figures were compared with measurements of the amount of food eaten by captives, the two sets of figures were in close agreement.

The daily food requirements of the various species ranged from 8.3 grams for the house sparrow to 17 grams for the Brewer blackbird. The total amount consumed by all birds at the feedlot was arrived at by multiplying the daily food consumption of each species by the average daily number of birds of that species present in the feedlot. It was learned that during the five months when birds were attracted to the feedlot, they consumed between 200 and 500 lbs of food per day, which adds up to between 32,500 and 74,000 lbs for the winter season.

Because approximately 40% of the food was spillage or was extracted from manure and could not have been utilized as cattle food, that amount had to be subtracted from the total to arrive at a correct dollar and cent figure of the extent of economic damage done by birds.

By subtracting that part of the diet of the birds which was waste grain, it was found that the direct economic loss caused by birds at the Rummonds Brothers Feedlot amounted to between $3.60 and $8.40 per day—or between $564 and $1,296 for the five winter months. These figures closely match estimates made in studies at a Denver, Colorado feedlot by the U.S. Fish and Wildlife Service.

It should be emphasized that the economic loss which birds cause feedlot operators by stealing grain directly from the troughs may be offset by beneficial habits elsewhere at other times of the year. It is particularly important to know the feeding habits of the birds during the greater part of the year when they do not congregate at the feedlot. Therefore, before control methods are undertaken, the total ecological and environmental impact of the birds should be given consideration.

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SOIL RECYC
OF CANNERY

A. D. REED

W. S. SEYMAN · R. S. AYERS

IN 1969, CONCERN FOR THE ENVIRONMENT and problems with existing methods of disposal of solid wastes from canneries led the Santa Clara County canning industry to investigate new approaches to waste disposal. In 1970 the local industry formed the Cooperative for Environmental Improvement (CEI) and, in conjunction with local government officials and farm advisors of Santa Clara and San Benito counties, developed the program now in use. The program utilizes the process of soil incorporation to achieve aerobic degradation of the cannery wastes. Plant nutrients released in the process become available for "recycling" by subsequent plant growth.

Soil incorporation

Screened tomato and fruit waste solids formerly disposed of as sanitary land fill or in livestock feeding operations are now hauled to a 2,300-acre leased site and are systematically spread onto prepared land. Following additional field spreading by a tractor-drawn double pipe drag-float, the wastes are allowed to air dry for two days prior to discing. The process of dragging and discing is alternated several times at appropriate levels to complete drying and soil incorporation of the wastes. The primary management procedures are directed toward the prevention of fly problems and excessive odors.

This method results in the soil incorporation of about 15 tons of dry matter derived from 150 tons of wet waste per acre per application. Currently, only one application is made during the season to each acre of land used.

Site

The 2,300-acre waste disposal site in these tests is located in northern San Benito County approximately six miles southeast of Gilroy. The area largely consists of flat, westerly sloping, poorly drained, basin land clay soil of marginal agricultural value. Mainly used for pasture and occasionally for grain, the land is annually subject to localized winter

Beginning of a delivery "run" by a 30 cu. yd. capacity "end-dump" semi. Evenness of spread of cannery waste material along the "run" is influenced by trucking equipment, driver skill and consistency of waste material.

'LING WASTES

W. E. WILDMAN

J. D. PRATO · R. S. RAUSCHKOLB

Top photo: Cannery waste recycling site from 65,000 feet (see article, page 3) (as indicated by arrows)—U-2 flight, March 3, 1971. The cross figure (center left) is the runway of the Hollister airport, San Benito County.

Center photo: Aerial view of a portion of research plots ("ladder"). White strips show Anza wheat growing in areas treated with varying rates of tomato and fruit wastes.

Bottom photo: Ground level view of portion of research plot area planted to Anza wheat. (Black and white prints were from infra-red slides.)

flooding and to more general flooding during very wet winters—which occur on an average of one year in ten.

Except for the 1972 season when heavy early October rains forced closure, site conditions have not caused serious operational problems. Since July, 1970, approximately 270,000 tons of fruit and vegetable wastes have been incorporated, using a little less than half of the total 2,300-acre area. Regular monitoring by Santa Clara-San Benito County Health Departments has reported no fly or sanitation hazards during the three seasons of site operation.

Basic equipment

Four basic pieces of equipment are used in the operation: a wide tread, four-wheel-drive 140 hp diesel tractor; a weighted 18-ft-wide drag float constructed of two tandem arranged ten-inch-diameter heavy-walled steel pipes; a heavy duty, reinforced hydraulic 16-ft double disc; and a folding boom spray rig.

The first three units are used to prepare the ground in the pre- and post-harvest seasons and to spread and incorporate the wastes applied during the harvest season. The folding boom spray rig is a stand-by unit for fly control purposes. To date, it has not been used—a testimonial to the successful management and use of the other three units.

