TECHNICAL NOTES

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Organic Processing Tomatoes in Yolo County: Moving Towards Sustainability

As the search for sustainability in California agriculture progresses, many conventional large-scale farmers are realizing there are viable alternatives to traditional chemical tools. Exclusive reliance on synthetic agri-chemical tools is giving way to acceptance of management practices that are both ecologically less intrusive and economically feasible. For example, varying formulations of *Bacillus thuringiensis* (B.t.), a bacterial pesticide, can be effective in the management of many lepidopteran pests like the beet armyworm, especially when coupled with practices which create favorable conditions for beneficial insects. Organic agriculture, an approach to farming that restricts and regulates the use of synthetic agri-chemical tools, is commonly regarded as most applicable to small and medium sized farms. Large-scale organic production is thought to be impractical by many conventional growers. Nevertheless, the California Department of Food and Agriculture (CDFA) has documented an annual increase of about 25% in registered organic growers between 1992 and 1995, while gross organic sales have doubled, suggesting that the number of large growers is increasing or that the size of existing operations has increased* (Klonsky and Tourte, 1996). While the preponderance of organic farms are indeed small scale, a considerable fraction of farms have “established sizable organic markets and operate on a commercial scale” (ibid.). As the demand for organic products by mainstream consumers increases, it will be these large-scale farmers that will produce the supply. This, in fact, has already come to fruition for some crops, such as organic tomatoes. Yolo County, a major tomato producing area, has at least two large-scale producers growing organic processing tomatoes who, at one time, were farming entirely conventionally. Hence, it is the purpose of this Technical Note to expound upon the meaning of organic farming and to profile the major management changes in organic processing tomato production from conventional methods.

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*As of 1993, Yolo County had registered with CDFA a total of 31 organic growers who farmed 1,410 organic acres, contrasting with Kern county which had 17 growers farming 5,716 acres (Klonsky and Tourte, 1995). Official CDFA figures for ‘94-’95 crop years have yet to be released.

Background - What it Means to be "Organic"

The California Organic Foods Act of 1990 and the Federal Organic Foods Production Act of 1990 (not yet implemented) legally define organic livestock and crop management, processing, handling, and marketing. Currently, the state act only requires that organic producers be registered with the state. Certification with an agent such as California Certified Organic Farmers (CCOF) is voluntary. However, the federal act will soon require all organic producers, except those grossing less than $5,000 annually, to verify production via an accredited certifying agent (Klonsky and Tourte, 1994). There are about eight active certifying organizations in California (ibid.).

To be registered with the State and certified with CCOF, a producer must adhere to basic "organic" standards of production and management.* For organic processing tomatoes and other fruit & vegetable crops, these standards generally include: the land to be certified must be free from the application of prohibited materials for 36 months prior to harvest of an organic crop; the grower must implement a long-term soil management program with the goal of creating a fertile, healthy soil; accurate and comprehensive maps and input, sales, and harvest records must be maintained; only approved and regulated material inputs (e.g. pesticides & fertilizers) are to be used while registered and certified; and adequate boundaries and buffers, usually a minimum of 25 feet wide and preferably planted with non-crop vegetation, should be maintained around organic fields to reduce the incidence of chemical drift from conventional farms (CCOF, 1996).

Though these requirements may seem daunting, they have not discouraged many conventional farmers from making the transition to organic farming practices. In fact, management practice changes for processing tomato production may not differ greatly. Often times, one practice will be substituted with another. For example, rather than maintaining clean post-harvest fields, one might plant a late summer cover crop of Sudangrass (or cowpeas) or a winter vetch crop. Pest management might include the use of alternative pesticides, release of beneficial insects, enhancement of beneficial insect and animal habitat, increased scouting and monitoring, etc., rather than the once obligatory applications of synthetic chemical pesticides. Of course, the degree to which farmers will alter their management will vary, depending on such factors as farm operation scale, outlets to alternative markets, acceptance of alternative practices, and time. The following is a profile of organic processing tomato production as compared to conventional production in Yolo County.

Conventional vs. Organic

By current convention, a clean fall & winter fallow period usually follows harvest of wheat, in a tomato/wheat rotation (refer to Table 1 for Example Crop Rotations). Fields are worked and bedded-up in the fall and kept relatively free of vegetation through the winter. Occasionally, fields may be cultivated for weed control in the winter, weather permitting. Rather than continuing with this fallow period, organic processing tomato producers will take this opportunity to plant a cover crop for soil quality management. A nitrogen-fixing cover crop of

* The CCOF Certification Handbook explains in detail what is required to be certified with them for organic crops & livestock and for organic processed and handled products. It also contains the text for the California Organic Foods Act of 1990 and the Federal Organic Foods Production Act of 1990. Federal, State, and independent organizations maintain separate, though often overlapping, regulations and standards.

