NITROGEN LOAD OF SOIL IN FROM

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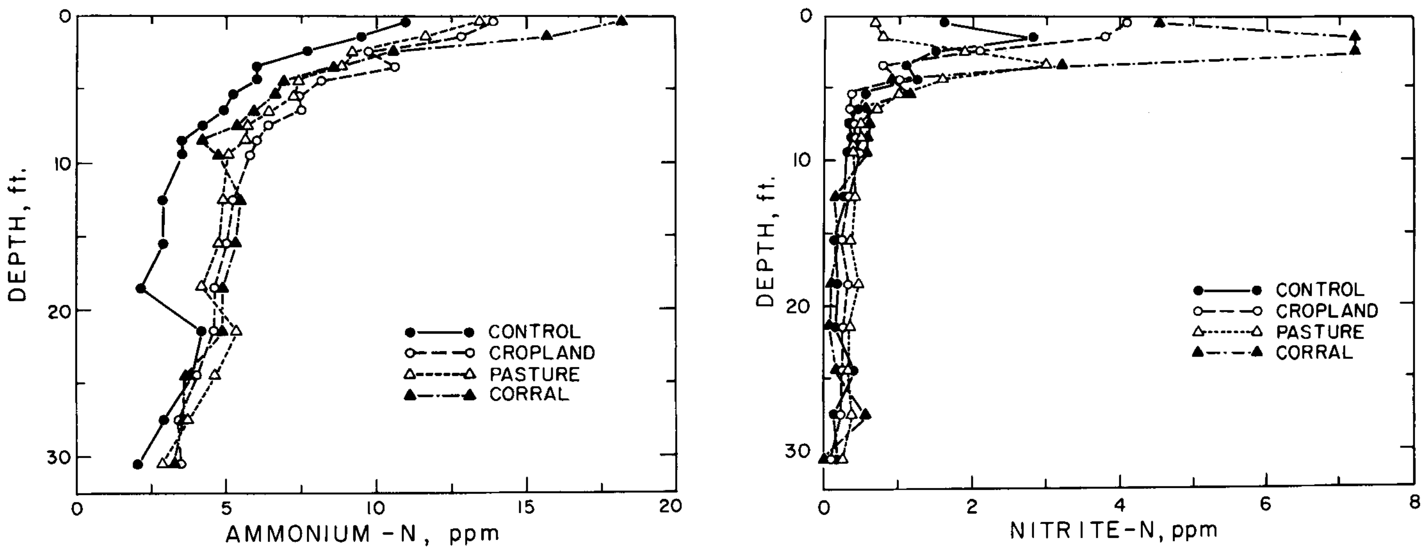
GRAPH 1 (LEFT) AVERAGE NH_4^+—N (AIR-DRY BASIS) IN SOIL PROFILES UNDER CONTROL (UNDISTURBED) (2 SITES), CROPLAND (6 SITES), PASTURE (5 SITES), AND CORRAL (2 SITES) IN THE CHINO-CORONA DAIRY AREA—GRAPH 2 (RIGHT), AVERAGE NO_2^-—N (IN SATURATED-PASTE EXTRACTS) IN SOIL PROFILES UNDER THE SAME SITES DESCRIBED IN GRAPH 1



Deep drilling of soil profiles in the Chino-Corona dairy area, which has an estimated average NO_3^- concentration of about 315 ppm (70 ppm NO_3^-–N) in drainage water underneath croplands and pastures. Predictions for the NO_3^- concentration in the drainage water in the unsaturated zone for this disposal rate agree with this determined value. The disposal rate should be lowered to about three to four cows per disposal acre to have an acceptable NO_3^- load in the drainage water.

THESE MANURE DISPOSAL TESTS were begun in November, 1969, with the drilling of 15 deep holes in the Chino-Corona dairy area, about midway between Los Angeles and Riverside. The tests included two control or undisturbed sites with no manure or irrigation water applied; six acres of irrigated cropland which were disposal sites for barnyard manure, or liquid manure, or both; five irrigated pasture sites where wastes from milking operations were disposed of; and two corral sites where manures were generally scraped twice yearly and discharged to croplands or pastures. Drilling to the water table was done with a power-driven auger.

Additional sites were drilled to the 19-ft depths with hand augers in January 1971 to make a total of nine sites for each category outlined above. Soil samples from these holes were collected and analyzed for ammonium-nitrogen (NH_4^+–N), nitrate-nitrogen (NO_2^-–N), and nitrate-nitrogen (NO_3^-–N). At the same time, waters from the water tables (shallow wells) were sampled for NO_3^- and total salt analysis. For comparision, waters from adjacent domestic wells (deep wells) were also collected and analyzed.

