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In This Issue:

Components Articles: Any Suggestions?

If you take a moment to review the contents of the first four issues of Components, you will see that the 48 articles cover a wide range of topics relevant to sustainable agriculture in California. This scope of technical information for researchers, advisors, and other agricultural consultants. To maintain this diversity and integrity of information published, we need your help.

First, please let us know if you have any ideas or suggestions for articles to include in Components. To adequately cover the base of technical information on sustainable agriculture requires the expertise of many individuals, and a network of various information sources. Your input and suggestions will help to extend and enhance that base of information.

Second, we want your feedback on the newsletter. We would also like to hear from you if you have any special comments or criticisms of particular articles. Send you comments to Dave Chaney, Components editor, UC Sustainable Agriculture Research and Education Program, University of California, Davis, CA 95616.

-*Bill Liebhardt*, Program Director

New forestry.

Harris, Richard

North Coast Forest Echoes, UC Cooperative Extension, Humboldt County 2(6):1-3. 1990

Editor's note: This article written by UC Forest Advisor Richard Harris introduces North Coast foresters to the concept of "new forestry" and highlights some of the environmental concerns and management issues facing land owners and the timber industry in the Pacific Northwest (reprinted with author's permission.)

"The term 'new forestry' was probably coined by Dr. Jerry Franklin, Chief Ecologist for the Forest Service and professor of ecosystem science at University of Washington. Dr. Franklin and his research associates at Oregon State University, Forest Service Experiment Station in Corvallis and Washington have authored hundreds of papers concerning the ecology of Pacific Northwest Douglas-fir/western hemlock/sitka spruce forests. The concepts of new forestry spring both from that ecological knowledge as well as from what Franklin refers to as a 'kinder and gentler' approach to management.

"Dr. Franklin recently delivered two lectures on new forestry to large audiences at Humboldt State University. For those of you who missed the talks, I have videotapes and will arrange showings if you contact me. In the meantime, I would like to review some of the basic principles raised in his talks. 'Landscapes to be managed for a long-term ecosystem function, wildlife habitat and timber should be carefully designed to fulfill all those roles rather than allowed to evolve as by-products of traditional approaches to road systems and timber sale layout' (COPE Report 3:1, p.8). This statement summarizes one basic tenet of new forestry: Management actions must be viewed in the context of the landscape. Corollary to that is the ethical responsibility to avoid unplanned negative impacts to resource values. From this perspective, for example, the spotted owl 'problem' or the decline in northcoast fisheries are cumulative results of individual activities undertaken without the benefit of a whole-system understanding. A practical application of the principle which is advocated by Franklin is 'minimum fragmentation' timber harvest patterns. This approach entails aggregation of timber harvest areas into larger units while retaining large blocks of habitat and corridors between them. The approach has been used on one Oregon National Forest and is described in the winter, 1990 COPE Report (3:1) and in Franklin and Forman's paper in Landscape Ecology 1:1. Watch for the approach soon in California! The recently-released report on a conservation strategy for the northern spotted owl advocates establishment of 'habitat conservation areas' encompassing groups of owl pairs, rather than 'spotted owl habitat areas' for each pair. These will be large with a primary objective of preventing habitat fragmentation. Franklin's concept fits neatly with the emerging strategy for spotted owl protection.

"Minimum fragmentation is a radical departure from the dispersed harvest unit approach currently used on federal lands and mandated by the California Forest Practice Regulations on private lands. There have been no field studies comparing it to conventional harvesting. Theoretically, the approach would benefit wildlife requiring large unbroken habitat patches. Concern has been expressed about potential effects on aesthetics and watershed values. Obviously, the concern would only pertain to potentially enlarged harvest areas and not to the larger patches of preserved habitat.

"In addition to the landscape-scale concepts of new forestry, Franklin also discussed new approaches to silvicultural prescriptions within harvest areas. He advocates modification of standard clear-cutting prescriptions in ways that structural elements of natural forests can be preserved. Of particular concern is standing and downed large wood but he considers it important to leave green trees and hardwood in harvest areas too for wildlife values. In effect, a new forestry prescription for a clear-cut would probably change its appearance to more closely resemble what is called a shelterwood today. There should, however, be no removal of the overstory after the new generation of trees is established. This type of prescription would probably preclude broadcast burning on many sites.

"Even before the invention of new forestry there were many areas on public and private lands throughout the northwest where similar prescriptions were developed and used to protect other resources in timber harvest areas. Franklin is 'codifying' a set of practices and promoting their broader application. Some researchers, such as Dale Thornburgh at Humboldt State University and Bob Heald at UC's Blodget Forest are developing experimental prescriptions and monitoring their results. As we move into an era of changing priorities in forest management we will need real information on what practices work and where. In that vein, the aforementioned spotted owl task force report, in referring to studies of spotted owls conducted in private forests of California, states that 'Silvicultural prescriptions might be developed that would yield significant volumes of wood products while maintaining suitable habitat for spotted owls, but we find no clear evidence that such prescriptions currently exist. . . . Nonetheless, examining younger forests where spotted owls reproduce successfully should yield valuable insights into silvicultural techniques that could produce both wood products and owls.' The implication is that by studying managed forests where owl habitat was unintentionally protected we may be able to develop intentional prescriptions.

"Two further items from Franklin's talk might be mentioned. One questioner asked what the impact of new forestry practices would be on timber harvest levels of National Forests. Franklin's response was interesting. He said that the annual allowable sale quantity should be reduced by 40 percent immediately. This would allow foresters the flexibility to develop new prescriptions. After a certain period, if it is proved that prescriptions can be developed that allow a greater level of harvest while still protecting other resources the allowable cut could be increased.

"Along similar lines, I brought up the observation that social trust in foresters on the West Coast seems to be at an all-time low. On the one hand, initiatives, rulemaking, and legislation are acting to prescribe forestry activities and on the other hand, Franklin is advocating flexibility and experimentation with prescriptions. In response, Franklin agreed with the observation and expressed the idea that foresters need to do a better job at public communication. He also seemed to be wary of social prescriptions that are not well-founded technically and scientifically."