'Lana' vetch, for example, is planted in late September through mid-October after a light field discing. If early fall rains are lacking, the vetch may need to be irrigated for stand establishment. However, late fall rains should provide the crop with adequate moisture for continued vegetative growth. During late March, the vetch is incorporated into the soil, providing it with nitrogen-rich organic matter. 'Lana' vetch was shown to fix up to 230 lbs./acre of nitrogen prior to incorporation for tomatoes (Strivers and Shennan, 1991). A seed crop can be harvested from the vetch before incorporation if time permits; however, this may reduce the total plant nitrogen content. Transplants can be used rather than direct seeding, facilitating quick crop stand establishment and allowing a wider window of opportunity for pre-plant weed cultivation. Using transplants may also result in reduced need for certain pesticide applications for cutworms and darkling beetles. These insects are of most concern to farmers at or immediately after seedling emergence (Olkowski and Olkowski, 1996) in a direct seeded field. However, large numbers of cutworms prior to transplanting can also be detrimental.

Tomatoes following a vetch cover crop are typically planted later, resulting in late-season harvest. A summer/fall cover crop of Sudangrass can be planted after tomatoes to increase soil organic matter. Following a light post-harvest discing, the Sudangrass is planted in August. After two irrigations during the vegetative growth phase, the grass is incorporated into the soil in fall. Although Sudangrass is not a nitrogen fixer, it does "mine" the soil for residual nitrogen that may otherwise leach or volatilize and thus become unavailable to the next crop. Groundwork after the Sudangrass cover crop is similar to that of conventional production. Weeds can be managed by cultivating or flaming throughout the winter and just prior to seeding (Benson, 1994) the next crop, safflower for instance.

Soil fertility management constitutes a significant input for organic tomato producers. As much as 45% of the total cost of inputs (minus irrigation, harvesting, and overhead) goes into soil fertility management whereas 13% is typical for conventional tomato producers (Benson, 1994). Much of the fertilizer (e.g. compost, livestock manure, gypsum, and rock phosphate) is applied as pre-plant amendments. These amendments may be less critical for tomatoes (or other crops in a rotation) following a winter vetch cover crop than they are for tomatoes following a summer/fall Sudangrass cover crop. Strivers and Shennan (1991) showed that tomato yields (42 tons/acre) following a winter 'Lana' vetch cover crop were the same as yields from tomatoes fertilized with 200 lbs./acre of chemical fertilizer. Because nitrogen inputs from green manure crops can be variable from year to year, pre-plant amendments are still used to supplement crop nutrient needs.

Although the cost of fertilizers may tend to be high in organic production, this cost is offset by potential long term soil quality benefits (e.g. improved structure, enhanced bio-activity) and by the reduced need for weed, insect, and disease management inputs relative to conventional management. This is not to say that pest management is inconsequential in organic situations. In fact, it presents a special challenge because of the regulated nature of pesticide application in organic farming (as is true for fertilizer applications, too). Weed control poses one of the more formidable tasks. In conventional situations, weed problems are addressed primarily by a strict regimen of synthetic herbicide applications prior to planting, during crop growth, and after harvest. Since these same chemicals cannot be used in organic situations, weeds must be managed by cultural means - e.g. mechanical cultivation, flaming, and hand hoeing. Mechanical cultivation can only be accomplished before & after crops and during early plant growth when the plant stature is small enough for close cultivation. During the growing season, crews of laborers must go through the fields and hand hoe weeds like nightshade and watergrass. If tomatoes have been *seeded*, the cost for hand hoeing weeds & for thinning emerged seedlings can range between $100 and $150/acre/year. Hand hoeing costs can drop to $35/acre/year with tomato *transplants* because thinning is not required and mechanical cultivation can continue just prior to transplanting.

