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SAREP Newsletters to Merge

Beginning this fall, our two newsletters *Sustainable Agriculture News* and *Components*, will be merged into a single quarterly publication entitled,

Sustainable Agriculture

News and Technical Reviews from the UC Sustainable Agriculture Research & Education Program

The new publication will feature current news and announcements regarding sustainable agriculture in California, practical information for farmers and ranchers, as well as the technical/research summaries you are used to reading in *Components*. This is the last issue of *Components* as a separate publication; the final issue of *Sustainable Agriculture News* will be sent in July. Your subscription will automatically be transferred to the new quarterly starting with the fall issue coming out in October. If you have any questions or comments about these changes, please call one of our editors, David Chaney (530/757-3280) or Lyra Halprin (530/752-8664). Thank you for your interest and support.

Sustainable agriculture research in the ideal and in the field.

Anderson, Molly D. and William Lockeretz

J. Soil and Water Cons. 47(1): 100-104. 1992

The authors conducted a survey to compare the reality of field research in sustainable agriculture to the goals and methods expressed in general writings and discussion about the subject. The "rhetoric of sustainable agriculture" led them to predict that field research should involve:

- whole farm integration of practices,
- analysis of off-farm environmental or social effects,
- general processes leading to agroecological principles,
- integration of crops and livestock, and
- a time frame of at least several years.

They surveyed 216 researchers considered to be involved in sustainable agriculture research. Seventy-four percent (159) of the surveys were returned. From these surveys, they identified 122 sustainable agriculture field research projects that were underway before December 1989 and described their characteristics as identified in the survey. Of the 122, most were in the north central or western regions, with California in the lead (n=24) followed by Iowa (n=14). Important findings include:

- The most popular topics studied were crop rotations, cover crops, strip-cropping, and nutrient sources (usually nitrogen from legumes).
- Only one-fifth of the projects addressed whole farms.
- Only one-fifth studied general processes not linked to particular commodities.
- Only one-fourth included livestock.
- Nearly half of the projects included more than three major topics of research in the same project.
- The median duration of a project was three years.
- Only 7 percent analyzed any off-farm socioeconomic effects.
- Forty-four percent included measures of environmental pollution.

Projects that took place on commercial farms were compared to those that took place on experiment stations, since on-farm research is sometimes claimed to be more appropriate for sustainable agriculture. On-farm projects were found to be similar to experiment station projects in the topics that they investigated. As expected, on-farm projects studied whole farms more frequently (44% vs. 3% of experiment station projects), whereas experiment station projects studied several related commodities more frequently (47% vs. 11% of on-farm projects). About 40 percent of the projects at either type of site studied individual commodities only. None of the 31 experiment station-based projects examined off-farm socioeconomic effects, unlike 11 percent of those based on farms.

The authors conclude that sustainable agriculture research is somewhat different when it is discussed in the ideal versus in specific research projects. The long-term and whole-farm emphasis often discussed in the ideal may not be appropriate to all research questions, or may not be feasible given funding and other constraints.

"...the talk about sustainable agriculture and the research done on it do not reinforce each other...much of the talk has been overly dogmatic, asserting as good in an absolute sense some attributes that might contribute to developing sustainable systems. Greater recognition is needed for the complementary roles of various research styles and goals...we are not recommending that projects in this domain ignore ideals of sustainable agriculture research when they are difficult to attain. We are suggesting instead that pat, general assertions about what sustainable agriculture research should involve are not sufficient guides for researchers to structure individual projects so that they contribute to sustainability most effectively."

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(ISA. 105) *Contributed by Jill Auburn*

Modified stability analysis of farmer managed, on-farm trials.

Agronomy Journal 76:271-274. 1984

Reviewer's note: On-farm research has been discussed as an important component of sustainable agriculture. It helps researchers become more responsive to farmers' needs and constraints, utilizes the talent and innovative ideas that farmers possess, and may also promote more rapid adoption of new technologies. One of the difficulties of on-farm research is selecting a method of data analysis that can handle the considerable variation in farmer management, as well as the effects of different soils and climate. Modified stability analysis is a possible solution for dealing with this variability. On November 19, 1991, the author presented this method to about 25 researchers at a two-day course at UC Davis, sponsored by UC SAREP.

Modified stability analysis expands on ideas advanced by Eberhart and Russell (1966) and MacKenzie et al. (1976). According to Hildebrand, this method is valuable to on-farm researchers because it makes use of environmental variation rather than trying to block it out, as in conventional statistical analyses. In modified stability analysis, "environment" is viewed as a function not only of soils and climate, but of farmer management as well. By deliberately including a wide range of farm environments, the risk of extrapolation is minimized, the difficulties of year-to-year variation at a single site can be reduced, and needed recommendations about a particular technology can be delivered in a timely fashion.

To explain the concept, Hildebrand considers a hypothetical case of farmer-managed trials conducted over a large number of farms, evaluating an improved cultivar of maize and a local variety. No changes are made from the farmers' usual practices. The only constant at each location (farm) is the cultivars. Each farmer subjects them to different soil conditions, planting dates, pest management, and fertilizer applications.