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(DEC.189)
Contributed by Richard Harris
UC Coop. Ext., Humboldt County

Fall 1990(v1n4)

Considering the water relations of cover crops in vineyard and orchard managed systems.

Munk, Dan

Presentation at **Cover Crops Training Session**, Kearney Agricultural Center, Parlier, California. August 15, 1990. Sponsored by the UC Sustainable Agriculture Research & Education Program. 1990.

In California, conventional cultural practices in orchard- and vineyard-floor management include the use of herbicides and tillage to maintain a weed-free surface. This approach is thought to discourage pests from establishing near the cash crops, to reduce the threat of frost, and to improve crop nutrition. However, clean cultivation and herbiciding can lead to deterioration of soil structure, increased soil crusting, and decreased water infiltration. The latter can lead to greater use of irrigation water, which is of increasing concern in this drought-conscious state.

Use of cover crops has long been known to alleviate soil crusting and to promote better soil structure by increasing the incidence of water-stable aggregates. On the east side of California's Central Valley, soils with low organic matter are particularly prone to crusting and impeded water infiltration, with steady-state water-intake rates of as little 0.1 inches per hour.

Blando brome (*Bromus mollis*) is a self-reseeding winter-annual grass with an extensive but superficial root system (in the 0-6 inch stratum). In 1989, studies in vineyards of 'Thompson Seedless' grapes showed that water depletion was greater in plots with no cover crop than in plots that were broadcast-seeded with Blando brome at six pounds per acre. Thus, bare ground actually lost more water than did ground that sustained a cover crop. Moreover, cover cropping increased water intake by 300 percent or more over that observed in control plots.

Cover crops can dramatically increase water infiltration rates with minimal cost to the grower. It is important to not that not all cover crops require as little water as does Blando brome.

(DEC.201) *Contributed by Robert Bugg*

Unkrautbekampfung mit organischen Bodenbedeckungen in Apfelanlagen: Auswirkungen auf Ertrag, Fruchtqualitat und Dynamik des Stickstoffs in der Bodenlosung. (Weed control with organic mulches in apple orchards: Effects on yield, fruit quality, and dynamics of nitrogen in soil solution.)

Niggli U., F.P. Weibel and C.A. Potter

Gartenbauwissenschaft 54(5):224.232. 1989

Orchards, especially young ones, benefit from keeping the tree row free of weeds. This has been documented in many research projects and has become the accepted practice for most orchardists in the U.S. Most growers keep their tree rows weed-free by using herbicides. A small number of studies indicate that mulches offer growers an alternative to pre-emergence herbicides. These experiments showed that mulches can help to control weeds in the row and may also improve soil structure. This paper presents results from an eight-year study in which six different organic mulches were compared for their ability to control weeds and for their effects on yield, fruit quality, nutrient supply for the trees, and other factors.

Three apple varieties, 'Gloster', 'Boskoop', and 'Golden Delicious' were tested in two different locations in a randomized complete block design with either three or four replications. The treatments, initiated in 1981, were:

1. compost from garbage (discontinued due to weed seeds and other problems)
2. bark compost (renewed in 1986)
3. fruit pulp (composted pulp reapplied in 1986)
4. rapeseed straw (reapplied 1983, 1985, 1986, 1988)
5a. oak bark and 5b. conifer bark (both barks reapplied in 1986)
6. spring applications of Simazine.

The bark and compost materials were applied 10-12 cm thick, requiring about 340 cu. meters/hectare of orchard. The mowed grass in the drives was used for mulch under all trees. Nitrogen fertilization was done on all plots in May of each year. All treatments required one or two annual post-emergence herbicide applications.

Weed Control. Both of the uncomposted bark treatments controlled weeds more effectively than the herbicide treatment during the course of the experiment. The single application of bark in 1981 provided excellent weed control for four years; it was reapplied in 1986. The effectiveness of the bark was attributed to both the physical impediment to weed seed germination and to the herbicidal properties of substances derived from the bark. Rapeseed straw also controlled weeds, but only for one year. Applications of the straw were made every two years. The other mulch materials, which were partially composted or easily decomposed were rich in nutrients but did not provide effective weed control.

Yield. 'Boskoop' yields in all but two treatments were similar and showed a strong tendency toward alternate bearing. Rapeseed straw and oak bark treatment yields were significantly higher and tended to equalize yields during the alternate years. Yields for the other two varieties tested were not significantly different except in 1986, when the harvest was least in the plot with herbicide.

Soil Nitrogen. Soil nitrate levels at the 10-40 cm depth under fresh oak bark were consistently low during 1986-87, while they were much higher and increased with time in each year in the rapeseed straw and herbicide treatments. However, leaf and fruit analyses showed very few differences between treatments and all were within optimal levels. Previous studies have shown that the upper soil under a bark mulch contains more water and higher percentage of fine roots than that of exposed soil, which results in increased efficiency of nitrogen uptake in the root zone. Nitrate was also sampled at the 10, 30, and 70 cm depths. In the herbicide plots nitrate increased sharply after June 1987, but remained low at all levels in the oak bark treatment. These differences were less during 1988. In all cases, the soil profile down to 70 cm was depleted of nitrate due to winter and spring rains until April.

Organic Matter. The humus content of the soil increased more rapidly and to a greater extent when pre-composted materials were used compared to fresh bark. Rapeseed straw had the least effect on humus content. The availability and supply of potassium was increased by the addition of any organic matter, but more so by rapeseed straw and fruit pulp. Soil water content was measured weekly at the 10, 35, and 70 cm depths. The soil under oak bark mulch was consistently more moist than the herbicide treated soil as a result of reduced evaporation from the surface soil. Little difference was noted at the greater depths.