Generally, arthropod (i.e. insect and mite) pests problems are different in organically managed tomatoes than they are in conventional tomatoes. Problems such as pesticide resistance, primary pest resurgence, and secondary pest outbreaks are typically associated with use of conventional pesticides. Conventional growers may make "applications of preventative pesticides simultaneously with necessary ones" or make "'insurance' applications of pesticides" to reduce risks (Olkowski and Olkowski, '96) whereby exacerbating pest problems. Organic growers do not typically experience this "pesticide treadmill." Rather than approaching infestations from a "control and eradicate" perspective, pests are addressed from an ecosystem management approach. Because experience shows that low levels of certain pest populations may not affect yields (Olkowski and Olkowski, 1996)), pest management applications are not initiated unless monitoring (preferably by independent pest control advisors) shows population levels above economic thresholds.[*] Moreover, it may be desirable to have low levels of certain secondary pest species in fields to provide alternative prey for existing generalist predators (e.g. lady beetles, green lacewings, minute pirate bugs, etc.). Studies by Campbell et al (1991) comparing conventionally treated and biologically treated tomato plots suggests that the higher occurrence of aphids in biologically treated plots would attract a variety of generalist predator insects, leading to an increase in predation on lepidopteran pests. Undoubtedly, there will be times when pest levels do surpass economic thresholds, creating the need to perform some management measure. These may include, but are not limited to, beneficial insect releases, applications of B.t., or use of other approved pesticides[†] (e.g. sulfur for mite control).

Most arthropod pests that are common in conventional tomato systems can also be problematic in organic systems. Refer to Table 2 for a comparison of organic and conventional controls for common tomato pests in Yolo County. These include the russet mite (which can be managed in both situations with sulfur dust applications), cutworms, fruitworms, and beet armyworms (most "worm," or lepidopteran larvae, pests can be managed with applications of different formulations of B.t. with variable results). Late season use of endosulfan (Thiodan®) and esfenvalerate (Asana®) may elicit avoidance of parasitoids such as *Trichogramma* spp. to lepidopteran pests (Campbell et al., 1991). Stinkbugs are usually not problems in organic situations. In low- or no-pesticide use farms, the complex of indigenous and imported egg parasites can potentially be effective biological controls for stinkbugs (Hoffman et al., 1991). Furthermore, the superficial blemishes stinkbugs cause on tomato fruit are tolerated to a degree, especially if they are intended for tomato paste. However, they can be problematic if tomatoes are grown for fresh market or for whole peel processing. Organic soaps may be effective on nymphal stages of stinkbugs. Methamidophos (a.k.a. Monitor ®) is commonly used in conventional situations for stinkbug control.

A practice that can be implemented in both conventional and organic situations is the establishment of beneficial insectary hedgerows (or other similar plantings), which can provide habitat for natural enemies of pests. Recent discussion regarding the efficacy of these hedgerows

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[*] Economic thresholds or action thresholds are largely regional and numbers for certain pests may even be at the experimental stage.
[†] CCOF and the State maintain a list of approved, regulated, and prohibited materials. In situations that require the use of prohibited materials, land may be temporarily withdrawn from certification.

in attracting adequate and appropriate populations of pest predators and concerns that pests may build up in these hedgerows to later move out into adjacent crops have prompted research to address these matters.* It is critical that hedgerows are continually monitored for both beneficial and pestiferous insects and that subsequent data is appropriately applied to the design and management of future hedgerows. Notwithstanding, it is still generally considered that hedgerows consisting of a diversity of plant species are more beneficial than deleterious. For instance, umbelliferous plants, "due to the great accessibility of their nectar" and high incidence of parasitoid wasp visitation (Jervis et al., 1992), may increase the immigration rate of parasitoids into crop fields (van Emden, 1963) if used in hedgerows or interplanted with the crop. Hedgerows not only provide necessary nectar; they provide pollen (an alternative food source) for adult stages of lacewings, syrphid flies, and other generalist predators. They serve as refuge areas during groundwork activities and as overwintering sites. When native perennial grasses are included, benefits can include: weed suppression, increased rainwater infiltration & percolation rates, and sediment filtration leading to improved surface water quality. Wind and drift protection (especially useful for satisfying border buffer requirements for organic sites) can also occur if larger stature shrubs and trees are included.

Insectary hedgerows should be designed to include preferably native trees, shrubs, and groundcovers (although certain non-natives provide excellent insect habitat). Emphasis should be placed on including enough of a diversity of plants so as to have something flowering at any time during the year. Such plants might include willows, *Ceanothus* sp., mule fat, and yarrow for early-year flowers; coffeeberry, holly-leaf cherry, toyon, elderberry, and buckwheat for mid-year to late-year flowers; and coyote brush for late-year flowers.