A recognized major hazard to maintenance of a trouble-free operation is the possibility of premature site closure due to substantial unseasonal rains. Available alternatives designed to deal with this situation are limited. If rains are not prolonged, the use of unworked, hard-surfaced land at the site provides one means of coping with the problem. The other alternative is through temporary reversion to the sanitary land fill method.

Management

General management of the program is vested in the non-profit Cooperative for Environmental Improvement, Inc. (CEI), formed by the local canning industry for the express purpose of dealing with the industry's waste disposal problems. Business matters are dealt with by elected officers and a board of directors.

Hauling of cannery wastes from the canneries to the recycling site is on a contract basis between the individual canneries and local independent trucking firms. Management of the recycling site operations is on a contractual basis between CEI and the site operator.

The key elements in the successful management of this particular cannery waste disposal operation are: (1) development of a canning industry organization (CEI) to manage the industry's waste disposal program on a continuing basis; (2) study of recycling site requirements and care in choosing site locations as related to public nuisance and sanitation hazards; (3) conscientious on-site management by a knowledgeable manager with respect to strict maintenance of health department standards of sanitation; and (4) recognition of the need for study and research on the long-term potential benefits and hazards of the method to the recycling site area and to the surrounding environment.

Costs of disposal

Costs of disposing of cannery waste at the San Benito County site include transportation to the disposal area, and operating costs at the site. Hauling costs have varied from $1.50 per cubic yard for hauls of 10 miles or less to a high of

High consistency tomato waste being spread with double-pipe drag-float. "Mounding" of delivered wastes, as shown here, is undesirable because repeated "passes" are required to spread waste to a desired (maximum) 2" to 4" depth.

ANALYSIS OF APPLIED FRUIT WASTE MATERIAL IN SOIL RECYCLING OF CANNERY WASTES*

Kind of† material	Water‡ content	Total N	Total P	Total S	Soluble Cations Na	Ca	Mg	K
	% FW	Percent DW			ppm DW			
Peach-Pear	86.27	0.978	0.133	0.076	16.9	33.8	72.6	82.3
Tom.-Mixed	89.86	1.838	0.313	0.219	13.7	20.4	23.6	125.3
Peach-Pear	88.70	0.818	0.128	0.169	8.3	15.3	11.3	94.4
Peach	85.42	0.608	0.099	0.065	10.5	16.5	51.7	89.2
Mixed Frt.	89.38	0.999	0.152	0.151	20.0	28.2	15.8	67.9
Peach-Pear	82.74	0.601	0.087	0.087	11.3	20.1	79.7	77.3
Peach	84.80	0.891	0.126	0.062	7.2	16.3	18.3	105.3
Pear	87.17	1.368	0.179	0.371	23.6	32.4	14.4	120.6
Peach-Pear	88.99	0.914	0.093	0.027	23.2	9.1	13.7	99.2
Mixed Frt.	88.39	0.702	0.109	0.069	37.2	34.3	16.4	65.8
Mean	87.17	0.97	0.14	0.13	17.18	22.64	31.74	92.72

* Each figure represents a mean of 9 analyses (3 samples × 3 replications).
† Mixed fruit samples were a mixture of peach, pear, plum, grape, and cherries.
‡ Calculated on a fresh weight basis; all other data on a dry weight basis.

$3.00 per yard for hauls of 30 to 40 miles.

Costs of running the recycling site were 90 cents a cubic yard for the first year and 65 cents the second year. The first-year costs were higher due to organizational and start-up costs. Also, a 20% higher volume of material was handled the second year with the same amount of manpower and equipment.

Costs of operating the recycling site were divided as follows:

	Costs per yard
Land rent	$ .30
Equipment	.12
Equipment operators	.04
Manager	.10
Payroll taxes	.05
Insur., office, accounting, etc.	.04
TOTAL	.65

The site contains considerably more land than is actually being used so it might be possible to reduce the land cost by renting less area. On the other hand, the extra land may be good insurance in terms of isolation, room for future expansion, or a potential discovery that land will not handle such large applications of waste for a prolonged period.

Environmental effects

U.C. researchers have worked to develop information about environmental concerns in the recycling site area. To date, these investigations suggest that under the specific conditions of this recycling site, adverse environmental effects are not likely to occur. Also, results to date indicate that the procedure may provide certain limited "bonus" benefits to the land.

Investigations also suggest that under these specific conditions, the annual per-acre rates of cannery waste application are limited more by immediate on-site sanitation requirements than by the rate of soil assimilation of the wastes.

Water quality

There are two concerns about water quality in the land disposal of cannery wastes: (1) the potential for degradation of surface waters; and (2) the potential for degradation of the deeper underground water supply.