Fruit Quality. Fruit taste tests were conducted in three years of the experiment. There were differences in taste between the treatments although panelists indicated the differences were small. In general, the taste of fruit grown with bark mulch (oak, conifer, or bark compost) was positively affected. Firmness as well as sugar and acid contents of fruit flesh were also tested and all values were found to be within an optimal range. The authors concluded, as others have, that "fruit quality without losses in yield can be improved by a low supply of N which in times of need is sufficient." This would also reduce the risk of contaminating groundwater through nitrate leaching.

An economic analysis was not conducted for this experiment. The costs and benefits of the various mulch treatments would have to be compared before deciding which is the most profitable in the long-run.

For copies of this article write to: Eidgenossische Forschungsanstalt fur Obst-, Wein- und Gartenbau, Wadenswil, Switzerland.

(CI.APP.OO1) *Contributed by Chuck Ingels*

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Fall 1990(v1n4)

Alternative methods for controlling codling moth: The use of granulosis virus

Falcon, L.

Presentation at **Organic Farm Field Day & Transition Conference**, Linden, CA. August 22, 1990. Sponsored by the Committee for Sustainable Agriculture. 1990

Background. The codling moth (*Cydia pomonella* L.) is the principal insect pest of apples, pears, and early blooming walnuts in California. A number of synthetic pesticides effectively control this pest, but there are several problems which may limit their use in the future. First, the insecticides used for codling moth kill natural enemies that suppress secondary pests (such as aphids and mites), requiring more pesticide applications. Second, recent observations indicate that codling moth is developing resistance to Guthion, a primary insecticide for its control for about 30 years (S. Welter, personal communication). Finally, the current regulatory environment and the increasing public demand for unsprayed fruit is drawing attention to alternatives to chemical control.

One alternative for control of codling moth is *Bacillus thuringiensis* (BT) and oil. BT is a biological insecticide often used by organic apple growers with limited success. Researchers are also evaluating pheromone mating disruption. This technique, believed by many to have the greatest potential for nonchemical control of codling moth, has shown promise in apples and pears, but not yet in walnuts. A third alternative, codling moth granulosis virus (CMGV), was the subject of this presentation. This biological control method is currently in the registration phase.

CMGV Mode of Action. According to Falcon, the granulosis virus is ingested by the larva while feeding on the fruit and moves with the food to the gut. The fluids of the gut, having a relatively high pH, dissolve the outer envelopes of the DNA, releasing the DNA into the gut wall. The virus converts the gut wall cells to viral DNA, which migrates and attacks other cells. The larva dies in about 36 hours, but it becomes sick and stops feeding well before this time. This virus can only infect codling moth larvae and those of a few closely related species, so it poses no hazard to humans or other nontarget organisms.

Factors Influencing Effectiveness. The residual activity of the CMGV is far less than that of synthetic insecticides such as Guthion. The reasons for this are the same ones that may reduce its effectiveness in the orchard:

1. Sunlight is the most effective means by which to destroy microbiological agents; thus, altered canopy management may be necessary to sufficiently shade the fruit without killing the fruiting wood.

2. One of the most critical factors in maintaining the effectiveness of the CMGV is the pH. As with BT, it is important to continually monitor the pH of the spray solution and keep it at no more than 7.5 and preferably at 7.0.

3. Proper timing and complete coverage by the sprays are also essential in obtaining control. Falcon is currently investigating encapsulation of the virus to increase the effectiveness and residual activity of the CMGV sprays.

Comparative Costs. Although the CMGV is not as effective as Guthion (the virus can achieve about 97% control under the best conditions), the cost of control may be similar between the two insecticides. Up to 12 sprays may be required when using only CMGV, while growers using Guthion may spray only about four times. However, because Guthion often kills beneficial insects, additional pesticide sprays are required to control infestations of secondary pests adding to overall pest control costs. Furthermore, the market value for organic apples and pears is often significantly higher than conventional fruit, resulting in potentially greater net returns when using organically acceptable control methods.

Falcon outlined some of the positive characteristics of the CMGV. It is host-specific, it is non-polluting, it is cost-effective, it is not hazardous to use, it will not induce resistance, and it is amenable to genetic engineering. The virus is currently in the testing phase and is expected to be registered in the near future.

For a video of this presentation, contact: Committee for Sustainable Agriculture, P.O. Box 1300, Colfax, CA 95713.

(CI.-PEST.025) *Contributed by Chuck Ingels*

Fall 1990(v1n4)

Earthworm ecology and sustaining agriculture.

Werner, Matthew R.

Article written for Components. 1990

Earthworms can play a variety of important roles in agroecosystems. Their feeding and burrowing activities incorporate organic residues and amendments into the soil, enhancing decomposition, humus formation, nutrient cycling, and soil structural development (Mackay and Kladivko, 1985; Kladivko et al., 1986). Earthworm burrows persist as macropores which provide low resistance channels for root growth, water infiltration, and gas exchange (Kladivko and Timmenga, 1990; Zachmann and Linden, 1989). Quality, quantity and placement of organic matter is a main determinant of earthworm abundance and activity in agricultural soils (Edwards, 1983; Lofs-Holmin 1983), as are disturbances of the soil by tillage, cultivation, and the use of pesticides (Doran and Werner, 1990).

This article will review recent information on earthworms as it relates to the sustainability of agriculture. For further information, see Lee (1985) or Satchell (1983).

Earthworm Ecology

Earthworm species can be classed in one of three morpho-ecological groupings (Bouche, 1977 [summary in Lee, 1985]). Epigeic species live in organic horizons and ingest large amounts of undecomposed litter. These species produce ephemeral burrows into the mineral soil for diapause periods only. They are relatively exposed to climatic fluctuations and predator pressures, and tend to be small with rapid generation times. A common example is *Eisenia foetida* (redworm, manure worm) which is used in vermicomposting.

Endogeic species forage below the surface, ingest large quantities of soil with a preference towards organic rich soil, and build continuously ramifying burrows that are mostly horizontal. These species are apparently not of major importance in litter incorporation and decomposition since they feed on sub-surface material. They are important in other soil formation processes including root decomposition, soil mixing, and aeration.