Modified stability analysis supposes that yield is an indicator of environment. A farm with high average yields of the two cultivars is considered a "good" environment; conversely, a farm with low average yields is considered a "poor" environment. "Environment," according to Hildebrand, "becomes a continuous, quantifiable variable whose range is the range of average yields." Yield for each variety can be related to environment by simple linear regression:

$$Y_i = a + be$$

where Y_i = yield of variety i , and e = environmental index equal to the average yield of all treatments at each location (farm).

By fitting this equation independently for each variety, and plotting the yield response against the environmental index on the same graph, it is possible to

visually compare varieties.

An example from Malawi

The data from a trial of two maize varieties conducted in southeastern Malawi are shown in Table 1. Standard analysis of variance was not indicated in the article, but significant differences were reported among farmers and between villages. No differences were detected for variety. Furthermore, the distribution of confidence intervals from the results of the trials showed that the local variety had a higher average yield and a more stable yield for both fertilizer situations. Based on this analysis, one would conclude that there is no advantage to using the improved variety for this area, and that there is a distinct response to fertilizer.

Using modified stability analysis, the data for each fertilizer level and for each variety were fit to equation 1 by linear regression (figures 1 and 2).

In each case the R² value (the proportion of the variation in yield accounted for by regression) indicated a very good fit and the "t" and F values were highly significant, indicating positive responses to environment for each variety with and without fertilizer. This analysis shows that the two varieties respond differently to environment. The local variety is superior in poor maize environments, while the improved material is superior in good maize environments.

Table 1. Maize yield from on-farm trials, 1981/82. Phalombe, Malawi								
Treatments	Farm/location, first village							
	1	2	3	4	5	6	7	8
	—tons/ha—							
Local maize (LM)	2.2	2.2	1.9	1.2	1.3	0.9	1.0	0.5
Local/fertilizer (LM + F)	3.6	3.7	4.3	3.2	2.3	2.3	3.1	2.8
Improved maize (IM)	3.5	2.0	2.9	0.4	0.6	0.5	0.6	0.3
Mean for farmer (environ. index)	3.6	3.2	3.4	2.1	1.7	1.4	1.9	1.6
Treatments	Farm/location, second village							
	1	2	3	4	5	6		
	—tons/ha—							
Local maize (LM)	1.8	1.1	1.6	1.0	1.6	0.6		
Local/fertilizer (LM + F)	3.2	2.5	2.9	1.2	1.9	0.8		
Improved maize (IM)	2.2	0.7	0.9	0.3	1.1	0.3		
Mean for farmer (environ. index)	2.5	1.7	1.9	0.9	1.4	0.5		

Different Recommendations

The recommendations from this analysis differ from those obtained through standard analysis of variance. In this case, there is strong evidence for partitioning the farms into two recommendation domains. In poorer maize environments ($e < 2$), the local variety should be used whether or not the

farmer fertilized at the rate used in the trial. In better maize environments ($e > 2$), the new variety should be used regardless of fertilizer rate.

In addition, the frequency distribution of yields for each recommendation domain showed that in poorer environments, fertilizer increases the yield of the local variety above that of the new variety; in contrast, the yield of the new variety in better environments is higher than the local variety whether or not fertilizer is used.

The superiority of the new variety in the better environments probably reflects the more refined and controlled environment found on the experiment station where the variety was developed. Hildebrand highlights the danger of extrapolating from the better environment of the experiment station to the poorer environments found on the majority of the farms.

How Many Years and Locations are Adequate?

One of the major advantages of using the environmental index, according to the author, is that it negates some of the problems associated with only one year's data. The index is an indicator of the quality of the environments, independent of the reasons those environments are good or bad. Year-to-year variation would be evident in shifts of the data points to the left or to the right, but a "3" environment will still be a "3" if the same treatments are used each year. So, two or more years' data are preferable, but not necessary.

Modified stability analysis works best with a wide range of environments and farm locations. The Malawi example presented in this article (14 locations) is approaching the minimum number of locations for accurate estimation of treatment differences. Hildebrand also adds that replicated trials within a farm would be useful in order to check the accuracy of the data and to give more stability to the estimate of the treatment means.

References

Eberhart, S.A., and W.A. Russell. 1966. Stability parameters for comparing varieties, *Crop Sci.* 6:36-40.

MacKenzie, D.R., W. T. Mills and J.O. Watts. 1976. Predicting yield and processing quality of potato breeding selections. *Am. Potato J.* 53:87-98.

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(DEC.334) *Contributed by David Chaney*

The role of land tenure in regional development: Arvin and Dinuba revisited.

Wischemann, Trudy

The California Geographer. 30:101-127. 1990

This paper addresses the influence of land tenure on regional development, social issues and resource policy decisions in California's Central Valley. It continues the line of research investigating the social consequences of domestic land tenure patterns and the trend toward concentration in U.S. agriculture begun by Walter Goldschmidt between 1940 and 1944. Goldschmidt constructed his famous, yet controversial, Arvin-Dinuba study to test the relationship between the developmental level of two farm towns and the different farm scale and tenure patterns surrounding them. He found that Arvin, surrounded by large farms, was markedly under-developed relative to Dinuba, the town surrounded by small-scale, family-operated farms. Goldschmidt attributed the differences to the different proportions of farm operators and farm laborers in each town produced by the different land tenure patterns, according to Wischemann.

