger growers tend to almost exclusively use applied controls, but they do not necessarily use chemical controls (i.e., allowable pesticides), as part of their interest in organic experimentation is to learn new techniques. For example, a few well-capitalized growers will release predator insects via helicopters, ironically aping the same mechanisms by which the most toxic of sprays are applied. In the technically-sophisticated Salinas and San Juan Bautista areas, both of which are centers of nationwide vegetable production, many growers use bug vacuums. It is rare, then, for a large grower to intentionally adopt plant design controls to any major extent. A few might leave in some weedy flowers in an otherwise unusable embankment, or plant flowers at the end of a row. Yet, since it is often the case that large conventional enterprises experimenting with organic production do so on marginal land to avoid the costs of lengthy transition periods, their organic blocks often are physically separate and skirted by trees, ditches, and weedy buffers anyway. By serendipity, such buffers may act as beneficial insect habitat (although some of these same growers complain that such surroundings create pest problems). But generally speaking, the large mono-cropped parcels that characterize large-scale operations leave little room for non-crop agriculture.

In marked contrast, small growers tend to farm away from the major agricultural zones, often by necessity. They are often situated where there is beneficial habitat, since their farms have been more recently carved out of spaces that have never been brought into agricultural production. While it may be difficult in these cases to discern what is the result of design and what is the result of neglect, and ultimately it may not matter, these growers tend to incorporate more design controls and beneficial habit. That said, there are many small-scale market garden growers who religiously use the most discouraged (but allowable) of bio-insecticides to manage their pests.

The above observations primarily apply to vegetable growers. Orchardists, especially nut, stone fruit, and pomme fruit growers, are faced with some formidable problems in pest control, in part related to the fact that these crops must meet maturity in ways that vegetables do not. Some of the more intractable problems such as husk fly, brown rot, and coddling moth require much more intensive techniques that tend to be labor intensive and expensive. These would include pheromone disruption (ties, strips, puffers, traps for monitoring), sticky tape, and even hand removal of pests. Because of the intense management required (as well as the historical geography of fruit production in California), most commercial orchard operations are small, between 10 and 100 acres, although at $6,000–12,000 in sales per acre for these crops, their revenue makes them appear as larger scale operations. In contrast, much of California citrus is under biological control, so it is feasible to have several hundred acres of organic citrus under one operation; most organic citrus groves in the state, however, are 2–3 acres and are planted on residential real estate (which confers the tax advantages of agricultural land).

3. *Avoidance of legally restricted/controversial materials*

Many of the battles over organic regulation are battles over the materials that are allowed to be used. While the "materials list" is constantly evolving, at any given time there are many substances that are restricted (not to be confused with prohibited), meaning they can only be used as a documented last resort.[9] The general idea is that these are questionable materials – because they are potentially more toxic, environmentally problematic, or involve synthetic production processes, the last of which goes against the fundamental definition of organic production. There are several other materials that are completely acceptable by the rules, but are still controversial: these include blood and bone meal, which are the byproducts of some of the worst aspects of livestock management, or sulphur, a naturally mined product but one that causes more farm worker injuries in California than any other substance (Pease et al., 1993). In the most restricted meaning of agro-ecology, none of these should be necessary, but many are highly desirable. They are effective for particular purposes and allow growers who would otherwise be frustrated in their attempts to grow organically to do so with relative ease.

Growers at all scales use legally restricted or controversial materials but growers with mixed operations tend to use them more than growers who are only organic. For example, the use of treated seed is restricted or in some cases altogether prohibited. When restricted, organic rules stipulate that their use must be justified by documented attempts to find non-treated seed. Yet, it is challenging to find non-treated seed for certain crops, as commercial seeds are often covered with fungicides and the organic seed industry is extremely undeveloped. Growers say the only way to avoid the use of treated seed is to develop relationships with a seed company and to inform them of planting decisions far in advance, as seed treatment is done significantly in advance of sales. Nonetheless, growers do show a marked difference in commitment to find non-treated seed, and mixed growers do so less.

