Summer 1990 - Vol. 1, No. 3

In This Issue:

READERS RESPOND

The first two issues of COMPONENTS have been well received. Thank you to all those who took the time to respond to the survey. Of the 30 who responded, 63 percent thought COMPONENTS was "very useful" to them while 29 percent rated it as "useful". Readers liked the broad scope of topics covered and specifically noted that the summaries and highlights of research, articles or presentations were relevant to their work. Both the longer articles synthesizing information from several papers and the shorter, single-paper abstracts received favorable comments. Some readers suggested that COMPONENTS could be improved by including articles on forestry and livestock production. Others thought that we should place greater emphasis on research specifically for California, especially reports which give practical results that can be recommended to farmers. We have made an effort to address some of these concerns with this third issue and will to continue to look for ways to present good, summarized information on the range of topics relevant to sustainable agriculture in California.

Based on this positive response, we are pleased to make COMPONENTS available to a wider audience beginning with the third issue. In addition to farm advisors, specialists, and faculty, it is now being offered to other organizations and consultants interested in sustainable agriculture. Sources of information for this issue include Cooperative Extension newsletters and publications, journals, meeting and conference presentations, and reports of special projects.

We recognize that there are many approaches to improving the sustainability of California farming systems. Please continue to let us know of any information or research that would be appropriate to the newsletter. The survey form is included again to solicit feedback and comments.

- *Bill Liebhardt, Program Director*

Pumping nitrogen.

Hirschfelt, Donna

Vine Lines, UC Cooperative Extension, Fresno County, June, 1990, pp. 1, 5. 1990

Editor's note: a recent article by UC Farm Advisor Donna Hirschfelt for Fresno County grape growers may be of interest to other growers pumping extra well water this year (reprinted with the author's permission):

"The drought has had many implications for farmers. Some of these are extremely serious while others are perhaps not as noticeable. Most growers are pumping extra well water this year, and it is important to keep in mind that this water is of different quality than the mountain water used by the irrigation districts. While most east side growers don't need to be concerned about salt problems in well water, it is worthwhile to have your well water analyzed for nitrogen content. Many growers may be 'applying' nitrogen each time they irrigate. This should be taken into account when calculating the vine's nitrogen needs.

"Some of these vineyards may have problems with excessive vigor, especially if supplemental N is applied. The amount of nitrate-nitrogen varies considerably from well to well, however, Pete Christensen's surveys in the early 1970's indicated that 75 percent of the east side wells contained enough N to contribute significantly to the vines' total nitrogen needs. Recently I have analyzed results from several vineyards where the grower doesn't need to apply any additional nitrogen.

"Allow the pump to run for 30 minutes before collecting the water sample. The sample should be collected in a clean, well rinsed pint jar that seals tightly, and should be delivered to a commercial lab within one or two days.

"Lab results will be expressed as either ppm NO3 (parts per million nitrate) or ppm NO3-N (parts per million nitrate nitrogen.) To determine the amount of nitrogen pumped per acre-foot, use one of the following calculations or graphs:"

For ppm NO3: ppm x .61 = lbs. N per acre-ft of water

For ppm NO3-N: ppm x 2.73 = lbs. N per acre-ft of water

(JSA.103) *Contributed by Donna Hirschfelt,*
UC Coop. Ext. Fresno County.

The role of organic matter in soil compactibility: A review of some practical aspects.

Soane, B.D.

Soil & Tillage Res. 16:179-201 1990

This extensive review article (63 references) examines the influence of organic matter on soil compactibility. Soil compaction is recognized as a worldwide problem that, unless corrected, can lead to a reduction in crop yield and quality, poor water infiltration, and increasing power requirements for tillage practices. The author recommends a two-pronged approach to solving the problem: Reduce the high-weight axle loads and stress imposed by heavy agricultural equipment, and look for ways to decrease the compactibility of the soil. Compactibility is a function of soil texture, moisture content, aggregate stability, and organic matter content. Changes in cropping system and management practices can influence soil organic matter levels "and this review is concerned with the possible benefits of such action in reducing the sensitivity of soils to applied loads."

Basic laboratory and field tests suggest six possible mechanisms by which organic matter reduces soil compaction:

- Chemical binding. Long-chain molecules increase the cohesion among particles and aggregates.
- Dilution effect. Because the bulk density of organic materials is much less than that of mineral soil, the average bulk density of a mixture of organic matter and soil will be less than that of the soil alone.
- Filament effect. Biologically derived filaments such as roots and fungal hyphae bind soil particles and increase aggregation.
- Effect on electrical charge. Some organic materials may alter the electrical charge of clay particles so as to increase the repulsive forces between them.
- Friction. Organic substances on the surface of particles and aggregates may increase the friction between them.

Both basic studies and a range of practical, field-oriented experiments show that:

1. The beneficial effects of soil organic matter are more apparent at low stress loads than at high.

2. Organic matter improves soil aggregate strength. Management practices that enhance aggregate stability will increase the resilience of soil to compaction

by heavy loads.

3. Though bulk density is the most common method of measuring soil compaction, other characteristics such as porosity and permeability should be considered because of their direct influence on plant growth and development.

4. Some controversy exists over the interpretation of tests that measure the exact relationship between organic matter and soil compactibility: 'Impact loading' experiments indicate that higher levels of organic matter reduce compactibility, while 'uniaxial compression tests show no significant differences in compactibility from organic matter additions.

5. The stage of decomposition of organic matter should be carefully considered when evaluating its long-term effects on compaction. The effect of humified (well-decomposed) organic matter on aggregate stability is complex and not well understood in field situations.

6. Modified tillage practices (shallow cultivations, reduced- or zero- tillage), and the incorporation of manure, compost, and/or crop residues can result in significant differences in soil compaction.

For copies of this article write to: Scottish Centre of Agricultural Engineering, Bush Estate, Penicuik, Midlothian, EH26 OPH, Great Britain.

(DEC. 159) *Contributed by Dave Chaney*

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Long-term effects of manure on soil nitrogen, phosphorus, potassium, sodium, organic matter and water infiltration rate.

Meek, Burl, Lucy Graham and Terry Donovan.

Soil Sci. Soc. Am. J. 46:1014-1019. 1982

This paper reports the results of a nine-year study conducted at the Imperial Valley Conservation Research Center in Brawley, California. Seven different manure treatments were evaluated for their effects on extractable phosphorus, organic matter, nitrogen balance, potassium and sodium, and water intake in a clay soil. The following table summarizes manure treatments and cropping history of the experiment. Each treatment was replicated four times. Manure was applied in January or February and mixed uniformly in plots 12.2 m x 12.2 m.