Critiques of Goldschmidt's Study

Goldschmidt's study was conducted as part of the original feasibility investigations for the federal Central Valley Project (CV P). Some of the first critics were large landowners and their proponents who were trying to get the CVP exempted from the 160-acre limitation and residency requirement stipulated under U.S. reclamation law. They opposed the Goldschmidt study because it revealed the social impacts of agricultural scale and the implications of federal water policy for rural communities, according to Wischemann. Pressure was put on the Bureau of Agricultural Economics, the agency under which the study was conducted, to prevent the results from being published and to prevent further research on this subject.

Recently, criticisms of Goldschmidt's study have been more academic, but continue to be used to counter pressure to enforce the reclamation law. One major criticism, and probably the only scientifically valid one, according to Wischemann, is that the relationship between farm scale and rural community conditions cannot be extrapolated to all communities from a two-community study. This hypothesis, however, has now been statistically tested using macrosocial accounting methods for 98 agricultural counties in the Sunbelt (MacCannell, D., *Components* Vol.2, No.3). The results of this and other studies by the Macrosocial Accounting Project support Goldschmidt's thesis.

Another criticism of Goldschmidt's hypothesis is addressed in a 1984 paper by Hayes and Olmstead called "Farm Size and Community Quality: Arvin and Dinuba Revisited." It suggests an alternative hypothesis to the influences of land tenure on the two rural communities; namely, the developmental impetus of the Southern Pacific Railroad (S P). The remainder of Wischemann's paper

examines the merits of this alternative hypothesis and whether land tenure is indeed a factor in influencing the quality of lives in rural communities.

Hayes and Olmstead suggest that since the SP went through Dinuba and not Arvin, the two towns differed in terms of their railroad service, and this significantly influenced their developments. This paradigm, according to Wischemann, implies that rural development is dependent upon urban-based capital flowing into the region. The Arvin-Dinuba study directly challenges this paradigm since it suggests a model of positive community development resulting from local, independent financial inputs. Wischemann then carefully examines a variety of historical documents to determine the influences of the SP and other outside financial interests on the development of towns and agriculture in Tulare County (where Dinuba is located) and in Kern County (where Arvin is located).

Tulare Development: SP and Small Farmers

Wischemann found that although the SP contributed to Dinuba's development, a more important factor was the prior development of small-scale, intensive, irrigated agriculture which prompted the Southern Pacific's involvement in Dinuba in the first place. Where small farms *did not* develop in Tulare County, even the SP was not enough to provide sustained community growth. Developmental history also shows that in areas where the SP was granted public land to subsidize construction, settlement was sparse compared to areas where public lands were opened entirely to settlers.

Kern Development: SP and Large Landowners

In Kern County, land ownership and irrigation development patterns provide insights into Arvin's fate. First, the existence of large landholdings in Kern County as part of privately-owned Mexican land grants were instrumental in determining the route of the Southern Pacific. The availability of public land for railroad acquisition and for town sites was limited, and controlled the route selection of the SP.

Wischemann notes that these large landholdings also had a major impact upon the form and location of both agricultural development and settlement patterns. She states: "Beginning with Edward F. Beale's questionable acquisition of several Mexican land grants, through public land acquisition schemes of San Francisco-based investors (Livermore and Redington, Miller and Lux, Haggin and Carr, and a few others), to the present day, Kern County development has been determined by only a few major landholders." In fact, when Southern Pacific lands were sold (potentially for settlement), most went to the largest landholders: Haggin and Carr.

Large corporate investors also obtained control of water rights in Kern County. Unlike Tulare County, locally-developed systems of minor canals operated by small farmers and capitalists were eventually taken over by several San Francisco investors involved in various land development schemes. The net result was that near the turn of the century, the total flow of the Kern River was apportioned between the ranching empires of Miller & Lux and Haggin & Carr. The Haggin-Carr-Tevis association was incorporated as the Kern County Land Company (KCLC) in 1890 and controlled 375,000 acres in Kern County alone and over three-fourths of the county's water

supply. The KCLC was purchased by Tenneco West in the 1960s and these lands were then sold to Castle & Cooke in 1987. "Hence the pattern of large-scale dominance over land and water persists to this day."

The KCLC and Arvin Area Development

During the first forty years of the 20th century, before Goldschmidt studied Arvin's development, the KCLC made a major change in the irrigation patterns of the county. The KCLC channeled Kern River surface flows north to irrigate its holdings there. The KCLC lands in the Kern River Delta which had been irrigated by the surface flows were shifted to irrigation by ground water pumping. Both of these changes resulted in a rapid lowering of the ground water table, including the Arvin-Edison area, east of the Kern River delta. Wischemann asserts that the KCLC's creation of an unnatural water deficiency in the Arvin area led to its later development relative to the rest of the county. The KCLC and other large landholders also delayed new surface water supplies for the Arvin-Edison area as a way of guaranteeing cooperation of the Bureau of Reclamation in developing the Friant-Kern Canal without an acreage limitation.