The clearest correlations in the use of restricted/controversial materials, however, are geographic and crop specific. That is, with the exception of the broad fertility-enhancing properties of say, blood and bone meal, usually controversial materials are associated with a particular region or a particular crop. For instance, sodium nitrate (also called Chilean nitrate) is a soluble nitrogen. While naturally mined, like other nitrates it is a source of ground water pollution leading to eutrophication of fresh water sources (Conway and Pretty, 1991). Soluble nitrogen is thus a very contentious substance within the organic industry, and in the process of being phased out. Yet, contrary to agro-ecological wisdom, some growers seek the quick nitrogen fixes of soluble nitrogen. Sodium nitrate is especially used among large growers in the southern and western San Joaquin valley and the desert valleys of southern California, where much off-season produce is grown. Growers claim to need a quick fertility source to get the crop going within the narrow window of opportunity. In these areas, it is most often used by large-scale industrial growers, both all-organic and mixed, but even smaller "movement-oriented" growers occasionally prefer the quick fix of soluble nitrogen over the slow release from compost.

The use of a substance like sulphur, in contrast, is specific to certain crops. Grapes are thought to be one of the easiest crops to grow organically, primarily because there is a wide range of available and acceptable products to deal with pests and grapes tend to get to a stage of self-regulation fairly quickly. In addition, processing grapes (e.g., wine, raisin, and juice) do not need to meet size and blemish specifications. The biggest problems with grapes are powdery mildew and bunch rot (Klonsky, 1992, 1997). Yet, copper and sulphur, both of which serve as anti-fungal agents, are allowable organic inputs in certain forms, because they are found in nature and are not consider highly toxic, despite sulphur's association with worker injuries. Thus, there are thousands of acres of organic wine and raisin grapes in California, more than any other crop, and virtually every organic grape grower uses sulphur.

4. *Innovative weed control practices*

Weed control is said to be the most costly component of organic production, if not the most technically challenging. While there do exist innovative cropping and cultural practices that reduce weed problems (see Altieri, 1995), farmers at all scales and all regions rely most heavily on more traditional mechanical and hand controls. Of mechanical controls, some are more elaborate and capital intensive than others. In row crop systems, most growers try to "bring up" weeds by pre-irrigation so they can be cut mechanically before any planting takes place. This works best though when land is not planted intensively, just one crop per year. After planting, growers rely on both mechanical and hand cultivation, the balance of course depending on the nature of the crop, with more delicate crops requiring more hand labor. In general, orchardists also use mechanical controls, especially in the areas where crown covers do not naturally shade out weeds. Those who use cover crops complain less of weed problems, which is not only related to the weed suppression that covers provide, but that growers who like covers seem less concerned with "clean" orchards. Indeed, there is tremendous variability among growers in their tolerance of weeds, but it is not a variable clearly related to any specific taxonomies.

Still, there is some innovation in weed control that growers differentially adopt. Among these innovations, seemingly high-tech flame weeding is perhaps the most popular although few growers are enthusiastic about it. It appears to work better with some crops than others, and has been most often adopted by large-scale farms. In contrast, drip irrigation and mulches also reduce unwanted weediness, and are considered water conservation technologies as well. Although mulches can be composed of plant residues, wood chips, or straw, black plastic is by far the most widespread (and itself a source of controversy). Even then, surprisingly few organic growers use mulches as a weed suppressant and only on some crops such as berries and melons. Plant residue mulches are found on only the smallest garden-like farms. Finally, although weeder geese and chickens are effectively used for both weed control and field clean up, this sort of control is employed only on very unusual diversified farms.

It is worth mentioning here that frustration with the lack of technologies for weed control is the most commonly stated impediment to expanding organic production, although it is more accurately framed as a cost issue. After all, hand weeding and hoeing are effective technologies, albeit extremely labor intensive ones. In any case, many mixed growers claim that the rest of their operations are "virtually organic" except that they use herbicides like Round-up® for spot or pre-emergent weed control.

5. *Bio-diversified cropping patterns*

With the proliferation of inorganic fertilizers since World War II, the general trend in US farming has been to minimize rotations of fertility enhancing crops (Altieri, 1995). Although rooted in economic structures (e.g., land values, commodity subsidies), this sort of technological innovation has furthered tendencies toward mono-cropping, which from an agro-ecological standpoint, exacerbates all kinds of non-fertility problems, such as disease, weediness, insects pests, and so forth. It has also enabled an unprecedented degree of intensification, as evidenced by growers in the coastal areas who can get up to five cash crops per year on any one piece of land, if the crop mix is right.

