Experimental *Eucalyptus grandis* plot at U. C. South Coast Field Station, Santa Ana, harvested twice a year produced fuel at a rate of up to 22 metric tons per hectare.

variance; thus, future plot sizes for species screening will be reduced with considerable savings in maintenance.

Clearly there is intense competition within the plots that accounts for the major portion of the plant-to-plant variance observed at individual harvest. Moreover, plants on the eastern side of the plots produce considerably more growth, which suggests that less water stress and, hence, more photosynthesis occurs before noon than after noon. This is common in regions where afternoon temperatures and atmospheric water demands are higher than in the morning. The implications of the east-west yield variance with respect to plot design are important. The border plantings may not be sufficiently dense to create uniform conditions within the yield area and hence the absolute yield values reported may differ from those obtained in larger scale plantings.

Undoubtedly, there is seedling variance, known to be high in eucalyptus species, but it has not yet been identified sufficiently to warrant further studies on vegetative propagation of high yielding individuals.

Improved management, particularly leaving more foliage on the plants at each harvest, may increase yields. This may require more frequent harvesting, perhaps three times annually, timed with a light interception index. Ideally we should like to harvest at 100 percent incident light interception and cut plants so that the remaining vegetation still intercepts 50 percent of the incident light.

So far we have failed to obtain response to fertilization, perhaps because of underground runoff from other experiments some distance from our plots. Similarly, varying irrigation regimes has not successfully altered growth rates; the plants may be deeply enough rooted in the sandy loam soil to tap aquifers or runoff from other experimental plots. Future research on short-rotation perennial crops will be done in more isolated areas where drainage from neighboring fields can be controlled. The greater than 20 ODT per hectare per year is typical of yields from annual agricultural crops, such as corn, sorghum, and sugar beets, grown with high nitrogen and water. One would expect yield to decline with reduced fertilization and irrigation in isolated, frequently cropped eucalyptus plantings as in other high-yielding crops.

It should be emphasized that, since plot establishment, there have been no further costs for pest or weed control or land preparation. We have partially achieved our initial objective, namely, to produce biomass at lower cost than is possible with most annual crops. A corn crop grown for grain on a neighboring plot with similar fertilization and irrigation, but greater weed control problems, produced half the biomass of *E. grandis*. Silage corn, planted at higher densities, would have yielded significantly more biomass than did our 60,000 corn plants per hectare, but overall annual yields would have been lower, because *E. grandis* has a much longer growth period.

We have been sufficiently encouraged by these studies to extend them to several other perennial species, including *Acacia melanoxylon, Ailanthus altissima, Eucalyptus camaldulensis, E. camaldulensis × rudis, E. globulus* 'Compacta', *E. oleosus, Pinus radiata, Populus* hybrids, *Robinia pseudoacacia, Sequoia sempervirens, Salix* spp., and *Tamarix.*

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Geologic nitrogen may pose hazard

Several studies by University of California researchers have suggested that high, potentially hazardous levels of geologic nitrate occur naturally in alluvial soils along the western San Joaquin Valley. Nitrate concentrations are uniform to great depth in unirrigated profiles of these soils and range up to 2,000 milligrams per liter in the soil solution. The major focus of our research was to examine the relationship of this nitrogen to the soil system and to identify the sources of the naturally occurring nitrate in the alluvial soils.

Two index drainage basins were selected for investigation. Cantua Creek Basin is immediately to the west of alluvial soils previously reported to contain high levels of indigenous nitrate. It also has a representative suite of the geologic sediments that occur in the Coast Ranges. The Ortigalita Creek Basin, on the other hand, was studied because it is not near soils with high levels of naturally occurring nitrate and because it contains an incomplete suite of the Coast Ranges' geologic sediments (represented by the Panoche and Tulare Formations). These two basins have physiographical characteristics similar to those of the numerous basins throughout the eastern flank of the Coast Ranges that drain into the San Joaquin Valley.

Results

Total nitrogen concentrations in the Cantua Creek Basin geologic sediments, determined by standard methods, ranged from a few micrograms per gram ($\mu g/g$, dry weight basis) to nearly 4,800$\mu g/g$. Organic nitrogen was the major nitrogen species in older shale sediments, reaching a maximum concentration of nearly 1,200 $\mu g/g$ in the Panoche and Moreno Formations. These dark, organic-rich shales are typically interbedded with light-colored sandstones.

Nitrate concentrations were always less than 100 $\mu g/g$ in the older sediments and did not contribute significantly to the total nitrogen concentrations. However, nitrate was the dominant species in the younger sediments and played a significant role in their total nitrogen concentrations. The most recent sedimentary formation (Tulare) had a maximum total nitrogen concentra-

in soils

Scott M. Strathouse

Garrison Sposito

tion approaching 4,800 μg/g, contributed principally by nitrate nitrogen. These younger sediments crop out at the mouth of Cantua Creek near alluvial fans, which at present support lush stands of cotton.