Summary

Wischemann concludes that the regional developments of Tulare and Kern Counties have been strongly influenced by land tenure patterns. Particularly in Kern County, large-scale monopolization of public lands and control of surface water supplies by urban financial interests were more complete. Small farmers on the Kern River were not able to withstand these outside sources of control and community development opportunities were lost or stunted. Thus, large landholders in Kern County suppressed the development of small farms and kept small communities such as Arvin from developing in all but the backwaters of the watershed.

In Tulare County, small farmers managed to gain a foot-hold and support communities which today have become thriving rural towns. Dinuba's development, including its SP platting, was the result of small-scale agricultural development and irrigation. Small farmers were able to become established on the deltas of the Kings and Kaweah Rivers despite the SP and other sources of urban capital.

The developmental histories of Arvin and Dinuba—of Kern and Tulare Counties—show the importance of land tenure in regional development and puts the influence of the Southern Pacific Railroad in perspective. These histories also challenge the current paradigm about outside investment interests being critical to the development of communities. In fact, these interests may actually be more detrimental to a community than the slower process of indigenous development.

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(GWF.008) *Contributed by Gail Feenstra*

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Is there farming in agriculture's future? The impact of biotechnology.

Smith, Stewart

Presentation at College of Agriculture and Life Sciences Lecture Series. University of Vermont, November 14, 1991.

This paper attributes the decline of farming to publicly-subsidized technologies that shift activity from the farm to the non-farm sectors. The author is a senior economist with the Joint Economic Committee of the U.S. Congress. Smith describes a dramatic shift in value-producing, economic activities away from farms to input suppliers, processors, and marketing firms. This process squeezes farmers economically and reduces productive efficiency for society. To reverse these trends, Smith urges land grant universities and government policy-makers to promote farming-intensive technologies like sustainable agriculture.

Smith presents data from the U.S. Department of Agriculture to demonstrate a steady erosion of farming activity to the input sector since 1910. He notes that if current trends continue, it is conceivable that there would be no farming in the agricultural system after the year 2020. He questions the view that the decline in farming is a function of increasing efficiency:

" . . . when we were told that all those farmers moved off the farm because we were getting more efficient and we didn't need them any longer, we were told only half the truth. The whole truth was that much activity performed by those existing farmers was assumed by non-farm firms and not passed on as system efficiencies."

As farmers spin off economic activities to the input and marketing sectors, they experience "excess management capacity." "This allows them to focus more of capital and management capabilities on producing commodities, but at a reduced margin since they are getting rewarded for less activity per unit of production."

To prosper economically in this situation, farmers must constantly expand their output. This allows them to increase net income and to spread their costs over more units of production. These costs include explicit costs, such as fertilizer or tractors, which are directly entered on bookkeeping ledgers. They also include opportunity costs, the value of the farmer's time and energy devoted to the business as opposed to potential returns in a different activity. As Smith puts it:

" . . . farmers do not expand to reduce explicit costs, but rather to increase net income. Understanding that process helps explain why farm enterprises are constantly pushing beyond the size of lowest (explicit) production costs. As they spin off economic

activities, they reduce their returns that cover their opportunity costs. Expanding output allows farmers to recapture lost returns even if explicit costs per unit increase."

From a productive standpoint, the loss of farming activity is actually inefficient. Smith illustrates this point by referring to data from the annual Northeast Farm Survey:

"As seen in the 1990 survey of dairy farms, when considering explicit costs only, the smallest sized herds are most efficient. However, if substantial opportunity costs (which are not strictly size-related) are included, the larger farms are more efficient. In terms of transforming inputs to outputs, society would be better off with the smaller farms, provided those farmers could use their excess management capacities to recover their opportunity costs with activities other than the production of commodities. Recovering opportunity costs with a diversity of activities is a key to the economic viability of many alternative farming Systems, including sustainable agriculture."

Smith faults both land grant universities and government policy for failing to maintain farming activity. Land grant research, he states, is not so much size-biased (toward larger farms) as it is sector-biased (favoring the expansion of non-farm activity). The reason, says Smith, is twofold: (1) as university budgets shrink, land grant research agendas are increasingly driven by private funding from corporations in the input and marketing sectors, and (2) research scientists in land grant universities have stronger professional ties with private sector scientists than they do with farmers. The phenomenon of the "revolving door" of research scientists between the two sectors exacerbates these ties.

While researchers determine what technologies will be available, it is farmers who adopt them. Smith argues that they do so in the context of government policies that slant adoption incentives in particular directions. For example, chemical inputs have been rendered cost effective because public funds have been allocated to subsidize their research and testing as well as the environmental and social costs of their use. Tax policies and technical assistance also encourage expansion into specialized production and a greater reliance on nonfarm-produced goods and services.