Cover cropping and non-crop plantings have already been discussed, both of which happen to increase farm diversity, but are generally used more narrowly as fertility management and pest control techniques. The focus here is on farm diversity more broadly as an indication of intensive management and ecosystem-oriented cropping systems.[10] To increase diversity within agricultural systems, agro-ecology recommends that farmers plant and rotate crops in a mosaic pattern of small blocks, and incorporate non-crop plants into the agro-ecosystem.

There is tremendous variation among organic growers in regards to diversity, which is primarily regional and crop specific, although there are clear connections with scale and ideological predispositions as well. In annual systems, the minimum practice is that of temporal crop rotations, where the same crop is never planted on the same piece of land twice in a row. The median is the practice of spatial and temporal rotations, that is, planting different crops, presumably with very different strengths and susceptibilities, in small adjacent blocks, although block sizes can be highly variable. This sort of practice is obviously not practical with grain crops that are mechanically harvested. The maximum are poly-cultural practices, such as inter-cropping vegetables between fruit trees, mixing two or three crops in any given block, and introducing livestock into the cropping system. In perennial systems, options are more limited, with the minimum being cover cropping, the median being varietal diversity, and the maximum, again being some sort of poly-culture, such as inter-cropping with annuals or livestock integration.

Almost all growers do some crop rotations, even those in the largest scale mixed categories, and even on their conventional acreage, although they may not necessarily rotate in a fertility-enhancing crop. The pattern observed in this study is that for produce crops, only strawberries, sweet potatoes, tomatoes, and carrots are grown back-to-back in conventional systems, all of which are once a year crops. Although growers recognize the potential for more difficult-to-contain pest problems, especially nematodes, this pattern is often replicated when they move into organic production. Small scale growers of specialty crops such as heirloom tomatoes also face the same problem, but are more inclined to do intensive soil improvement during the off season.

There is more significant variability in the degree of spatial diversity on any given parcel. At one extreme, some growers will plant quarter-section blocks (160 acres) in one organic crop, usually carrots or processing tomatoes, which have well-developed markets. Other large scale, and mixed operators, plant in 20 to 40 acre blocks, which viewed from the ground, hardly seems diversified. What drives this sort of system is less a commitment to diversity, and more the fact that they may have only 80 to 160 acres in organic production altogether. Recognizing the need to do temporal rotations, these growers have to spatially diversify to meet their marketing obligations.

When it exists, the sort of small block diversity of several species is found only on small to mid-size farms, and is as much guided by marketing strategy as anything else. That is, those who do direct marketing, especially through subscription boxes and farmers' markets generally desire as diverse a crop mix as possible to smooth out the timing of when crops become ready and to have an array of choices for the buyer. So even direct market fruit growers will diversify varietals so they come ripe at different stages.

Farms that incorporate near-ideal poly-cultures, however, are few and far between. I witnessed perennial/annual inter-cropping on only four farms, three of which are owned by long time activists in sustainable agriculture. All are subscription farms, where member-customers sign-up in advance and receive a weekly box of various commodities, and all have sales in the medium range. These farms and only a handful of others have livestock on the farm, but the others tend to be more segregated, where there may be a horse corral from which manure is collected. In other words, in this study there were only four or five farms where livestock was integral to the management of crops, by providing weeding service, post-harvest clean-up (thereby reducing tillage requirements), and/or insect control, in addition to manure.

6. *Evidence of planning and testing*

For a surprising number of growers, the idea of organic farming as opposed to conventional is doing nothing at all – that is, "organic by neglect." Diehard organic farmers cringe at this notion, claiming that organic farming takes much more management than does conventional, particularly in the areas of testing, observation, and hands-on controls. A fully diversified operation is a complicated one indeed.

This measure, however, is not easy to gauge: is an overgrown field one that is being neglected or one that is allowing the beneficial insects to take hold? Growers seem to run the spectrum, especially when different crops in fact do take different levels of management. Most growers pay much attention to their operation, and large scale business-oriented ones, conventional *or* organic almost certainly do. Those who are truly "organic by neglect" tend to be on residential real estate where farming is not their main source of income, especially on relic citrus or apple orchards (Neglected apples are bound for vinegar, juice, or applesauce). Statistically speaking, then, it is the smaller growers who are more neglectful; serious commercial growers of any size do not stay in business for long without more intensive management.