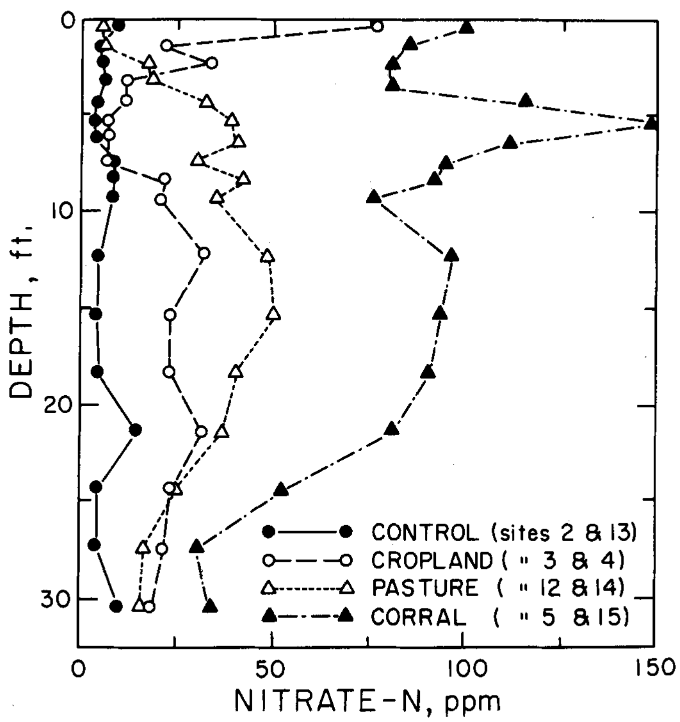
Protein N

The barnyard manure contained about 2% total N at the time of application to croplands—mostly in organic form (example: protein-N). During farming operations, the manure is plowed under or disked in. Through microbiological transformations, the organic N is converted to NH_4^+, then to NO_2^-, and then to NO_3^-. This process is favored by aerobic conditions. Crops recycle N by absorbing NO_3^- or NH_4^+ and converting it to proteins in plant tissues. However, some NO_3^- escapes the root zone with drainage water and may eventually reach the water table. Under anaerobic conditions, soil NO_3^- can be microbiologically denitrified to N_2 or N_2O gaseous forms and thus escape to the atmosphere. This process has been shown to be primarily responsible for low NO_3^- contents of shallow groundwaters in Imperial Valley. Thus, denitrification may find a new role in the abatement of groundwater contamination with NO_3^-, if it can occur below the root zone during growing periods.

Nitrate concentration in groundwater is of concern, since high NO_3^- is a health hazard if ingested via drinking water. The U. S. Public Health Service has set a standard of 45 parts per million NO_3^- (or 10 parts per million as NO_3^-–N) as the maximum NO_3^- content of water for safe drinking. High NO_3^- in water, as well as in feeds, has been reported to reduce milk production and in some cases cause abortion in dairy cows.

GROUND WATER
DAIRY MANURE

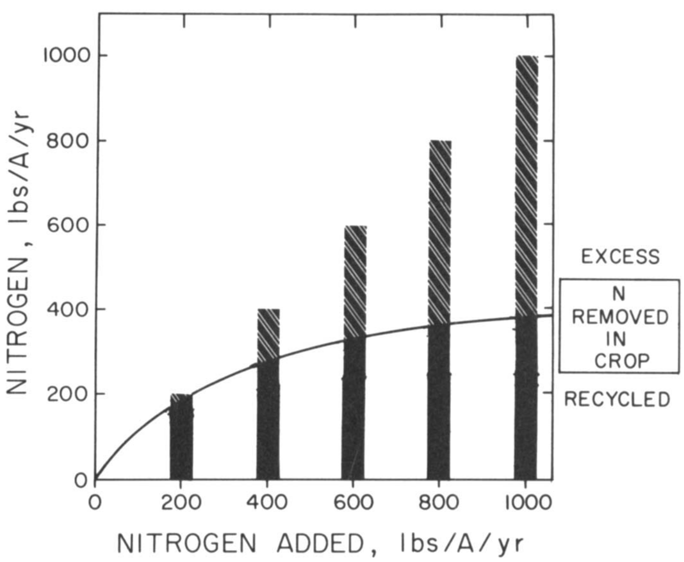
GRAPH 3. AVERAGE NO_3-N (IN SATURATED-PASTE EXTRACTS) IN SOIL PROFILES UNDER CONTROL (UNDISTURBED) (2 SITES), CROPLAND (2 SITES), AND CORRAL (2 SITES) IN THE CHINO-CORONA DAIRY AREA