Species which build permanent, vertical burrows that penetrate the soil deeply were termed anecics by Bouche. These species are detritivores and come to the surface to feed on partially decomposed litter, manure, and other organic matter. The permanent burrows of anecics create a microclimatic gradient, and the earthworms can be found shallow or deep in their burrows depending on the prevailing conditions. Anecics have profound effects on organic matter decomposition, nutrient cycling, and soil formation. The most common examples are the nightcrawlers sold by fish-bait dealers consisting of

Lumbricus terrestris and *Aporrectodea longa.*

Palatability of different types of litter to earthworms may depend on nitrogen and carbohydrate content, and the presence of polyphenolics such as tannins (Satchell, 1967). Earthworms prefer materials with a low C/N ratio, such as clovers, to grasses which have a higher C/N ratio (Ruz Jerez, 1988). Colonization of litter residues by microorganisms also increases palatability (Cortez et al., 1989), as does leaching of feeding inhibitors.

Benefits of Earthworms

Deep burrowing species such as L. *terrestris* can burrow through compacted soil and penetrate plough pans, creating channels for drainage, aeration, and root growth (Joschko et al., 1989). Recent work by Shipitalo and Protz (1989) elucidated some of the mechanisms by which earthworms enhance soil aggregation. Ingested aggregates are broken up in a liquid slurry that mixes soil with organic material and binding agents. The defecated casts become stable after drying. Stewart et al. (1988) also presented evidence that earthworms initiate the formation of stable soil aggregates in land degraded by mining.

In forest ecosystems earthworms, especially litter feeders such as L. *terrestris*, can consume all the litter deposited on the soil surface within a period of several weeks (Knollenberg et al., 1985) or months (Satchell, 1967). Incorporation of litter by earthworms in apple orchards can be an important mechanism for preventing outbreaks of scab fungus, spores of which are transmitted from litter to new foliage by spring rains. Raw (1962) found a high correlation between L. *terrestris* biomass and apple leaf litter incorporation, with over 90 percent of litter incorporated during the winter when this species was abundant. Incorporation of surface litter may be an important function of earthworms in no-tillage agroecosystems.

Introduction of earthworms to areas not previously populated has led to improvement of soil quality and productivity in New Zealand grassland (Martin, 1977), on drained Dutch polders (Van Rhee, 1977), in heath-land in Ireland (Curry and Bolger, 1984), and in mining spoils in the U.S. (Vimmerstedt and Finney, 1973).

Earthworm casts are sources of nutrients for plants. Lumbricids in a pasture soil produced casts that contained 73 percent of the nitrogen found in the ingested litter, indicating both the importance of earthworms in incorporating litter nitrogen into the soil and the inefficiency of nitrogen digestion by earthworms (Syers et al., 1979). Earthworms increase the amount of nitrogen mineralized from organic matter in soil. Because nitrification is enhanced in earthworm casts, the ratio of nitrate-N to ammonium--N tends to increase when earthworms are present (Ruz Jerez, 1988). Nitrogen-fixing bacteria are found in the gut of earthworms and in earthworm casts, and higher nitrogenase activity, meaning greater rates of N-fixation, are found in casts when compared with soil (Simek and Pizl, 1989).

Earthworms may increase levels of metabolic activity in soils, as measured by the amount of C02 evolved, yet nematode abundance and microbial biomass may decrease (Yeates, 1981; Ruz Jerez, 1988). This occurs because earthworms reduce the amount of substrate available to other decomposers, and because earthworms ingest other decomposer organisms as they feed. This process would tend to accelerate nutrient cycling rates.

Management Effects on Earthworms

Earthworms are not favored by tillage, and in general the greater the intensity and frequency of disturbance, the lower the population density or biomass of earthworms (Haukka, 1988; Mackay and Kladivko, 1985; Edwards, 1980; Gerard and Hay, 1979; Barnes and Ellis, 1979). Agricultural soils are generally dominated by species adapted to disturbance, low organic matter content, and a lack of surface litter. Earthworms are dependent on moderate soil moisture content and cultivation tends to lower soil moisture, thus having a negative influence on earthworms (Zicsi, 1969). Some common agricultural lumbricids are Allolobophora chlorotica, the Apporectodea caliginosa species complex (*App. trapezoides*, *App. turgida*, and *App. tuberculata*), and L. *terrestris*. Species common to organic rich habitats, such as E. *foetida* are rarely found (Lee, 1985).

Earthworm populations are usually significantly depressed in cropped fields relative to pasture or undisturbed lands. Lumbricids in a South African soil were decreased by cultivation to about one-third of original levels. *App. trapezoides* was less affected than *Eisenia rosea*, possibly because it is able to burrow more deeply in the soil and escape the zone of disturbance (Reinecke and Visser, 1980). Gerard and Hay (1979) reported 93 earthworms per square meter in normally plowed plots, including *App. caliginosa*, *All. chlorotica*, *App. longa*, and L. *terrestris*. Earthworm abundance increased in plots that received disk cultivation, or no-till treatment. Earthworm abundance doubled in no-till soybeans as compared with plowing (Mackay and Kladivko, 1985).

While a major function of tillage is to decrease bulk density of soil and increase porosity, it only increases microporosity. Macropores, which may be of physical or biological origin and which can play an important role in conducting water rapidly into the soil, are destroyed by tillage. For instance, a 67 percent decrease in the rate of infiltration after plowing a tropical forest soil was attributed to the destruction of earthworm burrows. Infiltration in an adjacent arable soil, which was initially much lower than in the forest soil, increased by 23 percent after plowing because the surface crust was broken (Aina, 1984). Infiltration increases in cropped soils when an organic mulch is added in the fall, due to the increased activities of earthworms in these soils and the production of macropores (Slater and Hopp, 1947). Soil compaction caused by agricultural traffic can also decrease earthworm populations (Bostrom, 1986).