Treatment (tons/ha manure)								**N-appl**	
Year	1	2	3	4	5	6	7	kg/ha	Crop
1971	0	180	45	90	360	180	180	168	sorghum
1972	0	0	45	90	0	360	180	180/189	sorghum/lettuce
1973	0	0	45	90	0	0	180	231	sorghum
1974	0	0	45	0	0	0	0	170	sorghum
1975								196	sorghum
1976								150/179	barley/lettuce
1977								0	fallow
1978								168	cotton
1979								168	sorghum
Total	**0**	**180**	**180**	**270**	**360**	**540**	**540**		

Phosphorus. Manure increased the amount of extractable-P in the soil and kept levels at a higher level than the control throughout the nine year experiment. Plots that received manure only in 1971 still had more than double the phosphorus in 1979 as compared with the check. After the final application of manure in 1974, phosphorus levels declined an average of nine percent per year for all treatments that had received manure.

Organic Matter. Organic matter levels increased dramatically each season in plots that received large amounts of manure (180 and 360 tons/ha). Fifty-one percent of the organic matter in the initial manure applications, 1971, decomposed by September of that year; decomposition rates in succeeding years were much slower. After 1974 (the last year manure was applied) organic matter content showed a general decline to the levels shown in the following table:

Postharvest soil organic matter content (%)						
Treatment	**1970**	**1971**	**1973**	**1975**	**1977**	**1979**

1	0.8	1.0a*	1.1a	1.2a	0.9a	1.0a
2	0.9	1.9bc	1.6ab	1.9b	1.3b	1.3b
3	0.8	1.3a	1.9bc	2.2bc	1.4b	1.5b
4	0.9	1.4ab	2.3cd	2.6cd	1.5b	1.5b
5	0.9	2.2c	2.0cd	2.0b	1.6b	1.4b
6	0.9	2.0c	3.0e	2.8d	2.0c	1.7c
7	0.9	1.8bc	1.8de	2.7cd	2.1c	1.8c

* Values within columns followed by different letters are significantly different at the 5% level.

Nitrogen Balance. During the years that manure was applied the efficiency of N recovery was greater in plots receiving low rates (treatments 2,3, and 4) than for those with high rates of manure (treatments 5,6, and 7). The poor recovery of nitrogen from high manure rates was probably caused by denitrification and volatilization.

Potassium and Sodium. Exchangeable K increased in the high manure rate treatments; no increase in exchangeable Na was noted. Exchangeable Na should have increased by 544 ppm with total, 4-year rates of 540 tons/ha, but no differences were detected due to high initial levels of Na and a large coefficient of variability.

Water Intake. Manure applications had a greater effect on water infiltration measured during the cropping season as compared to measurements taken after harvest, between crops. "Water intake rates showed almost a straight line increase with increasing rates of manure applications. Organic matter was an important factor contributing to increases in water intake rates. A one percent increase in organic matter decreased the time required for water to infiltrate by 31 percent. With proper residue management a grower in the desert Southwest could increase organic matter and reduce salt problem and flooding times. The effect of manure on water intake rates lasts only one year after the year of application. Thus, to secure this benefit manure applications must be made at least in alternate years."

(DEC.122) *Contributed by Dave Chaney*

The effect of different fertilizer treatments on humus quality.

Brinton, William F.

Compost Science/Land Utilization. 20(5):38-41. 1979

This 19-year experiment conducted in Sweden showed that fertilizer applications do affect the composition and quantity of humus throughout a soil profile. Humus is the dark-colored, relatively stable fraction of organic matter. It is formed from organic matter through a combination of biochemical and microbial processes known as humification. Humification appears to be governed mainly by microbial activity. Chemical separation of humus distinguishes four major components differentiated mainly by their solubility characteristics:

- fulvic acids-- soluble in both acidic and alkaline solutions.
- humic acids-- soluble in alkaline solutions; precipitated (insoluble) in acid solutions.
- humates-- moderately insoluble mineral chelates of humic acids.
- humins-- highly insoluble in both acidic and alkaline solutions; believed to be deposited either within or on the surface of soil minerals.

Eight different fertilizer treatments were applied to a four- fold crop rotation (wheat - clover/grass -potatoes - beets) laid out in plots so that each crop was growing each year. Detailed analyses were made of five of the eight treatments:

1. Farmyard manure (FYM) composted with addition of one percent meat and bone meal each (4.4 metric ton/ha/year dry basis).

2. FYM, fresh, with meat and bone meal as above (4.1 t/ha/yr.).

3. FYM, fresh (2.2 t/ha/yr.) combined with inorganic N, P, K (15, 13, and 22 kg/ha/yr., respectively.)

4. Control, no treatment.

5. Inorganic N, P, K (62, 53, 86 kg/ha/yr., respectively.)

Measurements were made on organic matter content, humus quality and quantity, soil bulk density, soil pore space, number of earthworm canals, soil dehydrogenase activity and C02 respiration. Although individual fertilizer treatments were not replicated in this experiment, the author believes that the 19- year history of consistent management compensates for this deficiency. In order to test the significance of any differences based on source of fertilizer, data from treatments were grouped together as either organic or inorganic for variance analysis. In this manner, several key points are drawn from the study:

- In general, fertilization (regardless of the source) tended to decrease the portion of humic acids in the topsoil (0-10 cm) and increase them in the subsoils (25-35 cm) both relative to the control. On an absolute basis, the *available* humic acid pool for both top and subsoil were increased with organic treatment (1 & 2) and decreased with inorganic treatment (3 & S). All fertilizer treatments increased the level of inorganically bound (relatively unavailable) humates.

- As determined by the optical absorbance curve, the rate of humification in the subsoil was greater for organic treatments than for inorganic treatments. In the topsoil, all fertilizers (regardless of the source) reduced humification.

- The increase in humic acids in the subsoils decreased compaction, and increased water holding capacity, biological activity, dehydrogenase enzyme activity and the quantity of earthworm canals. Topsoil changes in humic acids and humins did not show significant relationships with these measurements.

Determining or predicting the movement and condition of humic constituents in soil is an extremely difficult task. "The cycling of organic matter in soils, its dissolution, deposition and resolubilization, has a number of physical-chemical- biological corollaries not easily categorized as either cause or effect." Practical management techniques for improving the cycling of humic materials will require further study into the biological associations and activity that determine the conversion of organic matter into humus.

(DEC.119) *Contributed by Dave Chaney*

Controlling plant disease with sludge compost.

Millner, P.D., R.D. Lumsden and J.A. Lewis.