If the reduction of farming activity is not efficient from a societal perspective, what can be done to maintain the viability of farms, farming and farm communities? Smith advocates a major shift in land grant research and government policy to support applied research directed at technologies that enhance farmers' activities. He fully supports increased funding for sustainable agriculture, which he sees as developing systems that allow farmers to replace many purchased inputs with farming activities such as crop rotations, locally produced nutrients, and increased management. At the same time, he suggests that land grant administrators scrutinize all research projects with respect to sector bias: "They must discontinue spending public funds to develop technologies that shift activity away from farmers to non-farm firms, *unless there is no alternative technology that might be developed which would be generally of equal efficiency.*"

Smith provides economically sound reasons to question the headlong rush into

biotechnology. For land grant researchers and administrators, he offers an alternative agenda rooted in the historic mission of support for farmers and fanning communities. As he puts it:

"Such a change could breathe fresh air into the Land Grant University system...(this change) provides more specific criteria to establish objective functions, gives the University more freedom to determine its own agenda, and offers a mission that warrants the enthusiastic support of a broad range of societal interests, including farmers."

(CI-SUST.074) *Contributed by David Campbell*

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Effects of cover crops on groundwater quality.

Meisinger, J.J., W.L. Hargrove, R.L. Mikkelsen, J.R. Williams, V.W. Benson

In Hargrove, W.L. (ed.). **Cover Crops for Clean Water**. pp. S7-68. Soil & Water Conservation Society, Iowa. 1991

This review article (55 references) describes the role of winter cover crops in nitrate leaching and in the conservation of nitrogen. Numerous experiments in annual cropping systems are cited, but results can be applied to tree and vine crops as well.

Nitrate is the most mobile agricultural nutrient and can leach to groundwater when (1) the soil contains significant nitrate, and (2) water percolates below the root zone. These conditions often exist in fallowed fields and deciduous orchards during the winter months, when percolation of winter rainfall can be high and uptake of water and nitrate by plants is minimal.

Winter cover crops can influence nitrate leaching in three ways: (1) water budget effects, (2) nitrogen uptake effects, and (3) timely water use of the cover crop during the rainfall season.

Water Budget Effects

Cover crops require water to grow-about 300 pounds of water are required per pound of aboveground dry matter. Thus, a winter cover crop producing 2,000 pounds of dry matter per acre will use about 2.5 acre-inches of water. In humid climates, this water usage can significantly reduce nitrate leaching. Similarly, nitrate leaching can be reduced in semiarid areas, however irrigation water is usually required for cover crop germination and for replenishing soil moisture. (*Reviewer's note: While water input is usually required as an "investment" to produce cover crops, tile mulching effect of a mowed cover crop can reduce evaporative losses of water from soil resulting in little or no net water loss.*)

Cover crops can also have an opposite effect on the water budget. Reduced surface runoff of water usually results from the presence of plant cover. Improved water infiltration can result, increasing the likelihood of leaching. The net effect of increased water use vs. increased infiltration depends on several factors, such as cover crop dry matter production rate, degree of soil cover and soil slope, soil infiltration rate, and rainfall intensity.

Nitrogen Uptake Effects

A winter cover crop can effectively immobilize large quantities of nitrate, delaying the nitrogen availability until crop roots become active in the spring. With *nonlegumes*, total nitrogen uptake is closely affected by dry matter production. Thus, nonlegumes that produce the most dry matter usually immobilize the greatest quantity of nitrate. Total nitrogen uptake with legumes

is affected by nitrogen concentration as well as dry matter production, because the nitrogen concentration among legume species can be quite variable. Furthermore, legumes fix atmospheric nitrogen, but fix far less in the presence of high soil nitrogen. Thus, the potential for legumes to reduce nitrate leaching depends on the extent to which they use soil nitrate rather than nitrogen fixation to meet their nitrogen requirements. With both legumes and nonlegumes, species with deep roots and high-root density will capture the greatest quantity of nitrate.

Timely Competition

Cover crops can also reduce nitrate leaching by competing directly for water and nitrate during the winter. The cover crop must become quickly established and grow vigorously in the fall in order to maximize the direct competition between nitrogen uptake and the nitrate leaching. A late-planted cover or one that produces nearly all its growth in the spring will therefore be unlikely to effectively reduce nitrate leaching.

Legumes vs. Nonlegumes

Several studies were cited in which grass cover crops reduced the mass of nitrogen leached by an average of about 60 percent. Of the grasses, cereal rye was the most effective at capturing nitrogen. Brassicaceous cover crops also have a beneficial effect on water quality, reducing nitrate leaching by 60 to 75 percent. The brassicas are known for their rapid establishment and cool-season growth. In general, nonlegumes are about three times more efficient than legumes at reducing nitrate leaching. The authors reason that legumes are slow to establish and produce little fall growth compared to nonlegumes. More nitrate therefore leaches below root zones of legumes before they resume active spring growth. However, legumes have a positive effect on the following crop in terms of nitrogen contribution. Mixing legumes and nonlegumes provides the benefits of reduced nitrate leaching and nitrogen contribution.

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(CI-GW.063) *Contributed by Chuck Ingels*

Meeting the nitrogen needs of processing tomatoes through winter cover cropping.

Stivers, Lydia J. and Carol Shennan

J. Prod. Agric. 4(3):330-335. 1991

Reviewer's note: Much of the current research on using cover crops as green manures has focused on the minimum- and no-till grain production systems of the Midwestern and southern United States. A growing number of researchers, however, are looking at the use of cover crops in the higher-value fruit and vegetable production systems of California. Two companion projects initiated in 1986 at the UC Davis Student Experimental Farm have generated important and useful information for row and field crop farmers in the Sacramento Valley. This article provides the first published results from one of those experiments.