A study in Denmark found that 200 T/ha of manure was optimal for increased earthworm abundance and biomass (Andersen, 1980). L. *terrestris*, *App. longa*, and *App. caliginosa* were increased by manure, while *All. rosea* and *All. chlorotica* were not influenced. The Rothamsted Experiment Station plots in England which received manure for 118 years also had increased earthworm abundance, and inorganic fertilizers in this case caused decreases in earthworm populations (Edwards and Lofty, 1974). Heavy applications of inorganic fertilizers may cause immediate reductions in earthworm abundance (Edwards, 1983).

Organic mulches enhance earthworm habitat by moderating microclimate and supplying a food source. In corn plots in Pennsylvania, earthworms were most abundant in the fall in treatments that were not plowed before winter and where corn residues had been chopped and left as a mulch, regardless of whether the plots were organically or conventionally managed (Werner and Dindal, 1990).

Effects of agricultural pesticides on earthworms depend on the chemical used. Herbicides tend to have low toxicity for earthworms, but can cause population reductions by decreasing organic matter input and cover from weed plants. Fungicides and fumigants tend to be very toxic to earthworms. Application methods may have unique effects on ecological groups of soil animals. For instance, the fungicide benomyl caused reductions of field populations of earthworms. Anecics such as L. *terrestris* were most susceptible to surface applications, and were less affected by incorporation of the pesticide into the soil. Because L. *terrestris* forms permanent burrows, it does not come into contact with subsurface soil beyond its burrow. However, endogeic species such as *App. caliginosa*, which continuously extend their burrows as they feed in the subsurface soil, were most susceptible when benomyl was incorporated (Edwards and Brown, 1982).

Enhancing Earthworm Populations

There are many creative ways in which a farmer can manage for earthworms. A first step might be to determine what earthworm ecotypes are present, and how abundant they are. Endogeic species are most commonly found. These are useful, but a mixed community including anecic species as well would be even more beneficial, especially for incorporation of surface matter. 'Direct inoculation is one possible method, but transferring blocks of soil (one cubic foot each) from an area with a large earthworm population into a farm soil might work better. It is also important to consider what species should be introduced, and this is where research specific to seasonally-dry climates in California is needed. Much of our knowledge about earthworms concerns species of one family, the Lumbricidae, which are native to moist temperate areas of Europe. The spread of these earthworms has paralleled European colonialism around the world. They are the only earthworms present in the northeastern US and Canada, where glaciation killed the native fauna. In areas that have a native earthworm fauna, lumbricids often dominate in disturbed habitats. Morphologically, lumbricids are more muscular than any other family of earthworms, suggesting a greater capacity for burrowing (Hartenstein, 1986).

The earthworm fauna in California includes some native species, lumbricid immigrants, as well as immigrants from Asia and South America. From limited personal observations, the lumbricids found in California agricultural soils tend to have small populations that are active for relatively short periods during the wet season. This may reflect agricultural management practices as well as climate effects. There may be species that are adapted to seasonally-dry climates that would flourish in California agricultural soils, if provided the proper conditions.

One management idea for introducing desired species is to set aside a small area of land on a farm to be managed exclusively as an earthworm reservoir. If needed, the soil could be limed to bring it near pH 7, fertilized, and a cover crop established and cut periodically to provide an organic mulch as food and physical cover. In this area a community of the desired species could be established and built up. From this reservoir blocks could periodically be taken and introduced into the field. Rate of spread would vary with species and conditions in the field. L. *terrestris* is capable of travelling at least 19 meters on the soil surface in the course of one evening foray (Mather and Christensen, 1988). This is a long term process for establishing earthworms, and would only be successful if ample organic matter was supplied to the soil where earthworms were being introduced, and if physical and chemical disturbances of the soil were minimized. Organically managed perennial crops would be ideal for this method.

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Mixtec farm workers in California: Working and living conditions.

Feenstra, Gail

Article written for Components. 1990

Editor's note: This article summarizes three other articles (see references) written about the work of Bonnie Bade, an anthropology graduate student who spent the summer of 1989 interviewing farm workers in Madera and Riverside Counties in association with UC Cooperative Extension. Her field work was supported by a grant from the College of Agriculture and Natural Resources at UC Riverside (UCR) and with assistance from Michael Kearney (UCR), Martha Lopez (Madera County Cooperative Extension) and Linda Araujo-Wilson (Riverside County Cooperative Extension). The objectives of Bade's study were to identify the family and community development problems faced by these farm workers and to develop practical recommendations on how the resources within the University and the Division of Agriculture and Natural Resources could be used to address the problems identified.

"It is late afternoon in Madera. Men are clustered on the lawns and porches of the beaten shacks of the East side barrio, resting or quietly talking, bodies stiff and sore from the day's endless kneeling, picking and lifting. I'm sitting on the living room floor of one of the houses with twenty exhausted men and women who have been picking tomatoes since five in the morning. Some sprawl out on the floor, others lean against the wall and close their eyes." (Bade, April 1990)

This was a common scene for Bonnie Bade, UC Riverside anthropologist, as she interviewed Mixtec farm workers after they returned from a long day's work in the fields. An increasing number of Mixtecos, an ethnic group from Oaxaca State in Mexico, are coming to California to work as agricultural laborers. In certain areas such as San Diego County or the Willamette Valley in Oregon, Mixtecos may now be the majority of the workforce. Although migrant workers have historically supplied a cheap, plentiful labor force for seasonal agricultural production work, their working and living conditions are often unacceptable by any standards. According to farm workers interviewed by Bade, their situation is getting worse. In addition, many of the U.S. social service systems designed for the migrants of North Central Mexico are not working for the Mixtecos from Oaxaca in southern Mexico.