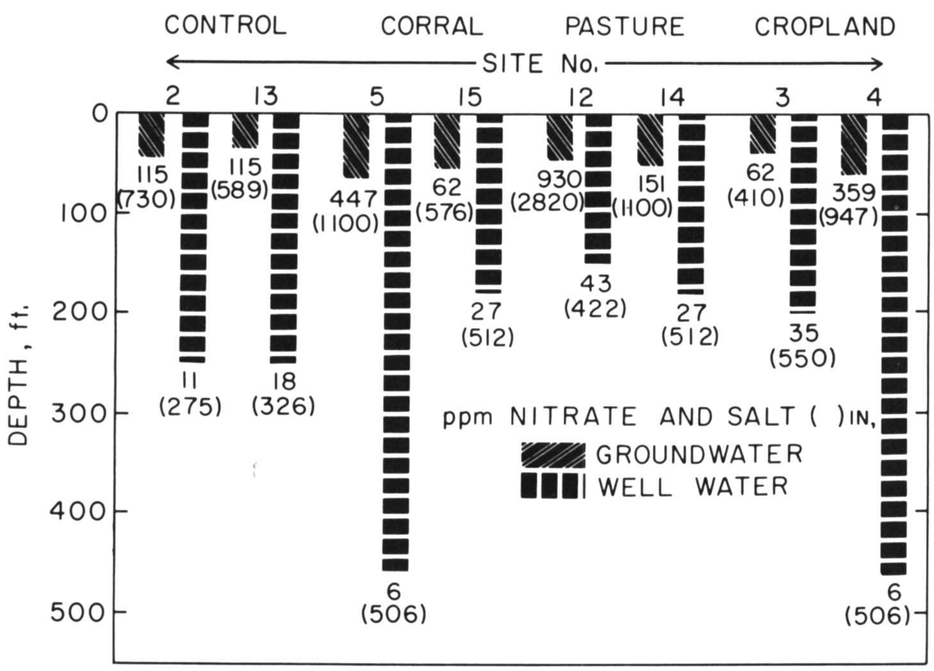
ANNUAL N INPUT IN SOIL, RECYCLED BY CROPS, EXCESS IN THE SOIL SOIL—BROKEN BAR REPRESENTS THE N EXCESS- AND CALCULATED NO_3 CONCENTRATIONS IN THE DRAINAGE WATER ASSUMING TWO LEVELS OF LOSS

Cow/ disposal acre	Total excreted	incorp. Soil	Crop removal	Excess in soil	NO_3 in unsat. zone % loss	35% loss
		lbs/acre per year			ppm	
3	438	219	190	29	38	25
5	730	365	270	95	126	82
10	1,460	730	350	380	503	327

GRAPH 5. HYPOTHETICAL N INPUT-REMOVAL CURVE BY FORAGE CROPS IN THE DAIRY AREA. SOLID BAR REPRESENTS THE N REMOVED BY CROPS FROM SOIL—BROKEN BAR REPRESENTS THE N EXCESS



GRAPH 4. NITRATE AND TOTAL SALT (VALUES IN PARENTHESES REFER TO TOTAL SALT) CONTENTS OF GROUND (SHALLOW WELLS) AND DOMESTIC WELL (DEEP WELLS), WATERS, IN DAIRY SITES DESCRIBED IN GRAPH 3



This dairy area has about 365 dairies totaling nearly 125,000 cows scattered mostly north of the Santa Ana River in an area of about 26 square miles—one of the highest concentrations of dairies in the world.

Two counties

Riverside and San Bernardino counties (in contrast) have a total dairy cow population of about 48,000 and 99,000 respectively. Thus, with about 85% of all the dairy cows in these two counties confined in a small area, and with most of the animal waste going on irrigated land, some concern for the groundwater quality in this area is justified.

Graphs 1 and 2 show the NH_4^+–N and NO_2^-–N concentrations in the 0- to 31-ft profiles of the sites investigated. Results from below 31 ft are not presented since fewer holes were drilled beyond this depth. Ammonium-N and NO_2^-–N were particularly high in the 0- to 2-ft depths under corrals. Although there were no marked differences in NH_4^+–N in concentrations in deeper layers, the average concentrations of NH_4^+–N in profiles under croplands, pastures and corrals were considerably higher than under the controls (graph 1). The NO_3^-–N load of the profile is presented in graph 3. Only two sites from each category were presented.