Objectives and Methods

The specific goals of this study were to compare the productivity of several winter legume green manures (cover crops), and to determine if they could provide adequate available nitrogen to reduce or eliminate the need for chemical nitrogen fertilizer in a processing tomato production system.

The experimental design was a non-factorial split-plot with four replicate blocks. Main plot treatments were either cover crops or winter fallow. The cover-cropped plot was subdivided into six cover crop species, and the winter fallow was subdivided into six rates of ammonium sulfate fertilizer applied to the summer cash crop.

Cover crops were seeded in October and then flailed and disked the following April for two consecutive seasons (1986-87 and 1987-88). The varieties used in this experiment were 'lana' woollypod vetch, Austrian winter peas, berseem clover, bell beans, oats, and an oat/vetch mixture seeded at 50%-50%. Cover crops were irrigated with 1.0 inch of water in October 1986 but not in 1987. Ammonium sulfate was applied as a banded split application (20 lbs. N/acre as April preplant, with the balance side-dressed in June) at rates of 0, 50, 100, 150, 200, and 250 lbs. N/acre in winter-fallowed plots only.

UC82B processing tomatoes were direct-seeded approximately three weeks after disking of the cover crops, sprinkle irrigated to establish the stand, and then furrow irrigated through the summer.

Measurements were taken on (1) above-ground biomass of the cover crops and the amount of nitrogen that the legumes fixed, (2) soil moisture, (3) total soil nitrogen, and (4) tomato plant growth and fruit yield.

Results

Cover crop biomass and nitrogen fixation. Biomass production was greater

in 1987 than in 1988, probably due to cooler and drier conditions in 1988 (figure 1). Lana vetch produced the greatest biomass of the legumes (about 8,000 lbs./acre in 1987) and fixed the most nitrogen 90 lbs./acre by February, and 230 lbs./acre by March, as determined by the difference method. Austrian winter peas had moderate dry matter accumulation and fixed 150 lbs. N/acre; bell beans produced slightly less biomass than peas, but fixed significantly lower nitrogen (only 80 lbs. N/acre by March).

Soil moisture and soil nitrogen. The use of cover crops, relative to the winter fallow, reduced water content to a depth of 24 inches. The decrease in water content, however, was quite small, equivalent only to 0.4 inch for the vetch and 0.8 inch for the oats. Water content in the top 8 inches showed no significant differences between treatments.

Soil mineral nitrogen for each treatment was measured as the amount of ammonium and nitrate available to tomato plants. Ammonium levels were low throughout most of the season (1 to 5 ppm), but peaked significantly after additions of vetch-nitrogen (late March) and the 200 lbs. N/acre chemical fertilizer.

Soil nitrate levels ranged from 10 to 40 ppm depending on the treatment. The readings for a particular treatment were similar in both years, and remained fairly constant between May 15 and September 15 (except for the 200 lbs. N/acre fertilizer which resulted in increased nitrate after side dressing with ammonium sulfate). Vetch plots and the 200 lbs. N/acre fertilizer treatment had the highest nitrate levels (30-40 ppm by mid-season). The authors noted that the irrigation water used on the experiment had a high nitrate concentration. Over the entire growing season, about 80 pounds of nitrogen from irrigation water were applied per acre of tomatoes.

Tomato yields. The yields of tomatoes in legume-cropped plots were as high as those in fertilizer-treated plots (table 1). Highest yields following legumes were obtained in 1987 using vetch and bell beans. These yields (42.4 and 42.1 tons/acre, respectively) were higher than the Yolo County average that same year. Berseem clover was mowed once in the winter and allowed to regrow; high yields obtained after this cover crop may indicate the addition of considerable below-ground nitrogen as a result.

Tomato yields in 1988 were low due to poor growing conditions and stand establishment, and strong weed competition. Tomato fruit quality was not affected by treatment. As supported by previous research, tomato yields in this experiment showed little response to applied fertilizer nitrogen.

Table 1. Tomato fruit yields and total plant N uptake following one year of cover cropping or chemical fertilizer treatment. Values shown are means of three or four replicates.

Treatment	September 1987	July 1987	August 1987
	Yield, tons/acre	N uptake lb/acre	
Cover crops:			
oats	27.6a ¹	73.7 NS	92.7ab
oats / vetch	35.0b	87.2	74.2a
winter peas	40.7bc	94.1	98.6ab
bell beans	42.1c	97.7	103.4ab

vetch	42.4c	118.7	138.8b
berseem clover	43.3c	102.1	130.6b
Fertilizer (lb N/acre):			
0	35.5 ²	71.8	92.1
50	45.8	140.9	119.6
100	43.9	110.8	125.9
150	39.1	117.1	126.8
200	42.3	157.5	152.1
250	39.7	87.3	127.3
<p>¹ Values followed by the same letter are not significantly different by LSD, P = 0.05. NS indicates no significant difference.</p> <p>² Analysis of data using linear regression showed no significant response to applied nitrogen.</p>			

Discussion

The authors highlight three main points in their interpretation of the results.