BioCycle 23(4): 50-52. 1982

This study is based on the principle that a balanced soil microflora can be antagonistic towards phytopathogens. These antagonistic activities include: antibiosis (production of fungal inhibitors by saprophytic microbes or plant roots), nutrient competition, and parasitism (direct attack of pathogens by non-pathogens).

Greenhouse studies were conducted on ten soil-borne diseases and six crops. Soils were either amended with sludge compost at a ten percent rate (dry weight basis) or unamended but supplied with a 10-10-10 fertilizer. After three to six weeks at optimal conditions for disease development, the following disease percentages were recorded for compostamended (CA) and unamended (U) pots:

			Disease %
Pathogen	**Host**	**U**	**CA**
Aphanomyces euteiches	pea-Alaska	43	3*
-Perf.Freez.		48	10
Rhizoctonia solani	bean-Blue Lake	63	25*
	Cotton-Stnvil.	88	60*
radish-Sc. Gl.		88	32*
Sclerotinia minor	lettuce-Paris	84	33*
-Boston		91	50*
Phytophthora capsici	pepper-Ca.Wond.	97	55*
Pythium ultimum	pea-Alaska	39*	68
P. aphanidermatum	bean-Blue Lake	14	12
Thielaviopsis basicola	bean-Blue Lake	36*	84
cotton-Stnvil.		49*	79
Fusarium solani	pea-Alaska	33	40
-Perf.Freez.		65	55

*indicates % disease significantly less than the alternative treatment, P = 0.05. Disease parameters based on either root rot severity or percent diseased plants.

Based on these findings, *S. minor* and *R. solani* were chosen for a field experiment evaluating the effects of composted sewage sludge on plant disease. Plots 2.5 m x 4.0 m were inoculated with either *S. minor* or *R. Solani*; *Pythium* was already present in the experimental site. In the spring of 1980 and 1981, composted sludge was incorporated into half the plots at a rate of 220 metric tons/ha; non- compost plots were supplemented with a 10-10-10 fertilizer and lime in order to establish plant nutrient and pH levels comparable to the compost plots. Lettuce seedlings were transplanted into *S. minor/Pythium* plots. Pea and cotton seeds were planted to R. *solani/Pythium* plots. Both fungicide-treated and untreated seeds were evaluated.

Results from three cropping seasons showed that lettuce leaf drop (*S. minor*) in the compost amended plots was significantly less than that in the fertilized plots. Compost had no effect on reduction of *Pythium* and *Rhizoctonia* damping-off in peas during the first crop season. During the second and third crop season, however, disease problems on pea were significantly reduced in compost amended plots as compared to the fertilizer treatment. "These results support the concept of a long-term mechanism for disease control. The exact nature of the mechanism is not yet entirely clear, however, antibiosis is suspected because pathogen propagule levels remained approximately equal in compost and fertilizer plots." The combination of compost amended soil and fungicide-treated pea seed had the greatest disease reduction in all crop seasons.

In contrast, compost had no significant effect on disease severity in cotton in either the first or the second season (no third season data were collected for cotton). The compost/seed-treatment combination had greater disease control in the first season, but not in the second. The authors suggest a strong plant species effect as the explanation for the different responses of pea and cotton to identical treatments.

In assessing potential disease control factors, the authors focus on competition between microbes present in the compost and those present in the soil. The most successful organisms will be those which adapt to the new soil environment created by the addition of compost. For example, populations of actinomycetes, bacteria, and fungi were evaluated in both the greenhouse and field studies. "The relative overall predominance of actinomycetes and bacteria in compost-amended soils was significantly higher than in nonamended soils. Certain species of fungi were also more predominant in compost-amended soils." Disruption of pathogen development cycles through antagonistic components of compost appears to be a viable alternative for control of some diseases.

(DEC.134) *Contributed by Dave Chaney*

Summer 1990(v1n3)

Biological control of insect pests In sustainable agriculture.

Bugg, Robert L.

Article written for COMPONENTS. 1990

The cultural practices that farmers use have important ramifications for insects. Crop rotations, toleration of some weeds, field-margin vegetation, and modified planting or tillage schemes can affect pest or beneficial insects. Biological control, in the narrow sense, has been defined as the action of natural enemies (predators, parasites, and pathogens) to reduce densities of pest insects. Biological control is only one facet of sustainable agriculture; it does not exist in a vacuum. This review shows that a number of cultural practices can exert a strong influence on biological control. Here we will emphasize recent or underexposed articles, to complement previous reviews by Altieri and Letourneau (1983) and Andow (1989), with examples from California given wherever possible.

Hedgerows and Windbreaks

Wind shelter afforded by windbreaks and hedgerows can lead to increased activity by aphidophagous **hoverflies** (Diptera: Syrphidae), based on studies conducted in England. Using segregating traps and painted pan traps containing water and detergent, Lewis (1%Sa) showed that adult syrphids occurred in areas sheltered by artificial windbreaks (three feet in height, made with horizontal slats, 45 percent open area), and that of all 13 insectan taxa assessed (diurnal and nocturnal), syrphids showed by far the greatest tendency to concentrate in the sheltered area. On the other hand, aphids are also prone to settle in the vicinity of shelter (Lewis, 1%Sb), so the net result of windbreaks is in question.

Because hedgerows and windbreaks often contain flowering plants used by syrphids, effects of shelter and of floral resources may be confounded. Bowden and Dean (1977) assessed the distribution of adult syrphids through use of suction traps on both sides and at two distances from a high (7 m) hedgerow. Prevailing wind did not seem to influence the distribution. Syrphids were consistently more abundant on the western side, which was more diverse floristically.

Pollard (1971) believed that shelter influenced syrphid oviposition, but that flowers did not. In Pollard's (1971) experiment, potted brussels sprouts plants were placed out in various habitats, then retrieved and inspected for syrphid eggs. Adult syrphids were more abundant in areas with flowers. However, oviposition was depressed in unsheltered areas, regardless of whether flowers were available nearby.

Windbreaks can also be important sources of **predatory true bugs** (Hemiptera) that can colonize adjoining orchards. For example, in England, predatory bugs, *Anthocoris nemorus* and *A. nemoralis* (Anthocoridae) can build up in windbreaks of flowering willows (*Salix caprea* and hybrids), and later disperse to pear orchards (Solomon, 1981). Similarly, a predatory mirid, *Blepharidopterus angulatus* (Fallen), can develop high densities on windbreaks of alder, *Alnus glutinosa* (L.) Gaertner (Betulaceae), infested with the alder aphid, *Pterocallis alni* (DeGeer), and later disperse to adjoining apple orchards (Solomon, 1981; Gange and Llewellyn, 1989).