The ammonium concentrations varied throughout the Cantua Creek Basin and ranged from a few to 360 μg/g. These values did not represent a significant fraction of the total nitrogen concentrations in any of the geologic units.

The total, organic, and nitrate nitrogen concentrations were considerably lower in the Ortigalita Creek Basin than in the Cantua Creek Basin. The maximum concentration of organic and nitrate nitrogen was only 500 μg/g in a geologic unit equivalent to the Panoche Formation in the Cantua Creek Basin. Organic or nitrate nitrogen usually did not occur as major species, in contrast to the trends observed in the Cantua Creek Basin geologic sediments.

The highest total nitrogen concentration found was 2,000 μg/g, but the dominant species (75 percent) was fixed and soluble-exchangeable ammonium retained in the clay matrix of a single sample of Panoche sandstone (equivalent in age to the oldest sediments that were sampled in the Cantua Creek Basin). Aside from this apparently anomalous sample, the fixed and soluble-exchangeable ammonium concentrations followed a random pattern similar to the geologic sediments in the Cantua Creek Basin. Moreover, the youngest geologic unit in the Ortigalita Creek Basin (equivalent to the Tulare Formation at Cantua Creek) did not contain the exceedingly high total nitrogen and nitrate nitrogen concentrations that were found in the Cantua Creek Basin.

The contrast in both concentration and chemical species of nitrogen between the two drainage basins can be understood in terms of their differences in sediment type. Geologic sediments in the stratigraphic section along Cantua Creek are dominated by fine-grained mudrocks and shales. Those along Ortigalita Creek contain more coarse-clastic rocks and very small amounts of mudrocks. Organic matter is closely

Definitions of Geologic Terms

Alluvium- Sedimentary deposits of recent origin resulting from deposition by stream activity.

Clastic- Fragments of rocks moved individually by geologic processes from their origin.

Mudrocks- Sediments composed of finely crystalline clay and quartz particles.

Sandstone- A consolidated or cemented rock composed of clastic grains. Mineralogical composition varies with the nature of the parent material.

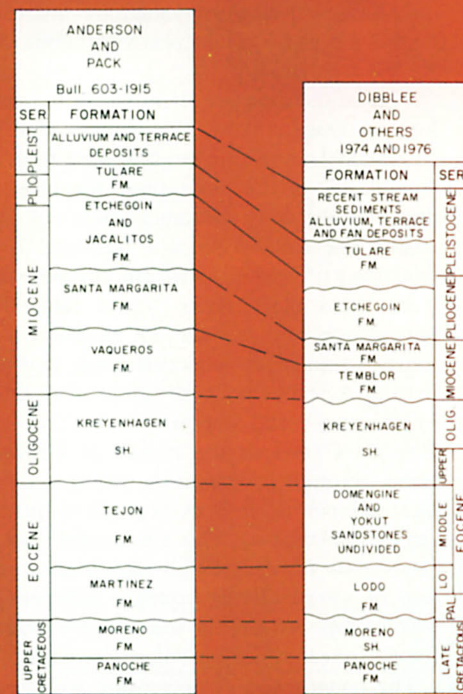
Sedimentary- A term used to describe rocks composed of sediment. Includes clastic rocks and those formed from solution-precipitation.

Shale- A sediment composed of clay and clay-size particles that displays a fissile or laminated structure.

Stratigraphy- Division of geology relating to the formation, sequence, composition, and correlation of rocks with a stratified nature.

Suite- Succession of sedimentary strata.

Stratigraphy of Cantua Creek Basin



Geologic sediments in Cantua Creek Basin range in age from about 90 million years for the Panoche Formation to roughly 1.8 million years for the Tulare Formation. Recent alluvial deposits are less than 10,000 B.P. (Before Present).

Typical exposure of the gravels, sandstones, and claystones of the Tulare Formation at the mouth of Cantua Creek. This formation contained up to 4,800 μg/g total nitrogen.

associated with fine-grained mudrocks and, consequently, Cantua Creek sediments contain a much higher portion of organic nitrogen. This form of nitrogen can be mineralized as a part of the natural weathering of the sediments.

The ultimate source of nitrogen in geologic sediments from the Cantua Creek Basin may be attributed to organic nitrogen compounds in the older shale formations that crop out along the upper reaches of the creek. The weathering and transport (by mudflow) of organic nitrogen compounds from these older rocks would facilitate nitrification and explain the observed increase in nitrogen concentrations downstream. A secondary enrichment of nitrate by transport and deposition thus would take place towards the mouth of Cantua Creek through progressively younger geologic sediments (see inset in graph of nitrogen concentrations). This mechanism could account for the exceedingly high concentration of nitrate in the younger sediments, which crop out at the mouth of Cantua Creek (for example, the Tulare Formation).