- The Sacramento Valley has an ideal climate for growing cover crops. Mild, wet winters favor high biomass production and high rates of nitrogen fixation.
- Legume cover crops supply enough nitrogen at the right time to obtain high tomato yields. Nitrate concentrations after incorporation of the vetch cover crop remained high throughout the growing season. These high levels, coupled with the narrow peak in ammonium level indicate that net mineralization was high, and net immobilization by microbes was low.
- For this particular location, the loss of soil moisture due to the cover crop is insignificant relative to the total amount of water required by tomatoes through-out the growing season.
- Cover crops may benefit the soil in other ways by reducing compaction and crusting, increasing water infiltration rates, and improving soil tilth.

The authors also alert farmers to two potential problems associated with cover cropping in processing tomato production systems. First, the nitrogen input from the green manure may vary significantly from year to year, so nitrogen management is more complex than when using synthetic fertilizers. Second, cover crops restrict the flexibility in the timing of tomato planting and harvesting. This is a significant limitation for growers who contract for early-season tomatoes.

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(DEC.333) *Contributed by David Chaney*

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Cool-season cover crops in the pecan-orchard understory: Effects on Coccinellidae (Coleoptera) and pecan aphids (Homoptera: Aphididae).

Bugg, Robert L., James D. Dutcher, and Patrick J. McNeill

Biological Control 1:8-15.1991

*Reviewer's note: This study was conducted in pecan orchards of southern Georgia. Two of the aphidophagous lady beetles considered convergent lady beetle and **Olla v-nigrum**, known in California as ashy-gray lady beetle, are abundant in California pecan and walnut orchards. Thus, some of the findings may be adaptable to pecan and walnut production in this state.*

Cool-season cover crops may be useful in providing aphid prey to lady beetles during the late winter and early spring when pecan trees are not in leaf. This could have implications for biological control of three species of aphids that attack pecan, mainly during the spring and autumn.

Mature pecan orchards under minimal or commercial management were planted with cool-season understory cover crops of hairy vetch (*Vicia villosa*) and cereal rye (*Secale cereale*). In the minimal-management orchard, control plots were dominated by annual ryegrass (*Lolium multiflorum*) and blackpod vetch (*V. sativa* ssp. *nigra* [also known as narrow-leaf vetch, *V. angustifolia*]); in the conventional orchard, annual ryegrass dominated.

Seeded cover crops sustained significantly higher densities of aphidophagous lady beetles than did unmown resident vegetation or mown grasses and weeds. In plots with cover-cropped understories, mean densities of aphidophagous coccinellids were nearly six times greater than in unmown resident vegetation ($P=0.0001$) and approximately 87 times greater than in mown grasses and weeds ($P=0.0004$). During late winter and spring, cereal rye harbored abundant bird cherry-oat aphid (*Rhopalosiphum padi*), whereas hairy vetch sustained pea aphid (*Acyrtosiphon pisum*), blue alfalfa aphid (*A. kondoi*), and thrips (*Frankliniella* spp.).

The following aphidophagous lady beetles were abundant in cover-cropped understories: (1) convergent lady beetle (*Hippodamia convergens*); (2) *Olla v-nigrum*; and (3) seven-spotted lady beetle (*Coccinella septempunctata*). During mid-April, *Olla v-nigrum* apparently moved directly from the cereal rye to the catkins of flowering pecan trees, and there fed on the associated flower thrips (*Frankliniella* spp.). In the orchard under minimal management, there was evidence that the cereal rye/vetch mixture led to enhanced densities of convergent lady beetle in the pecan trees ($P=0.0307$). However, no other effects on coccinellids were seen. There was no evidence of improved biological control of pecan aphids, which did not attain economically-important densities in any of the experimental plots.

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(BB.C32) *Contributed by Robert Bugg*

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Proceedings of livestock health and nutrition alternatives: A western states conference.

Hilander, Sally K. (ed.)

Proceedings of a conference on December 8-9, 1990, Bozeman, MT. Published by AERO. Helena, MT. 50 pp. 1991

Seventeen presentations made at a three-day conference are compiled in this proceedings. Topics of sessions include: planning for sustainability, ruminant nutrition, disease prevention, alternative management practices, and marketing.

- Keynote speaker Frank Baker of Winrock International described the potential negative and positive effects of livestock-based agricultural systems. He defined a sustainable livestock system as "a combination of production technologies and management strategies that enhance producers' profits and well-being, while having a positive effect on the environment."
- Vern Anderson of North Dakota State University's Carrington Station discussed the use of alternative feeds, including crop residues, annual forages such as foxtail, pearl millet, amaranth, Jerusalem artichokes, triticale, lupines, and beans, and a variety of perennial and biennial grasses.
- Doc and Connie Hatfield described their use of Holistic Resource Management on their 400-cow ranch in Brothers, Oregon. They use fire to keep their land from going to climax juniper, and intensive rotational grazing by their cows to promote optimal pasture growth.
- Private consultant Dale Grondahl said that the three major causes of mastitis begin with "M": mud, milking machines (with vacuum levels too high or too low, or too much static electricity), and man, who has bad habits such as leaving the cows on the milking machine too long.
- Two veterinarians from Montana State University, Jack Catlin and Randy Kidd, outlined the factors affecting disease susceptibility of animals and approaches to disease management. Kidd briefly discussed acupuncture, acupressure, chiropractic, homeopathy, blood-letting, and other novel methods.
- An integrated pest management program for flies was presented by Bob Gillespie of Montana State University. He discussed various indoor and outdoor traps, insecticides, and parasitic wasps.
- Montana rancher Bill Milton, who markets certified organic beef and lamb, said that quality of life is the principal reason for his approach to ranching, which includes stubble grazing in the winter, companion grazing of sheep and cattle, guard dogs, and intensive grazing.
- Margaret Scoles outlined standards for "lean" and "organic" meat, as defined by the state of Montana and by the stricter Organic Crop Improvement Association. She cautioned that the new national standards will change the situation markedly.