- **Green Lacewings** (Neuroptera: Chysopidae) are predatory in the larval stages, and some species are also predatory as adults. In other species, (e.g., *Chrysoperla carnea*) adults feed only on nectar, pollen, and honeydew. **Brown lacewings** (Neuroptera: Hemerobiidae) are predatory in the adult and larval stages, and have been shown to be important predators of artichoke plume moth in California (Neuenschwander and Hagen, 1980). Adults also feed on nectar. Adult lady beetles (Coleoptera: Coccinellidae) can also subsist (but usually not reproduce) on diets of nectar and pollen. Adult green and brown lacewings and **convergent lady beetle**, *Hippoddamia convergens*, are abundant on an introduced plant, soapbark tree, *Quillaja saponaria*, during flowering in late May and June (Bugg, 1987). This tree could be included as a secondary species in Californian windbreaks.

Cover Crops

Cover crops, like weeds, can harbor both pest and beneficial insects (Altieri and Letourneau, 1983; Bugg et al. 1990a). **Bigeyed bugs** (*Geocoris* spp., Lygaeidae) are opportunistic predators on a wide range of insects and mites. They will also feed on nectar. They are especially important from May to mid July when they are commonly found on melon, okra, pepper, and squash plants (Bugg et al., 1987; Bugg and Wilson, 1989; Bugg, unpublished data). These predators can also build up in cool-season cover crops, like berseem clover, *Trifolium alexandrium*, and subterranean clovers, *Trifolium subterraneum*, and may disperse to adjoining vegetable crops when the clovers die in early summer, as has been shown during studies in Georgia (Bugg et al., in press). Studies in California also indicate that *Geocoris* spp. will build up in and disperse from leguminous cover crops (Altieri and Schmidt, 1985).

Flowering buckwheat (*Fagopyrum esculentum*), commonly used as a cover crop, is attractive to adult **hoverflies** (Bugg and Dutcher, 1989; Bugg and Ellis, 1990). Among lady beetles common in California, **convergent lady beetle** is important in field, vegetable, and orchard crops; **ashgray lady beetle** (*Olla vnigrum*) is mainly important in tree crops. Studies in southern Georgia have shown that cover crops can afford alternate prey and harbor both species of lady beetle. A mixture of hairy vetch, *Vicia villosa*, and rye, *Secale cereale*, worked well in the cool season (Bugg, et al., in prep), and hemp sesbania, *Sesbania exaltata*, proved useful during the summer (Bugg and Dutcher, 1989). However, there was no indication that use of winter or summer cover crops in pecan orchards led to improved biological control of pecan aphids (Bugg and Dutcher, in prep; Bugg et al., in prep.). The lady beetles involved are highly mobile, and the experimental plots were relatively small (comprising 4 or 6 pecan trees and the associated understory plant communities). Perhaps larger-scale experiments could demonstrate differences due to cover crops.

Minute pirate bug (*Orius tristicolor*, Hemiptera: Anthocoridae) is an important predator of corn ear-worm. It attacks the eggs and young larvae of these and other moths. There is evidence that polycultures of various vegetable crops can harbor elevated densities of minute pirate bug (Letourneau and Altieri, 1987). A close relative, **insidious flower bug** (*Orius insidious*), has been shown in Massachusetts to build up on cover crops of buckwheat or hairy vetch (Bugg and Ellis, 1990).

Parasitic wasps (Braconidae, Chalcidoidea, and Ichneumonidae) are important in biological control of insect pests, and may rely on honeydew or pollen and nectar in the adult stages. Twenty species of Ichneumonidae were observed taking extrafloral nectar from faba bean, from late September through late October (Bugg et al., 1989). For unknown reasons, few ichneumonids visit buckwheat flowers. Among the Chalcidoidea, members of the genus *Trichogramma* are especially important as egg parasites of lepidopterous pests (Qlkowski and Zhang, 1990). *Trichogramma* spp. are known to benefit from dietary honey (Stavraki, 1976; Treacy et al. 1987) or extrafloral nectar (Treacy et al. 1987), and field studies in Texas suggest that the latter may be important in sustaining high rates of parasitization (Treacy et al. 1987). It is not clear whether cover crops that provide nectar or alternate hosts can be used to enhance performance of *Trichogramma* spp.

Predatory wasps include both social and solitary species. The social species include paper wasps and yellowjackets (Vespidae), which attack many species of caterpillars. Solitary wasps of the Sphecidae, as a group, attack wide ranges of insects, including caterpillars, crickets, and weevils. Cover crops that attract many predatory wasps include buckwheat, cowpea, and white sweetclover. Eighteen types were obtained from buckwheat, and eleven from annual white sweetclover (Bugg and Ellis, 1990). In Georgia, extrafloral nectar of cowpea attracted six types of Vespidae, four Pompilidae, and ten Sphecidae (Bugg, unpublished data). There is some evidence that predatory wasps may be of value in pest control.

Spiders (e.g., *Theridion* sp., Theridiidae) are believed particularly important in the suppression of grape leafhopper and variegated leafhopper in vineyards, and some researchers believe that cover crops may be useful in enhancing spider densities and resultant biological control (William Settle, personal communication). Several replicated trials are now underway m California to test this idea (Mark Mayse, Harry Shorey, personal communications). In the only relevant published study to date, Heidger and Nentwig (1989) used cover crops of rape, lupins, and clover in an unsuccessful effort to improve biological control of wheat pests by the spider *Dictyna arundinacea*.

Cover crops may require special attention if they are to serve as insectaries (Bugg and Ellis, 1990). Various management practices including mowing, chopping, plowing, and reduced-tillage can have implications for arthropods. Selection of the right cover crop species is important. A farmer could plant cover crops that harbor many beneficial insects, but relatively few insects likely to become pests on your crops. For example, subterranean clovers harbor many beneficial bigeyed bugs, *Geocoris* spp. (Bugg et al., in press), yet relatively few *Lygus* spp. (Hemiptera: Miridae). This is important because *Lygus* spp. can disperse from cover crops and damage economic crops (Bugg et al., 1990a,b).

Timing is another critical aspect of managing cover crops as insectaries. For example, when used as green manure, buckwheat is typically ploughed down alter seven to ten days of flowering. By contrast, minute pirate bug requires about 20 days to produce a new generation. Mowing or plowing while most bugs are in the non-dispersive nymphal stages would probably destroy most of them. On the other hand, hairy vetch takes longer to mature, and might produce more generations of minute pirate bug, but it typically must be chopped prior to being incorporated as green manure. This also would probably kill a large proportion of the associated minute pirate bug and lady beetles. In such cases, the timing of mowing or tillage may be adjusted to allow maturation or dispersal of beneficial insects. Remnant strips of cover crops could provide habitat to beneficial insects, and arrest movement by dispersive pests, such as *Lygus* spp. Use of sickle-bar mowers appears a gentler alternative to flail mowing, but is not always feasible. Setting flail or rotary mowers at greater heights might permit better survival of beneficial insects (John Freeman, personal communication).