Living Conditions

Most Mixtec farm workers live in overcrowded and unhealthy conditions. For many, home is a shack or shed in someone's backyard and they often lack basic amenities including bedding and indoor plumbing. The rare migrant family that can afford to rent a house frequently has boarders: up to 40 to 50 migrant workers sleeping in all rooms, hallways, closets and backyards. Others end up living and sleeping in their cars, parked in front of a co-worker's house. One renter explained, "My wife won't let everyone in to use the bathroom because it would just be too much, so they all go to the San Joaquin river to bathe and clean up after work." (Bade, July 1990)

Many laborers are unable to find housing with extended family or friends. These are usually single males who end up living in garages, shacks, orchards, caves or by the river. Outside faucets or hoses are used for bathing, cooking and clothes washing if they are available. If they are not, people use the rivers. The lack of space, water and facilities exacerbates the inability to rid bodies of the pesticide residues, sweat and grime of field work.

According to Bade, the lack of low-income housing for migrant farm workers is one reason for the unhealthful living conditions. Another is a rental system that fails to recognize the migratory nature of seasonal farm work and the accompanying mobile lifestyle. Long rental periods and large deposits are impossible for most farm workers. Farm workers are forced into substandard conditions which ultimately take a toll on their health.

Nutritional deficiencies are common, especially for women and children, due to inadequate cooking and food storage facilities. Families resort to buying their food prepared from restaurants and markets, which is expensive both financially and nutritionally. More highly processed foods are often purchased without an understanding of their lack of nutritional value or because they are easier to store (e.g., white flour tortillas instead of corn tortillas). Migrant families with children reported spending between $80 and $150 per week for food. A single male would spend between $40 and $100 per week, not including the lunches purchased from catering wagons in the fields.

Working Conditions

Field working conditions and wages are also substandard. The rights of newer Mixtecos, some of whom are undocumented workers, are frequently abused. Undocumented workers are particularly vulnerable. Bade describes three ways these workers get work. In "hide and pick," the undocumented worker hides among the crews in the fields and sells his buckets or sacks to legal workers at reduced rates. According to the study, this practice is quite common in citrus and tomato crops. Farm labor contractors allow it to continue because it increases the amount harvested. A second technique for an undocumented worker is to become a "helper" or "day laborer." The worker is picked up at designated corners or roads and paid cash for the day. No records are kept or government forms filed and a variety of abuses occur outside government regulation. Lastly, most undocumented workers purchase false residence permits, often from farm labor contractors. Since the enactment of the Immigration Reform and Control Act (IRCA) in 1986, false permits have become a profitable enterprise. The IRCA has created a system in which labor contractors can wield great power over workers' lives. Not only are contractors able to collect high prices for false permits, but they may simply refuse to pay undocumented workers, knowing that the workers are unlikely to seek legal redress.

Some labor contractors also reduce the take-home salaries of their employees by requiring workers to pay for a variety of "services" if they want to work, including transport to and from the fields, housing, food at the work site, and special tools. None of these "services" is cheap and, in fact, may be inflated, according to farm worker interviews. Transportation costs between $4.00 and $5.00 per day; lunch from a catering truck costs between $2.00 and $4.00 per day; and equipment can be from $10 to $30 for one tool. Requiring workers to buy work-related materials that are essential to performing the job is illegal, but workers, particularly those who are undocumented, have little recourse and pay the high prices.

Resources and Assistance

State and federally supported social services including education, medical care, economic aid and legal aid are available to these migrant workers. Unfortunately, language differences, illiteracy, confusing application procedures and continual mobility make aid difficult to obtain. Probably the most helpful source of social and economic support comes from within the migrant farm worker community itself. Basic needs such as loans, housing, job references, emergency money, child care and moral support are shared among the group as far as possible. Mixteco communities are trying to organize and educate themselves about how they might improve their situation.

Bade's study has identified specific migrant farm worker needs. Techniques are needed to assist this group in obtaining available social, medical and economic resources. Cooperative Extension and other agency workshops offered *at the work site and within farm worker communities* have the best chance of success. Topics for workshops might include:

- farm worker safety and pesticide awareness
- labor laws
- practical daily life skills (banking, driving, renting, phone/utility application and payments, library use)
- nutrition and buyer awareness
- disease prevention and household hygiene
- parenting, family life and dealing with spouse and child abuse
- social and legal service availability

Bade's analysis and descriptions point out how marginal life is for Mixtec farm workers. Her study also leaves us with the challenge of responding to their urgent needs, particularly for housing and improved working conditions, and assisting them in the context of their own networks and support communities. Cooperative extension can play a vital role in developing these programs with the Mixtecos.

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(GWF.004) *Contributed by Gail Feenstra*

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Soil surface management of annual rangelands.

George, Mel and John Menke

Material presented at **Ranch Resource Management Short Courses**, a series of workshops sponsored by UC Cooperative Extension. 1990

The long-term productive capacity of annual rangelands in California is closely linked to soil surface conditions. The characteristics of the top three to four inches of the soil profile including compaction, aeration, and organic matter content, affect both water and nutrient cycling, and ultimately determine seedling establishment, plant species composition and the amount of forage available for grazing in rangeland systems. This report provides some management guidelines for maintaining optimal soil surface conditions.

Soil Compaction. In rangeland systems, compaction seems to be most strongly influenced by stocking rate and the amount of grazing that takes place over time. Numerous studies have shown that soil bulk density (an indicator of soil compaction) at a particular site increases with the intensity of grazing. Soil compaction reduces water infiltration rates, decreases the effective depth of water storage, and increases runoff and soil erosion. Another result of compaction is that plant roots are concentrated near the surface. The reduced root biomass and rooting depth limit the cycling of water and nutrients and ultimately depresses grassland productivity. Management practices that promote root growth and development result in more vegetative growth. In addition to providing more forage for livestock, the increased growth may also increase levels of soil organic matter.

Soil Organic Matter. Organic matter improves the tilth and friability of the soil surface. This can facilitate water infiltration and reduces erosion.

Plant Succession. Optimal mixtures of plant species are most easily established by maintaining a mulch of standing and surface litter. When little or no residue is present on the soil surface, there seems to be a tendency for forbs, including many range weeds and wildflowers, to predominate over the grasses.