Bacterial speck can be common in both conventional and organic processing tomatoes probably because the incidence of this disease is primarily a function of weather, developing in wet & cool weather (Flint, 1990). Synthetic pesticides are used for control in conventional farms. Copper hydroxide is an allowed but regulated material for use on bacterial speck (CCOF, 1996) in organic farms and many conventional farms.

Harvesting for large-scale conventional and organic tomato operations remain unchanged, using available tomato harvesting technology. Furrow irrigation constitutes the most common irrigation system for both scenarios. However, overhead sprinklers are customarily used for pre-irrigation for tomato seed and weed seed germination. Irrigation tailwater return systems are used in both organic and conventional systems, increasing irrigation system efficiency and providing wildlife habitat if ponds are included in the design of the return system. Even buried drip tape has been tried, with mixed results, in Yolo County. This may be more viable where water costs necessitate improvements in irrigation efficiency. Crop rotations for organic tomatoes, and sometimes conventional, may include winter wheat followed by a crop of dry beans harvested the ensuing summer, continuing with a winter cover crop, and concluding with tomatoes. Variations exist for both organic and conventional systems, including occasional safflower, sugar beets, and alfalfa.

Making the Transition

Relative to large-scale production, one might conclude that conventional and organic

* The Yolo County RCD is currently conducting an insectary hedgerow project funded by the California Department of Pesticide Regulation to address some of these issues.

processing tomato management is actually quite similar. Organic certification requirements do necessitate that many changes be implemented especially in what material inputs can be used. However, these alterations can indeed be instituted without causing dramatic management changes. The decision to use less chemically intensive management practices might arise from any number of circumstances. Ultimately, a farmer's decision to switch over is strongly governed by economics. Farmers must be assured that net returns on their crop will still provide enough profits before they decide to convert. In many cases, the first few years of production during transition to organic practices result in lower than normal yields. To mitigate this, USDA's Environmental Quality Incentives Program funds might be used to help offset this difference. Special Practice 53, Integrated Crop Management, may be available or incentive payments for such practices as integrated pest management, cover cropping, or fertilizer management might also be available. Also, certified organic produce can sometimes bring premium prices. Production costs for organic processing tomatoes may be slightly higher on a per-acre basis and yields may be slightly lower than conventional production, nevertheless, the prices received for organic tomatoes have resulted in income comparable to and sometimes higher than conventional tomatoes. However, the ability to receive premium prices for organic processing tomatoes may be limited by the farmer's proximity to organic processors.

One should investigate the marketing potentials for each organic crop in the tomato rotation to realize maximum profits. Cover crops can be cut and sold for hay, for example. Direct retailing to local fresh markets (e.g. farmers markets, local grocers, CSAs[*]) can augment income. However, these markets may demand a greater variety of crops. Diversifying one's operation to include other crops will open doors to new markets. Of course, this presupposes that one be willing to accept more changes in crop management.

It has neither been the intention of this Technical Note to suggest that making the transition to alternative modes of production is simple nor does it suggest that organic farming is a panacea for all of agriculture's environmental woes. Nutrients will still leach, soils will still erode, and waters will still be contaminated with the improper implementation of any management practice, organic or not. Rather, organic farming offers options to traditional management practices that may reduce the risk of problematic conditions (e.g. acute and chronic pesticide toxicity). An integrated approach to pest management, for instance, prescribes that the farmer choose from the least toxic of chemicals when, and only when, a pest treatment is needed thereby reducing exposure of the most toxic of chemicals to the farm worker, consumer, and environment. With the potential socio-economic and ecological benefits that organic agriculture can offer, it may be worthwhile for conventional producers to consider integrating alternative management practices into their operations. With the acceptance of such projects as Biologically Integrated Orchard Systems and Biologically Integrated Farming Systems and proliferation of research in integrated pest management, sustainable agriculture & agroecology, the options for innovative farmers and conventional farmers alike will continue to grow, making the search for sustainability an ever imminent endeavor.

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[*] CSA or Community Supported Agriculture is a form of direct marketing to local communities which entails pre-season sale of crop "shares" to generate income for the coming crop season. Participating "share holders" are given periodic and frequent opportunities to pick-up or have delivered fresh produce throughout the growing season. This type of marketing is management intensive and has typically been suited to smaller scale operations. For more information contact Community Supported Agriculture West of the Community Alliance with Family Farmers Foundation at (916) 756-8518.