No-tillage approaches may conserve beneficial insects better than does conventional tillage. Many predatory wasps are ground nesting, and tillage would probably interfere with ongoing reproduction. On the other hand, digger wasps often nest in disturbed areas, and superficial tillage could make available new potential nesting sites.

Weeds And Other Wild Plants

Wild plants within or outside croplands can be important reservoirs for pest or beneficial insects (see review by Andow, 1988). In Northern California, two weed species have been suggested as major nectar sources for beneficial entomophagous insects: common knotweed (*Polygonum aviculare* L., Polygonaceae) (Bugg et al., 1987) and toothpick ammi (*Ammi visnaga* (L.) Lamarck, Apiaceae) (Bugg and Wilson, 1989). Both weeds commonly occur on agricultural field margins. The domesticated relative of yet another flowering fieldside weed common in California, sweet fennel (*Foenculum vulgare* Miller, Apiaceae), has been shown to attract 48 species of parasitic ichneumonid wasps (Hymenoptera: Ichneumonidae), four species of Sphecidae (solitary wasps) and four of Vespidae (social wasps) when grown in Massachusetts (Maingay et al., in press).

Grass fields, which can be a consequence of crop rotation, and strips of vegetation, which could be the result of polyculture, have been demonstrated to be important reservoirs of entomophagous insects (Gravesen and Toft, 1987; Klinger, 1987; Nentwig, 1989).

Minute pirate bug can build up on flowering weeds, such as common knotweed (Bugg et al., 1987), or toothpick ammi, which may lead to increased numbers and predation rates on pests of adjoining vegetable crops (Bugg and Wilson, 1989). On the other hand, vegetation on uncultivated land may actually divert its close relative the insidious flower bug, from adjoining soybean (Kemp and Barrett, 1989).

Conclusion

Cultural practices influence biological control, but there are almost no practical schemes that can be recommended to farmers with any assuredness that they will work. The use of cover crops, at least in orchard and vineyard systems, is often intended to improve biological control of insect pests. Some relationships between cover crops and beneficial insect activity have been documented for some cropping systems. In most instances, however, the state of the art is characterized by interpolation, extrapolation, and speculation.

The lack of practical research in this field is understandable given the many questions about experimental design and the difficulty of establishing the appropriate spatial scales for experiments. Landscape-scale experiments, perhaps with widely-separated farms as replicates, may be needed to show the effects of cultural practices on such mobile species as hoverflies, ichneumonid wasps, lacewings (Duelli, 1980a, b), and lady beetles (Ohnesorge, pers. comm.). On the other hand, epigeal predators such as carabid beetles and bigeyed bugs may prove tractable by smaller-scale experiments. Minute pirate bugs are probably intermediate in this respect: although dispersive, they can subsist on a relatively wide range of plant species and alternative prey.

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(DEC.162) *Contributed by Robert L. Bugg*

Economic risk and the 92-Year "Old Rotation": Implications for a 250- acre farm.

Novak, James L., Charles C. Mitchell Jr. and Jerry R. Crews.

Alabama Agricultural Experiment Station, circular 300. 1990

"Old Rotation" is a cotton-based rotation study begun in 18%. It is managed by the Alabama Agricultural Experiment Station. Data collected over the experiment's 92-year history have been aimed at evaluating the effect of alternative cotton-based rotation schemes on sustainable cotton yields. As part of this analysis, researchers have investigated the effect of winter legumes following cotton as a source of nitrogen (green manure) for subsequent crops. Evidence from the experiment indicates that diversification in crop rotations can be used to reduce the economic risk of a farm operation. The primary purpose of the research reported in this circular was to determine the rotation scheme that would both minimize risk and optimize expected returns for a 250-acre farm.

An economic model called Target-MOTAD was selected as the analytical tool because it treats both expected returns and risk as variables. Realistically speaking, the 'best' rotation scheme will vary from grower to grower, depending on their attitude towards risk and their expected return or income level at a particular point in time. Target-MOTAD handles this variability by specifying a *set* of optimal results for alternative target income and risk levels. In this case, yield and management data collected on the "Old Rotation" experiment between 1978 and 1988 were applied to Target-MOTAD to "develop a wide range of feasible and economically optimal rotation schemes for alternative target income and risk levels."

The first step was to determine the average annual net returns (during the previous ten-year period) for several cropping sequences used in "Old Rotation". These net returns are shown in the following table. Values in parentheses are annual rates of N-P-K per acre.

Rotations, 1978-1988	**Net returns**
1. Cont. cotton- winter legume (0-80-60)	55.09
2. Cont. cotton no legume (O-80-60)	-153.98
3. Cont. cotton no legume (120-80-60)	21.42
4. cotton (0-80-60)- legume- corn (0-80-60)	-0.51
5. cotton (120-80-60)- legume- corn (120-80-60)	9.89
6. cotton (0-80-60)- legume- corn (0-0-0)- small grain(60-0-0)- soybeans	120.31

Because rotations 2 and 4 resulted in average *negative* net returns, they were dropped from consideration; rotations 1, 3, 5, and 6 were the only ones included in the Target-MOTAD analysis. For each target income level used in the analysis (5, 10, 15, 20, 25, and $30,000), the highest net return resulted from planting the entire 250 acres to the three-year (R6) rotation. However, a higher net return is indicative of a higher level of risk. The Target-MOTAD analysis showed that risk can be reduced by substituting part of the R6 rotation with a continuous cotton-winter legume rotation (R1). How much of R1 to substitute for R6 would depend on the farmer's target income and the level of risk they wished to incur. For example, a producer who wanted to achieve an income of $25,000 at *minimum risk* should plant approximately 78 acres (32 percent) into rotation R1 and only 172 acres (69 percent) into the R6 rotation. Overall the proportion of R1 to include for the purposes of minimizing risk ranged from the 32 percent mentioned above ($25,000 target income) to 37.5 percent for a target income of $5,000.

For copies of this circular write to: Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama.

(DEC.158) *Contributed by Dave Chaney*

Herbicide use in citrus production and ground water contamination in Tulare County.

Pickett, C.H., L.S Hawkins, J.E.. Pehrson and N.V O'Connell

California Department of Food and Agriculture, Environ. Monitoring & Pest Management.
Report # PN 90-01. 1990

The majority of commercial citrus growers in the southern San Joaquin Valley apply pre-emergent herbicides to keep the orchard floor free of vegetation. The benefits of this particular strategy include economic weed control, increased frost protection, and reduced or no tillage. But detection of low levels of herbicides in many citrus growing areas may soon force a change in citrus floor management practices.