Conclusion

This paper illustrates that there are some distinct differences in organic practices between those growers who are entirely devoted to organic production and those who farm both organically and conventionally (and therefore are economically and ideologically closer to conventional farming). In addition, at least in some areas, there are clear gradations in practices between large scale and small-scale growers. The study also reveals, however, that in almost all cases, organic farming practices fall notably short of agroecological ideals, although they remain within the letter of organic rules and regulations. No doubt this deficiency exists in large part because there are very real agronomic challenges that are doubly difficult to address given a highly competitive economic and marketing environment, including what farmers claim are unrelenting expectations of cosmetically perfect produce. This leveling effect is also inextricably related to the codification of organic, a much broader topic taken up in Guthman (2000, forthcoming).

More strikingly, this paper suggests that key variations in practices are related to variables quite separate from scale and grower commitment. Some of these are geographic: practices are clearly shaped by biophysical and climatic opportunities and constraints, as well as regional norms and the existence (or lack thereof) of institutional support. Mostly, however, variation is related to crop specificities and the availability of efficacious technologies and inputs to deal with crop-specific problems. This so-called technology barrier crucially depends on how organic is defined, and again suggests the importance of organic rules and regulations in shaping the practices of organic production.

The fact that of all alternative agricultures only organic is legally circumscribed is a crucial particularity. Organic regulation creates both barriers and opportunities, and the translation of complicated biological and social processes into various rules and allowable materials makes all the difference as to who can practice organic agriculture and how effectively (see also Guthman, 1998). By setting minimum standards of allowable practices, it certainly allows industrial agriculture to enter the game, if not exactly on its own terms. Yet, it effectively creates ceilings as well. By codifying organic production, that is, it gives growers less incentive to incorporate an ideal practice when an allowable one will suffice.

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Notes

1. California agriculture has always been "exceptional" and this is no less true for organic. In that way, the reader must be cautioned against extrapolating these particular findings to other regions of the country, especially where crop mixes differ.

2. There are many other claims made about organic farming, of course, ranging from those made about grower values, to those about scale and locality, to those about social justice. And these, of course, are quite distinct from those made about organic food, in terms of qualities such as taste, nutritional value, and safety.
3. The California Organic Foods Act of 1990 allows growers to be registered as organic growers without having third party verification (i.e., certification). This dual system is a source of tremendous controversy.
4. CCOF's standards more or less serve as the basis of the California Organic Farming Act (COFA) which regulates all organic production in California.
5. These criteria were selected in consultation with Sean Swezey, then with the UC Santa Cruz Center for Agroecology and Sustainable Food System, and current Director of UC Davis's Sustainable Agriculture Research and Education Program. Miguel Altieri's *Agroecology* (1995) was used as an additional reference, as were course notes from his class in agroecology held at UC Berkeley.
6. Energy and water use are clearly aspects of the sustainability question that are not addressed in full here, in part because of spatial limitations and in part because they are not part of organic regulation. Given the extent of environmental transformation in California from water infrastructure alone, the absence of standards for water conservation is particularly striking. The larger study on which this paper is based (Guthman, forthcoming 2000) does address the issue of how it is that these sorts of concerns got written out of organic regulation.
7. The remaining six growers interviewed are either no longer in the organic program or did not provide enough information to evaluate their farming system.
8. Bt, or *Bacillus thuringiensis*, is a soil bacterium that releases toxins once ingested into an insect's gut. It is favored by organic farmers because it preserves natural enemies, degrades rapidly, and is not toxic to mammals, birds, or fish. Many of its advantages would be lost if crops genetically engineered to have Bt become widespread (Krimsky and Wrubel, 1996).
9. There is not enough space to extend this discussion here, but see CCOF handbook for explanation and list of restricted substances.
10. Over time the notion of biodiversity has increased in importance within the field of sustainable agriculture. Earlier literature focused on soil and soil fertility whereas biodiversity just made it into the CCOF principles very recently (CCOF, 1998; cf. CCOF, 1994), no doubt reflecting the increased salience of biodiversity in environmental discourse more generally.

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Address for correspondence: Julie Guthman Department of Geography, University of California, Berkeley, 501 McCone Hall, Berkeley, CA 94720, USA
Phone: +1-510-549-2297; Fax: +1-510-642-3370;
E-mail: jguthman@uclink4.berkeley.edu