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Table 1. Example Crop Rotations for Conventional and Organic Processing Tomatoes in Yolo County. Variations in crop rotations exist. Factors such as market demand affect type of crop grown. Other crops include sugar beets, alfalfa, and safflower. Selection of cover crop depends on nutrient needs of following crop. Fertilizers (e.g. compost, manure, gypsum, rock phosphate) are often used to supplement organic crop nutrient needs.

Conventional			Organic		
Year in Rotation	Crop	Notes	Year in Rotation	Crop (*Cover/green manure crop*)	Notes
1	Tomatoes	Post harvest fields kept clean. Field planted with winter wheat.	1	Tomatoes (*Sudangrass)*	Sudangrass planted in late summer after tomato harvest, “mines” residual nitrogen. Winter legume optional after grass plowdown.
2	Wheat/ Beans	An occasional double crop: winter wheat, summer beans. After bean harvest field bedded-up, kept clean through winter.	2	Safflower (*vetch)*	Summer dry beans may be next crop in rotation. However, Safflower becoming more common in both conventional and organic.
3	Tomatoes	Tomatoes planted sometime in spring with early-, mid-, late- harvest in mind depending on contract with processors.	3	Corn (*vetch/oats)*	Winter vetch/oat cover crop after corn will preclude winter wheat crop. If wheat desired, late summer cowpea an optional legume cover crop.
4	Wheat	Corn may be next crop in rotation instead of wheat. Field bedded-up after harvest, kept clean through winter for spring planting of tomatoes.	4	Wheat/Beans (*vetch)*	This double crop may follow tomatoes but typically precedes tomatoes. Vetch planted in fall, plowdown in spring. Tomato beds prepared & planted.

Table 2. Common Arthropod Pests of Processing Tomatoes in Yolo County and Example Control and Management Strategies. **Monitoring of pest and beneficial insect populations should always precede any pesticide treatment. Economic or action thresholds may vary from region to region, by tomato variety to variety. Consult an Extension Specialist or independent pest control advisor. Insectary plantings should exclude solanaceous plants, which may harbor pest of tomatoes.**

Common Name	Scientific Name	Example Controls/Management Strategies		
		Conventional	Organic	Comments
Cutworms: Variegated Black	 *Peridroma sancia* *Agrotis ipsilon*	carbaryl baits	*Bacillus thuringiensis* (B.t.) baits	Critical at or immediately after seedling emergence up to 5 leaf. Ensure clean fields prior to transplanting. Apply pre-plant control if monitoring necessitates.
Aphids: Potato Green peach	 *Macrosiphum euphorbiae* *Myzus persicae*	esfenvalerate endosulfan methomyl	Typically not a problem. Parasitoid/predator releases; various soaps and botanical insecticides	**Critical during plant rapid growth phase**. Many natural enemies, encourage by planting insectary habitat. Excessive pesticide use may disrupt enemy populations, exacerbating aphid problem.
Tomato Russet Mite	*Aculops lycopersici*	sulfur (dust & wettable)	sulfur (dust & wettable)	**Critical during plant rapid growth phase.** Control solanaceous weeds. Excessive pesticide (e.g. pyrethroids) use may disrupt enemy populations, exacerbating mite problem.
Beet armyworm	*Spodoptera exiqua*	methamidophos endosulfan	B.t. specific to armyworms	**Critical during vegetative growth through fruit for fresh market. Less critical during fruit stages for processing unless high populations present.** *Hyposoter exiquae* is primary parasitoid. Generalist predators also important. Plant insectary habitat.

Common Name	Scientific Name	Example Controls/Management Strategies		
		Conventional	Organic	Comments
Tomato fruitworm (a.k.a. Corn earworm)	*Heliothis zea*	methamidophos endosulfan	B.t. Trichogramma spp. releases	**Critical during green and ripening fruit**. Encourage beneficial insects with insectary plantings.
Stink bugs: Consperse Red shouldered Say Southern green	 *Euschistus conspersus* *Thyanta pallidovirens* *Chlorochroa sayi, & C. uhleri* *Nezara viridula*	 methamidophos endosulfan	Typically not a problem. Various soaps (for nymph stage) and botanicals. *Trissoculus basalis* releases (limited commercial availability).	**Critical during green and ripening fruit. Most critical for fresh market and whole peel processing.** Many natural enemies of stinkbug eggs; encourage with insectary plantings.