A 1987 CDFA report indicated that 49 percent of wells sampled in specific areas of eastern Tulare County had detectable levels of herbicide residues. Of the five herbicides detected, simazine, bromacil and diuron are widely used in citrus production. In 1988, CDFA conducted a mail survey of Tulare Co. citrus growers in order to "identity and characterize irrigation and herbicide practices that might be associated with well water contamination." A total of 820 (41.1 percent) usable questionnaires were returned. This publication is a summary and interpretation of the survey results.

One finding which may have an impact on groundwater contamination is that fall pre-emergent herbicide applications are more widely used (71.1 percent of growers) than spring applications (42.2 percent of growers). The greatest proportion of residues are therefore available for deep percolation in the fall and winter. A significant correlation was found between the proportion of contaminated wells and the number of growers using irrigation as a means of frost protection (see Figure). This was true for growers who use irrigation alone, as well as for those using irrigation in combination with wind machines. No such correlation existed for the number of growers using wind machines alone.

The relationship between the number of growers using a particular irrigation method for crop water needs (furrow, low volume, or dragline) and the proportion of contaminated wells was inconclusive, although there appeared to be a general trend toward increasing contamination with growers who used furrow and low volume irrigation. The authors reasoned that summer irrigation events probably do not pose the greatest risk of off-site movement of herbicides, since a larger percentage of growers apply herbicides in the fall. Cool fall and winter temperatures result in slow breakdown of residues, so winter irrigations for frost control "may represent the most likely scenario for promoting off-site movement of herbicide residues."

Direct pathways such as dry wells are also believed to play a role in herbicide movement to groundwater. However, only 6.6 percent of the respondents reported dry wells in their citrus orchards, 12A percent reported dry wells associated with their septic tanks, and 4.6 percent reported dry wells on adjacent property. These figures are unexpectedly low and may not reflect the number of dry wells in the area. They may also "demonstrate the sensitivity of some issues to growers, especially those concerning ground water contamination."

In response to the question about non-chemical weed control practices, 78 percent of respondents did not answer, 13 percent practiced tillage, 5 percent used ground cover, and 4 percent mowed. It was assumed that the great majority of growers use herbicides as the only method of weed control. The authors discussed the benefits and disadvantages of using cover crops and raised the possibility that environmental consequences of conventional weed management practices may encourage growers to reconsider using ground covers.

For copies of this report write to: Calif. Department of Food & Agriculture, Environmental Monitoring & Pest Management Branch, 1220 N Street, Sacramento, CA 95814.

(CAI.029) *Contributed by Chuck Ingels*

Designing a sustainable regional diet.

Herrin, Marcia and Joan Dye Gussow

J. Nutrition Education 21(6):270-275. 1989

This paper examines the feasibility of encouraging the adoption of a more localized, seasonal diet by analyzing a regional diet for the state of Montana. The authors' purpose is to describe a method that might be applied to other states or regions which might wish to design a regional food guide for their area. The assumption that agricultural relocalization would limit food choices unacceptably is also examined.

Using historical and current data, the authors identified the types of foods that had been and are currently produced and processed in Montana. National food consumption, local food marketing data and import data provided information to estimate the extent of the state's present and prior self-reliance in food. In 1941, about 32 percent of Montana's food supply was imported from outside the state and by 1980, the imported food supply had grown to 55 percent. Further increases in imported food were estimated to 66 percent for 1985.

Next, a seasonal list of potentially available local produce items was created to provide information to nutritionists and others interested in directing consumers to more local foods. The number of local foods available year-round or even seasonally, has declined markedly from 1941 to 1980. Foods once locally grown are no longer produced in commercial quantities; yet, increased consumer demand for local foods in season would open up new markets for area farmers.

The nutritional adequacy of a diet based on Montana-produced foods was tested by creating eight menus, two for each season, based on the U.S. government's Dietary Goals. Nutrient analysis of the menus indicated that they were nutritionally adequate. The winter menus, which included local potatoes, cabbage, and sprouted seeds, averaged 216 percent of the U.S. RDA for vitamin C without using citrus fruit.

The authors maintain that a better understanding of local food production would help nutritionists in advising consumers of more resource-conserving food choices. In Montana (and many states dependent on food imports) encouraging consumers to buy locally grown foods is the first step in fostering concern about sustainable food production.

In California, where much of the food consumed is grown instate, there will be different steps to reduce the energy and environmental stresses in our food system. These could include a greater emphasis on farmers markets or encouraging consumers to purchase low-pesticide products (Marcia Herrin, personal communication). The authors end by noting Cooperative Extension's 1988 National Initiatives which challenges nutrition educators to help consumers "understand the food system, the health/environmental aspects of food production and processing, and the need to sustain a productive natural resource base."

For copies of this article write to: Department of Home Economics, University of Montana, Missoula, Montana 59812

(GWF.002) *Contributed by Gail Feenstra*

Agricultural science and sustainable agriculture: A review of the existing scientific barriers to sustainable food production and potential solutions.

MacRae, Rod I., Stuart B. Hill, John Henning, and Guy R. Mehuys.

Biol. Agric. & Hort. 6(3):173-219 1989

This paper is the result of an interdisciplinary effort from researchers at Macdonald College of McGill University in Canada. Some of the discussion is specific to Canadian research, but many of the concepts may be applicable in the U.S. as well. The authors present a controversial view of the major obstacles to implementing sustainable agriculture.

The sustainable agriculture "paradigm" involves an ecological approach, taking into account the whole system and the relationships that exist within the system. It is argued that many features of reductionism -dividing scientific problems into discrete, manageable pieces - make it unsuccessful at integrating the pieces because of the failure to fully recognize the inter-relationships. In general, sustainable agriculture research has been neglected because it does not lend itself to a conventional reductionist approach to experimentation.

The authors propose several strategies for change. A general approach is to incorporate into the dominant goals of productivity and efficiency, objectives which reflect agriculture as a social process. Long-term goals for a sustainable food system are proposed under the broad categories of consumption, security, and equity.

The authors outline three actions aimed at universities and researchers to implement these goals and objectives: 1) Supports, which "create a positive environment in which creative ideas can flourish"; 2) rewards, which are short-term "incentives designed to reduce risk during a transition period"; and, 3) penalties, in which public finds are withheld from a university if an increasing proportion of its research budget is not dedicated over time to specific goals relating to sustainability.