For the croplands and pastures, the lowest (sites 3 and 14) and highest (sites 4 and 12) NO_3^- concentrations in groundwater were presented. The average (two sites each) NO_3^-–N concentration was highest under the corrals, followed by the pastures, then the croplands and the controls had the lowest. The NO_3^-–N concentration in corrals was about three times higher than that under croplands. However, on an areal basis, the croplands would probably contribute more NO_3^- to the groundwater than corrals since the cropland area is about 13 times larger than the corral area.

The NO_3^- concentrations in waters sampled from the shallow wells and deep wells are shown in graph 4. The NO_3^- in shallow wells under pastures ranged from 151 to 930 parts per million, whereas the NO_3^- under croplands ranged from 62 to 359 parts per million. In contrast, waters sampled from deep wells had considerably lower NO_3^- contents as compared with those sampled in shallow wells, and no NO_3^- concentration in deep well waters exceeded the PHS standard of 45 parts per million NO_3^-. Total salt concentrations were also generally higher in shallow well waters than in deep well waters. Thus, the present practice of dairy manure disposal to croplands and pastures is potentially hazardous to groundwater with acceptable NO_3^- contents. Shallow wells near corrals and other heavily manured areas could be contaminated with NO_3^-. A real problem with NO_3^- can arise if the profile is sandy.

Disposal rates

Data presented in the table show the method used to predict the NO_3^- concentration in the water leaving the root zone of pastures and croplands. Data in the first column show the disposal rate in terms of cows per acre. The total N excreted was based on a daily excretion by a cow of 0.40 lbs N. Assuming 50% of the total N excreted was lost by volatilization of NH_3, only half was available for incorporation into the soil. The amount recycled in crops was estimated from graph 5, based on knowledge of the forage crops and farm management in the area. Likewise, excess N values were estimated from graph 5. The concentration of NO_3^- in the unsaturated zone was calculated from simple dilution assuming a drainage volume of 15 surface inches per year, which corresponds to a leaching fraction of about 0.30 (usual for successful irrigation projects). The 35% loss represents the fraction of the excess N that is either lost by denitrification or by becoming a part of the organic N pool in the surface layers. The estimates with low degree of accuracy are the drainage volume, NH_3 volatilization loss, and denitrification loss.

The average cow population in the area is about 10 cows per disposal acre and at this disposal rate and at 35% loss, about 327 ppm NO_3^- in the water of the unsaturated zone is predicted. This is in close agreement with the average value of about 315 ppm NO_3^- found in the water at a 10- to 19-ft depth underneath croplands and pastures. From these data it is predicted that the disposal rate must be about three to four cows per acre per year to obtain a NO_3^- level of less than 45 ppm in the drainage water.

Research needs

The manure disposal problem in the Chino-Corona area is aggravated by (1) high costs of land; (2) the grouping together of many dairies to increase the efficiency of production, which favors even higher concentrations of cows than presently exists; and (3) manure trucking costs which make disposal of wastes on lands outside of the dairy area economically unattractive. If high rates of manure disposal within the dairy area are to continue, research is needed on (1) recycling of N and other nutrients under the local conditions so that proper limits can be placed on the rate of disposal of manure under present handling and disposal practices; and (2) modification of the product to remove salts and N so that rates of disposal can be increased without adverse effects on water quality. Research is also needed on alternatives to land disposal of manures.

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A progress report . . .

DATES

Asparagus is direct-seeded in California from early spring until late summer, with reasonable success. Normally, the plantings are made as early in the spring as possible, similar to the practice followed in transplanting crowns.

Direct-seeded asparagus plantings are grown for two seasons before the first harvest is made. The year of seeding is counted as one season of growth. Depending on the date of planting, the physiological age of the plants at the time of first harvest could vary as much as six months. This difference in the ages of the plants would result in considerable differences in plant size at first harvest and could adversely affect the performance of the planting in subsequent years.

This report summarizes the data obtained on plant size, plant density, and initial yields, as influenced by date of planting and cultural practices.

Three tests

Three tests were initiated at the Citrus Research Center, Riverside—all on Ramona sandy loam soil. In 1967 the trial was sprinkler irrigated. In 1968 a comparison was made between sprinkler and furrow irrigation. Asparagus Var. 500W was planted in two rows 14 inches apart in the bottom of flat-botton, pre-formed beds 8 inches deep. The beds were spaced 5 ft apart, center to center. Plants were grown the first season in open beds. Prior to the beginning of the second season, the beds were reshaped and the plants were covered with 6 inches of soil. The irrigation furrow was moved to the outside of the planted rows.

The four plantings (treatments) were made about the fifteenth day of the months of March, May, July, and September. Harvest data were collected on the furrow irrigated test. The two sprinkler tests were terminated the second season.