Management. "Managing residual dry matter is the rancher 5 main means of influencing soil surface conditions and ultimately soil permeability, water holding capacity and plant productivity." Residual dry matter (the dry plant material left on the ground from the previous year's growth) provides favorable microenvironments for germination, protects the soil from erosion, and increases soil organic matter. By maintaining adequate levels of residual dry matter at the soil surface, a slow process of change may be initiated whereby (over a period of years) rooting depth and above ground shoot growth are increased (see Clawson et al., 1982).

The other key management factor is grazing intensity. Avoid heavy grazing wherever possible. Light to moderate grazing leaves the necessary amount of residual dry matter and also reduces soil compaction. When heavy grazing is a necessity, subdividing pastures for rotational grazing is recommended. This gives pasture plants a period of rest following grazing allowing for adequate regrowth.

Water and nutrient cycles are important indicators of soil surface conditions. Assessing these cycles on a regular basis can help ranchers establish and maintain optimal conditions for rangeland production. Some specific things to watch out for are included in Tables 1 and 2.

TABLE 1.

Nutient Cycle Indicators Site Characteristics to Monitor	
Poor nutrient cycle	Good nutrient cycle
Low residue volume and slow decomposition rates	High residue volume and rapid decomposition rates
High soil loss from erosion	Minimal soil erosion
Shallow root systems	Deep root systems
Manure lying on surface, slow decomposition	Rapid decomposition of manure
Low soil organism populations and activity	Abundant soil organisms
Excessive soil compaction; low soil organic matter	Porous soil, rich in organic matter
	Healthy root systems on grazed plants

Source: Savory (1988).

TABLE 2.

Water Cycle Indicators Site Characteristics to Monitor	
Poor Water Cycle	Good Water Cycle
Soil surface exposed or seared	Soil surface permeable
Compacted soil layer	Permeable subsurface layers
High water run-off	Low water run-off
Excessive evaporation from exposed soil surface	Soil surface is covered, no exposed areas
Vegetative productivity low and declining	Vegetative production high with potential for increase
Low soil organic matter	High soil organic matter
Underground water supplies depleted	Underground water supplies replenished
Droughts and floods have more adverse effects	Droughts and floods less severe

Source: Savory (1988).

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(DEC.190) *Contributed by Dave Chaney*

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Western dairying: Environmentally responsible agriculture?

Bennett, Rick and L.J. Butler

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Environmental awareness has matured from the widely idealistic advocacy of the 1960's to the scientifically based, somber call for immediate action. Tragedies like the recent oil spills heightened sensitivity to the long-standing environmental problems of water pollution, acid rain, deforestation, and global warming. Environmental concerns have become mainstream issues. All forms of agriculture, especially dairying, are being scrutinized, and will be held accountable.

As the general public becomes more removed from production agriculture, the public attitude toward the farm community has become more critical of agricultural practices that are perceived as deleterious to the environment. Given the urgency of many environmental issues and the increasing involvement of the public in local concerns, it is not surprising to find that the dairy industry in the west has attracted criticism.

The issue of dairy waste management has been re-energized all over the country, and particularly in California. Back in the 1970's, the implementation of federal water quality legislation was initiated by the state and regional water quality control boards. Dairies in many parts of the state, especially those near the ocean, rivers, and creeks, were required to contain all dairy wastes on site year around. The so called "Point Source" regulations required that dairy manure in corrals, holding tanks, ponds or piles shall not be permitted to drain or otherwise pollute, contaminate or degrade the quality of the receiving water. Thus, virtually every stream or creek, even if it only flowed after a major storm, was protected by state and federal statute. By the early 1980's, the vast majority of dairy farms subject to point source regulations and enforcement had either retired or made considerable investments in facilities to contain the dairy wastes in a manner consistent with the regional water quality control board regulations. For several years after the initial implementation of the point source regulations, water board staff and dairy industry members were actively involved in monitoring the situation and providing assistance and enforcement as necessary.

The Changing Situation

Given the apparent success of the program in the 1970's, dairy producers are distressed to learn that the dairy waste issue has emerged anew. The reasons for this reemergence come from two distinct areas in the state. In the southern San Joaquin Valley there are many new dairies under construction. At the same time, a large number of dairy farms are considering relocation from Southern California to the counties of Tulare and Kern. Manure management issues have long been a concern in Southern California. Manure nitrates have been detected in ground water resources in Southern California and the occasional heavy downpour of rain can move vast quantities of manure into nearby waterways. As some of these farms consider moving to the South Valley, they have discovered that the concerns over manure have preceded them.

In the North Bay milk shed of Sonoma, Mann, and Napa counties, the dairy waste issue has arisen because dairy farms have grown in size, and in most cases, the capacity of manure containment facilities has not. A variety of public and private proposals have attracted much public attention to the region's waterways and, during the rains of March, many dairy waste complaints by the Bay Area and North Coast Water Quality Control Boards. Remedial action has been initiated by the industry. However, regulatory and public interest in the issue will persist into the foreseeable future.

Other Regulatory Priorities

Dairy waste management was reasonably successful in the early 1980's, but the issue returns a mere nine years later. The dairy industry must look to itself, as growth and relocation were bound to draw attention. In addition, the water quality control boards were thrust into new issues in the mid 1980's with the advent of leaking underground chemical tanks and the contamination of ground water resources. Due to urgent priorities, the dairy waste issue has been removed to a very low or no priority status. Unfortunately, the lack of regulatory attention to dairy waste control was perceived, by some dairy producers, to mean that they need no longer be concerned about point source control regulations. In the long run, the years of little or no oversight may prove to be more costly as new issues and regulatory agencies have emerged about the dairy waste issue.

Civil and Criminal Statutes

Enforcement of the source control statutes is effected through a civil administrative process. Dairy farms that allow wastes to escape into drainages may be subject to an abatement order. Fines for failing to abate can amount to thousands of dollars for each day that the discharge continues. Willful discharge of wastes may attract more severe penalties.