The authors also express the need to overhaul scientist evaluation criteria by de-emphasizing single author publications in disciplinary journals. Greater emphasis may be placed on evaluating the methodologies that scientists use, rather than the results they obtain. Finally, new approaches are suggested which place more emphasis on synthesis of information. Data collection approaches to help achieve this synthesis include descriptive, evaluative, applied, diagnostic, and explanatory/predictive studies.

For copies of this article write to: Department of Renewable Resources, Macdonald College of McGill University, Ste-Anne de Bellevue, QC Canada H9X 1CO.

(CAI.027) *Contributed by Chuck Ingels*

Summer 1990(v1n3)

California's Resource Conservation Districts.

Somerville, Jack

Presentation at Meeting of California Rural Development Committee, UC Davis, June 28, 1990.
1990

At a recent meeting of the California Rural Development Committee, Glenn County cattle rancher and President of the California Association of Resource Conservation Districts (CARCD) Jack Somerville described the role and outlook of the Resource Conservation Districts (RCDs). Established in the 1930's in response to the soil erosion and economic deterioration of the Dust Bowl, the RCDs have concentrated primarily on issues of soil erosion and water quality. More recently, they are recognizing the need to work with urban and environmental groups in addition to the more traditional rural and agricultural interests. Major technical support is provided by the Soil Conservation Service. The California Association of RCDs is currently asking Congress for a $15 million increase for the SCS in California to bring its staffing up to the minimum needed to address current needs.

Leadership development is a major focus of the RCDs today. There are currently 117 districts in the state, but some are inactive. Somerville projects that within the next five years there will be about 70 viable and active districts in California. Based on topography and special circumstances, a Resource Conservation District (as with the Susuin Marsh and Fall River area) may encompass more than on county. And in the case of particularly large counties, more than one district may be justified.

Each RCD is managed by five volunteer directors. The directors have only limited authority to plan and implement conservation activities so effective leadership and cooperation is particularly important. The Glenn County RCD, for example, has recently signed memoranda of understanding with a number of public and private agencies and utilities to take a coordinated approach to soil conservation and other environmental issues in their region.

The use of rural areas for recreation (other than hunting) is one way that the RCDs are becoming involved in economic development as well as more traditional resource conservation issues. Glenn County has been working with California State University at Chico on two surveys to identity these opportunities. One survey asked of Glenn County landowners: Would you be willing to allow people on your land for recreation, and if so, for what? A complementary survey asked of Bay Area and Sacramento residents: Would you be interested in rural recreation, and if so, what, and how much would you pay? The information from both surveys will be used to match the two groups.

The people and groups involved in rural resource conservation and economic development need to do a better job of addressing the problems of small- town merchants, said Somerville. Where rapid development takes place, larger chains often move in to supply such services as groceries, fast food, and gas. One aim of the Glenn County recreation program is to have people stay overnight, eat in local restaurants and buy film and other supplies at local shops. The value of local businesses for community leadership needs to be recognized, he added.

When asked about the role of UC Cooperative Extension (UCCE) in working with the RCDs, Somerville observed that the two organizations have often followed divergent paths in the past, but praised the Glenn County UCCE office for its cooperation. Ken Trott of the California Department of Conservation noted that his agency is working with UC Division of Agriculture and Natural Resources Vice President Ken Farrell to improve coordination between Extension and RCDs.

(JSA.102) *Contributed by Jill Auburn*

Summer 1990(v1n3)

Agricultural workers in central California in 1989.

Alvarado, Andrew J., Gary L. Riley, and Herbert 0.Mason.

Report submitted to Employment Development Department, State of California. 1990

In the summer of 1989, a study was conducted for the California Employment Development Department for the purpose of describing the work, workers and working conditions of a representative sample of agricultural laborers in the San Joaquin Valley. In addition, the study explores the data related to the future outlook of employment in California agriculture.

Investigators collected complete data from 347 employees with the cooperation of employers in Fresno, Kern, Madera and Tulare Counties. These interviews represented employers in all major labor-intensive crops in this area, as well as farm labor contractors. Employers were randomly selected from those that made Unemployment Insurance contributions during the tax year 1987 in California.

The five major categories described in the interview data include: an agricultural worker profile, work and working conditions, wages and other compensation, personal economics, and future employment outlook. "Long days, short annual employment periods, minimal pay by conventional standards, few benefits, and out-of-pocket job-related expenses seem to characterize the 'seasonal farm laborer' as defined by the data in this study." A few pertinent points in each category will be mentioned here.

Agricultural Worker Profile: Based on responses from the survey, investigators developed the following profile of agriculture workers:

- About 70 percent of workers are men.
- The mean average age of workers is about 35 years; half are 32 years or younger.
- Eighty-seven percent of workers were born in Mexico.
- On average, farm-workers have about six years of schooling.
- Thirty-three percent of workers are permanent or naturalized U.S. citizens; 59 percent are legal immigrants; seven percent are undocumented.
- Eighty percent of workers have fathers who are or were farm laborers.
- Sixty percent of workers are married and over 40 percent of those have spouses who are also employed as farm-workers; 20 percent of those with children said that at least one child is currently employed in farm

labor.

- One third are also employed in non-agricultural jobs during the year, mainly in cities outside of central California.
- Fifty percent of farm-workers are in excellent or good health, 20 percent are in fair or poor health. One out of five workers reported they had on-the-job injuries during the last five years requiring medical attention; hospitalization was required in 20 percent of these cases.

Work and Working Conditions: The average farm worker worked in at least two different crops during the 1989 summer season. The average length of employment for 1989 was 155 days (20 - 22 weeks). Vegetable, melon and tree fruit workers worked more days (about 205 days), while raisin workers reported the least working days (59). Those working for labor contractors reported the lowest 1988 period of full-time employment (3.24 months). Over half of the workers worked for the same employer the year before; particularly citrus workers. Raisin workers had only a 10.5 percent rate of return. As far as working conditions were concerned, ninety-five percent reported drinking water was available at the work site; 80 percent said toilet facilities were available and 76 percent reported wash water was available.

Wages and Other Compensation: Hourly compensation varied from crop to crop and averaged between $4.50 (tree fruits) to $5.10 (grapes). Those working through labor contractors consistently received less than those employed directly by farmers. Thirty percent reported receiving no fringe benefits and 59 percent received no health insurance. During periods of unemployment, families provide much of the financial support in the form of savings (39 percent of all respondents said they relied on family savings for financial support; 62 percent of those employed by farm labor contractors relied on family savings). Fifty percent also obtain financial help from unemployment insurance.