Four case studies illustrated the development of alternative production and marketing systems.

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(JSA.t06) *Contributed by Jill Auburn*

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Role of ants in pest management.

Way, M.J. and K.C. Khoo

Annu. Rev. Entomol. 37:479-503.1992

Reviewer's note: Ant populations are often abundant in nontilled orchards and vineyards, and can be troublesome in almond orchards. For a pictorial guide to the identification of damaging and nondamaging ants commonly present in San Joaquin Valley almond orchards, see Freeman, M., R. Coviello, and C. Sisk 1991. Ant Guide. Nut Grower 11(6):11-14.

Do ants play a role in agriculture other than as crop pests, allies of pests, or minute bestowers of pain? According to this review article (190 references), they can and do assist in pest management in numerous crops worldwide. The article focuses primarily on the role of beneficial ants in undisturbed perennial cropping systems of the tropics and in temperate zone forests.

Certain *Formica* species are particularly useful in temperate zones for the following reasons:

- they reach high population densities,
- they are active over a long season day and night at all levels of the forest,
- they are capable of killing many pests at multiple developmental stages,
- they concentrate increasingly on a particular prey species as its population increases.

Another benefit, which is also a significant problem in horticulture, is that they maintain their large populations when prey is scarce by attending Homopteran insects (e.g., aphids, mealybugs) to obtain honeydew. Ants can also kill substantial numbers of beneficial insects, but may benefit others. Cost-benefit judgments are needed before considering the use of beneficial ants in agriculture.

Techniques for manipulating the agricultural system to favor beneficial ants are also discussed in the article. Two main concerns must be addressed in making use of a particular ant species: (1) how to suppress undesirable competing ants that otherwise displace the desired ant or keep it too scarce to be effective, and (2) how to improve conditions for the beneficial ants. Insecticides are sometimes used to initially control undesirable species, but these species quickly reestablish if conditions remain favorable.

Several cropping strategies for encouraging beneficial ants in tropical areas are listed. For example, intercropping of cocoa and coconut palms leads to improved pest management through the enhancement of beneficial ants. Another example of habitat manipulation stems from preferences of ant species for undisturbed soils. For open-habitat species, it is recommended to maintain strips of bare soil, while those favoring a closed habitat are best enhanced by including vegetational diversification and shading. "The approach

therefore is to simulate in agricultural Systems the key elements of the equivalent natural ecosystem that benefit the chosen ant species."

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(CI-PEST. 102) *Contributed by Chuck Ingels*

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Evaluating the effectiveness of ants as biological control agents of pear psylla (Homoptera: Psyllidae).

Paulson, G.S. and R.D. Akre

J. Econ. Entomol. 85(1):70-73. 1992

Results of research conducted in two Washington state pear orchards are presented in this paper. Orchard 1 was a "minimally managed hobby orchard" with regularly mowed resident grasses. The orchard was sprinkler-irrigated and was not sprayed for at least 10 years. There was a naturally occurring high density population of *Formica neoclara* ants throughout the orchard. This species has been shown to be a predator of pear psylla. Orchard 2 was an organic commercial orchard with mowed resident weeds; drip and overhead sprinkler irrigation were used. Sixteen colonies of **F. neoclara** were introduced into the orchard.

Access to tree canopies by ants was limited to tree trunks through light pruning of the trees and cutting of the vegetation. Elaborate ant-excluding barriers were constructed around 32 trees at each site. Immature pear psylla population densities were estimated by leaf sampling (5 samples/tree), and adult densities were estimated using the beating tray method.

In Orchard 2, all stages of pear psylla were significantly lower in trees in which ants foraged than in ant-excluded trees in both years. Also, psylla densities were 4-5 fold lower in trees after introduction than before introduction. In Orchard 1, a similar trend was observed in only two out of the three years of the experiment; no differences were seen during one of the years.

Data from this study indicate that ants play an important role in pear psylla control. In general, psylla populations in both orchards were higher in trees in which ants were prevented from foraging.

*Reviewer's note: Another article provides information on techniques for transplanting ants into pear orchards: Paulson, G. S. and R.D. Akre. 1992. Introducing ants (Hymenoptera: Formicidae) into pear orchards for the control of pear psylla, **Cacopsylla pyricola** (Foerster) (Homoptera: Psyllidae). J. Agric. Entomol. 9(1):37-39.*

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(CI-PEST. 103) *Contributed by Chuck Ingels*

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