In recent years, the California Department of Fish and Game has begun enforcement of its statutes for protecting the state's wildlife resources. Dairy waste has several components that are very detrimental to fish and other aquatic life forms. The department has taken the position that contamination of streams with significant quantities of dairy waste is a violation of their criminal statutes. Reports or complaints of violation are investigated. Should the investigation provide ample evidence of violation, a criminal complaint will be filed with the county district attorney. In the execution of their duties, the courts have determined that Fish and Game Wardens may enter private property in the normal exercise of their duty, to protect the state fish and wildlife.

Water Quality in the State

The political battles over water and the quality of water that will be used for agriculture and urban uses, has also focused attention on dairy waste. The State of California is initiating discussion aimed at developing regulations for the control of "Non-Point Source Pollutants." For the Dairy industry a non- point source of pollutants might include a larger field or pasture that is used for the annual application of heavy amounts of dairy wastes. Pollutants such as excess salts and nitrates may then move, under appropriate conditions, into nearby surface and subsurface waters. Nitrates in drinking water is a growing concern, and was the topic of a recent report of the state Water Quality Control Board to the California Legislature. In that report most of the state's major dairy and agriculture production regions were identified as areas of nitrate contamination.

Given the situation in which the dairy industry finds itself, including the strong environmental agenda of the public and the current administration, what will be the response of the dairy industry, and are there opportunities to turn the environmental issue into an asset?

Compliance

While the necessary legislative and enforcement mechanisms have been in place for the last 10-15 years, actual enforcement of standards for the dairy industry have been given relatively low priority. In the larger context of the environment, the dairy industry has been, in the recent past, of relatively minor concern to enforcement agencies. As explained above, however, the current structure of the dairy industry and evolving environmental concerns are likely to combine in the near future to create a situation where the dairy industry may/will come under much closer scrutiny than it has in the past. This suggests that the dairy industry would be better off to take a much more proactive stance on environmental issues than it has in the past. That is, it would benefit the dairy industry to maintain some control of the environmental agenda that affects it, rather than waiting for enforcement agencies to take actions that may be more harmful than helpful to the long-term interests of the industry.

To put it another way, there are significant costs to noncompliance, both to the individual recipient of enforcement action and the entire dairy industry. A good example of the significant cost to industry is its inability to allay consumer concerns about Alar. While the use of Alar was limited to only a portion of the apple industry, the entire apple industry has experienced a significant blow, in terms of public relations, marketing, and political support.

Furthermore, there are also significant costs to "doing nothing." While doing nothing is a strategy option available to the industry, it is void of any benefits for the dairy industry. It also invites criticism and the risk of imposition of rules and regulations that may not benefit the dairy industry in the long term.

By the same token, there appears to be ample opportunity for the dairy industry to enhance its stature among the food industries by improving and demonstrating compliance to environmental regulation. Indeed, compliance to environmental regulation should be treated in much the same way as the dairy industry traditionally treats consumer demands; namely by responding in a proactive way to meet those demands. Opportunities exist to improve dairy industry public relations by taking a lead in environmental issues that affect the dairy industry. Similarly, consumer concerns in food quality and safety are substantially enhanced by industry proactivity, thus enhancing the marketing functions of the industry. In the same way, political support is more easily garnered by an industry that shows itself to be environmentally responsible.

Proactive Choices for the Dairy Industry

Perhaps even more important is the opportunity that exists to reverse that current philosophy on dairy waste in California. Currently, dairy waste is viewed as a necessary evil, and therefore, a problem. Yet, as most of us know, dairy waste is a valuable resource, not a valueless waste product. Cow manure is a natural and wholesome source of fertilizer. It is a valuable source of nitrogen, phosphorus, potassium, and a few other minerals. There is increasing evidence that many crop farmers are interested in acquiring or purchasing dairy manure as a source of nitrogen, phosphorus, potassium, and other minerals, and as a source of organic material for their cropping operations. For example, there is also evidence that dairy manure provides sufficient organic material to act as a soil quality enhancer.

Apart from being a source of nutrients, other minerals, and a soil conditioner, dairy manure is also a source of energy. At least four methods of feasibly producing energy from dairy manure exist. First, there is biogas or methane production from anaerobic digestion (bacterial fermentation in the absence of oxygen). The gas can be used in an internal combustion engine to produce energy plus heat. Second, there is direct combustion where dried manure is completely and immediately burned to produce heat as an energy source. Third, there is gasification which is similar to direct combustion, except that the manure is burned in an oxygen starved environment to produce gas which may be burned to produce energy. Fourth, there is ethanol fuel production. Ethanol fuel and other industrial chemicals can be produced by converting manure biogas to fermentable sugars which are then fermented and distilled to produce ethanol.

While the economic feasibility of these energy producing processes is highly sensitive to the cost of alternative energy and other factors, the possibilities for energy production from dairy manure are a positive aspect of what has often been considered to be a "problem."

Finally, apart from use as a fertilizer and soil conditioner and as a source of energy production, a third alternative for dairy waste exists. It is possible that manure could be processed and utilized in a variety of alternative ways. For example, manure can be densified (compressed) into logs, cubes, or pellets and marketed as feed, fertilizer, or fuel. (Densification enhances the transportability of manure and introduces the possibility of an export market.) Since Dairy Cattle are fed high-quality diets, the manure from these animals contains significant quantities of nutrients that could, after processing, be refed to dairy animals and other livestock. Currently, re-feeding of diary manure to mil cows is not legal. However, research on manure as a possible feed source should be initiated to resolve the legal question about residues, and to determine manure feed value.

These possibilities, and more, are currently being examined by the University of California Cooperative Extension Dairy Waste Management group, headed by Dr. Tom Shultz, Dairy Farm Advisor for Tulare Count. Other research is currently being funded by the University of California's Sustainable Agriculture Research and Education Program (SAREP) headed up by Dr. William Liebhardt at UC Davis. However, final responsibility for proactive strategies for an environmentally responsible dairy industry rests with the dairy industry itself. A concerted effort by producers, processors, and other dairy industry personnel is required to ensure that this industry is engaged in environmentally responsible agriculture.

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