The congruence of decreasing sediment age and decreasing surface elevation thus has produced a major source of nitrate nitrogen for the soils that formed on the alluvial fan at the mouth of Cantua Creek. In the Ortigalita Creek Basin, on the other hand, the absence of the older, organic-rich geologic formations means that no important source of nitrate nitrogen is available for downstream transport. Consequently, this species does not attain the high concentrations observed at Cantua Creek.

The possibility of geologic sediments contributing naturally occurring nitrogen to the soil system has been demonstrated in a study of two drainage basins from the San Joaquin Valley. The data indicate that a nitrate hazard may result in association with soils that have developed from parent materials originating in nitrogen-rich sedimentary units. This potential problem is likely to be encountered in many regions of the San Joaquin Valley that have basins with suites of geologic sediments similar to those in the Cantua Creek Basin. The problem may be compounded further where these naturally high-nitrate soils are used for irrigated agriculture. Attempts to regulate the concentration of nitrate in leachate waters reaching the groundwater zone would have to take into account the significant contribution of native nitrate predating the application of fertilizer nitrate to these soils.

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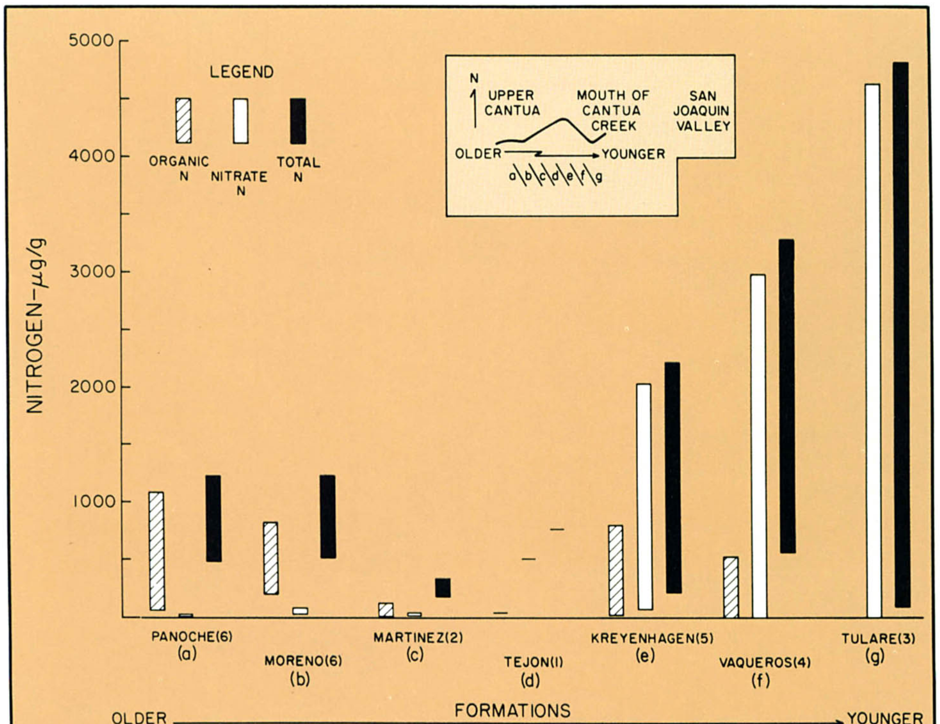

Organic nitrogen, nitrate, and total nitrogen concentrations found in geologic sediments from the Cantua Creek Basin, arranged according to decreasing age.

New "glance" measures dairy

The California dairy industry is characterized by large, high-producing herds. Dairy studies conducted outside the state are sometimes not applicable, particularly with regard to milking parlors because of the wide variety of types and sizes in California. Therefore, a reliable method of estimating cow flow and milker performance in California dairy facilities is being developed to provide data enabling Cooperative Extension workers and farmers to make sound decisions on remodeling or building parlors.

Preliminary trials were initiated to compare a new method of conducting time-and-motion studies with a more conventional method. This new "glance" technique was evaluated in 21 central California dairies—two with floor-level and 19 with elevated herringbone parlors.

The glance technique

The glance technique is a continuing spot-checking method for estimating time used in performing various chores. The investigator glances at the milker(s) and records an impression of the chore. Four random glances per minute for 100 minutes were found to be satisfactory and could easily be converted to percentage of time, seconds per cow, or other parameters.

The technique was first tested to determine its value for spot-checking milker routines and cow traffic patterns at the University of California milking facility in Davis. One technician recorded milker activity by the glance technique, and a second technician made a tape recording of the activity. Later, the tape was timed with a stopwatch for comparative analysis. Uniform chore classifications were developed, so that glance chores were the same as tape-recorded chores.

Observers attended two milkings to be-