Personal Economics: Forty-nine percent of those interviewed reported that they must buy their own tools; particularly raisin and grape workers. Most workers (78 percent) have to rely on others for their daily rides to and from work. Almost all (85 percent) rent their residences at an average cost of $208/month; nine percent live in farm labor camps and almost five percent live in their cars or outside. Over half of workers (56 percent) identified their greatest need as employment; 38 percent listed food and 37 percent listed legalization. According to investigators, the employment need reflects the low level of income prevalent in this population, resulting in other needs for food, housing and transportation.

Future Employment Outlook: Only eight percent of those interviewed said this was their first time coming to the U.S. for work. This could lead to a reduction in the farm labor pool if legal residents do not provide a sufficient farm labor base in the future. Results from this survey suggest little change in the labor pool as most workers (88 percent) said that they wanted to continue doing farm work as their occupation. Sixtythree percent said that they probably would be doing farm work in three years. These responses however, probably "reflect a sense of reality among farm-workers in terms of skills and contacts as opposed to occupational preferences."

This is one of the few studies available which asks farm-workers to describe their own concerns. A sizeable number of respondents (33 percent and 23 percent, respectively) identified pesticides and low wages as their primary concerns. Work hazards and abusive labor contractors were mentioned by less than ten percent. The investigators did not elaborate on these concerns, but resolving them and creating a more favorable work environment for farm-workers may be some of the most important challenges facing agriculture in the next decade.

For copies of this report write to: Employment Development Department, Labor Market Information iv., Attn: Special Projects Unit, 7000 Franklin Blvd., Suite 1100, Sacramento, CA 95823.

(gwf.003) *Contributed by Gail Feenstra*

Summer 1990(v1n3)

California's Central Valley: Confluence of change.

Nuckton, Carole Frank

Summary of presentations at **California's Great Central Valley: Confluence of Change**. UC Agricultural Issues Center symposia held May 3, 1990 in Sacramento and June 5, 1990 in Fresno, California 1990

The UC Agricultural Issues Center's major project for 1988-1990 was *California's Great Central Valley: Confluence of Change*. The study involved more than 70 university people on several UC campuses, together with many other experts outside the university. Several study groups were formed to consider the Central Valley's opportunities and problems. The project led up to two symposia held this spring in Sacramento (May 3) and Fresno (June S). The following is a summary of key points made at the symposia.

People are saying that the Central Valley today may be in the same position as the Los Angeles Basin or the Santa Clara Valley were a generation ago. Study groups agreed that the Central Valley is facing the same kinds of pressures, urbanization and competition for resources as the LA. Basin and the Santa Clara Valley even though it covers a much larger area. Now, we have an opportunity to learn from the experiences of these other regions in the state. The Central Valley is an irreplaceable resource. If we understand what is happening to it, we have a chance to guide its future, both as a place to live and as one of the world's great agricultural areas.

People Pressures. California's Central Valley population growth rate is now keeping pace with (and in some areas growing faster than) the rest of the state. There are three basic population groups--a traditional base of whites and Hispanics; new immigrants from other parts of the United States, Mexico, Central America, South East Asia, and elsewhere; and commuters to jobs in coastal areas. The ethnic populations as a group already constitute a majority in several Valley counties.

The current development pattern is the formation of a long continuous urbanizing strip through the Valley. There are, however, other options which should be considered. The Central Valley is a laboratory where over the next 20 years, California's new city form will emerge. Without planning, Valley cities will compete with each other and with agriculture for resources and growth, probably resulting in a fragmented, sprawling, dysfunctional urban form. Alternatively, with careful planning, complementary growth is possible--the coexistence of agriculture with urban and environmental uses of the Valley's resources.

Transportation. The state needs a major restructuring of institutions to facilitate regional and statewide transportation planning. This would include broadening the mission of state transportation agencies to respond to the need for multimodal and interjurisdictional solutions. We need leadership and a sense of vision to move away from conventional modes of transportation, especially the dependence on the private automobile, and toward innovative and efficient mass transit operations.

Resources at Risk. As the Valley's population grows, the resource base is coming under intense pressure. Agriculture may be the loser in competition' with urban areas for a limited water supply. Air pollution is already decreasing some crop yields in the San Joaquin Valley. This study group found that if state air quality standards were met by 2010, both producers and consumers of these crops would gain significantly. Cropping patterns will differ considerably depending on whether or not ozone air pollution is reduced. Because the formation and transport of ozone and other pollutants cross local jurisdictions, it seems axiomatic that air pollution effects on crops must be addressed on a regional basis.

Contentious land use issues relate to both the physical extent to which land is available for a particular use and its relative superiority or inferiority among uses. The midregion of the Valley (from Yolo through Stanislaus counties) has the highest peracre values of farm production and relatively low-cost reliable water supplies for agriculture, but is also where there is greatest development pressure. Already, some 10 percent of the land is urbanized there. Forces contracting the agricultural land base or reducing its productivity include conversions to urban and rural/urban uses, salinization, access to water, air pollution, erosion, and soil compaction.

Although there are official measures classifying 'primeness' of farmland that are of some help (in a global sense) in verifying if soils in one locale are relatively superior to those somewhere else, they are not sufficiently useful in local situations where the question is not whether conversions will occur, but rather where development should be located in order to conserve superior agricultural lands. Decision beg for more specific clarity about local land quality.

Government Gridlock. Growth and change in the Central Valley present new challenges to governmental institutions. The ability of local governments to deal with the problems they face is hampered by a mismatch of responsibility and resources. The state needs to reorganize local revenue rules so that the local governments (especially counties) regain some of their pre-Proposition 13 revenue discretion.

Many of the problems faced by Central Valley communities do not lend themselves to local solutions. This is because the problem's source frequently originates beyond the jurisdiction of local governments. While there needs to be more regional cooperation among local governments, comprehensive regional government is not recommended. Rather, stronger state leadership is needed in setting standards and priorities for growth management in the Central Valley. Local control, especially on such critical matter as land use, should be maintained as much as possible.

Finally, we must stress the urgency of tackling the growth issues in the Central Valley. This urgency goes beyond the borders of the 18-county region to take in the interests and welfare of all of California. When citrus, dairying, and other farm activities were forced out of Southern California and the Santa Clara Valley by urbanization-they relocated in the San Joaquin Valley. When further urbanization pushes them out of the San Joaquin Valley-where will they go? For the state's agriculture and for urban development, the Valley is the last frontier. Once that frontier is closed, there is precious little room left. Is this the legacy we wish to leave to future generations of Californians?

For more information write to: UC Agricultural Issues Center, University of California, Davis, Ca 95616

(DEC.160)*Contributed by Carole F. Nuckton, UC Agricultural Issues Center*