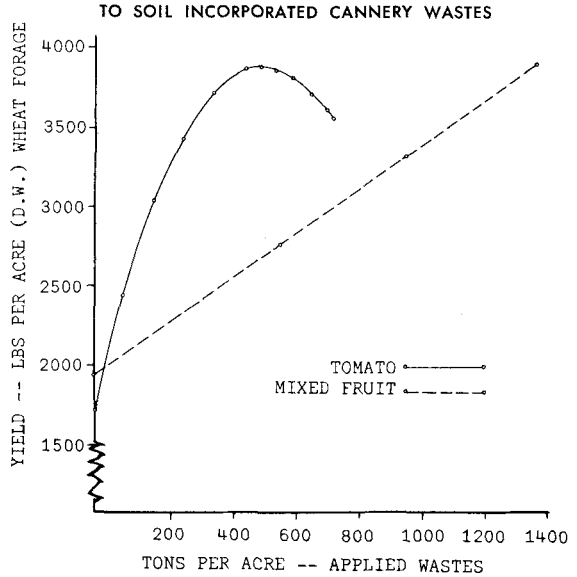
Surface drainage at the site and in the surrounding area flows to the Pajaro River and then to the sea. Low rainfall during the winter of 1971–72 soaked into dry soils and no run-off water quality data were obtained.

Sub-surface drainage is a comparatively slow process. Waters percolating down from the soil surface dissolve nutrients and other soluble materials. Under some conditions, these solubles could reach the deeper water basin. The surface soils of the disposal site, however, are heavy clays. Subsoils to 3 ft are also clays. Below this depth, alternating clay and sand layers occur to about the 9 ft level. A dense blue clay lies below the 9 ft level. The sand layers between 5 and 9 ft are usually saturated and hold a perched water table. In June, 1971, prior to disposal of wastes in the plot area, the water in this perched water table under the trial plot area was sampled.

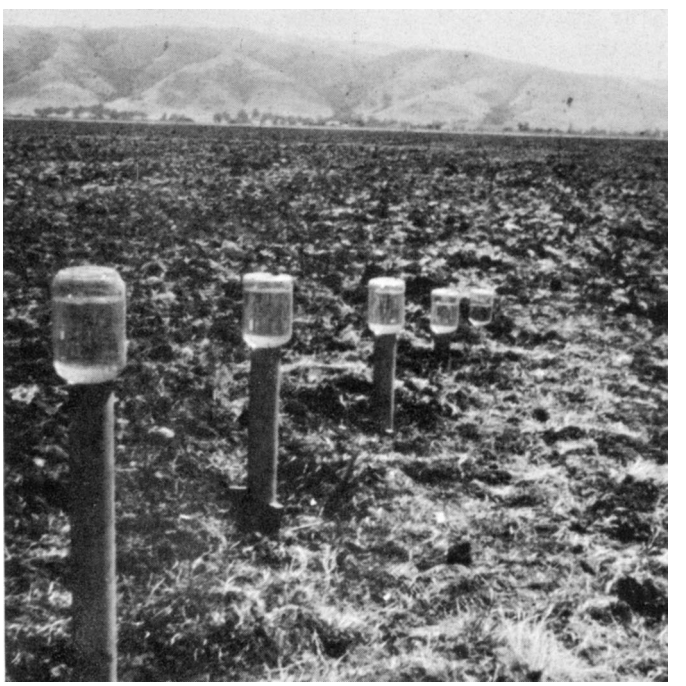
The analyses indicate the perched water table existing prior to disposal of cannery waste in the plot area is of unacceptable quality for any use. This water is about twice as salty as the ocean and is made up mostly of chloride and sulfate salts of sodium and magnesium. The clay surface soils coupled with severe restrictions to downward percolation and the unsaturated clay soils below the very poor quality perched water gives good indication that there is little chance the deeper permanent water basin will be degraded by applications of waste to the surface.

Possible benefits to soil physical and chemical properties that might be expected from applying wastes are primarily the improvement of soil tilth in the

WHEAT FORAGE YIELD RESPONSES (PROJECTED) TO SOIL INCORPORATED CANNERY WASTES



Infiltrometer Tests—Rates of water infiltration into soils in research area are checked prior to waste application.



Low consistency "ground" pear wastes being spread following delivery by "bottom-dump", 36 cu. yd. capacity truck-trailer unit (background).

Following several days of drying between each operation, waste treated areas are disced, dragged and, as shown here, re-disced.

near surface soil (0 to 12 inches), and the removal of salts and sodium from this and the upper subsoil (12 to 36 inches). The first-mentioned benefit derives largely from the more favorable soil structure promoted by repeated additions of organic materials, while the second benefit could result from: (1) greater infiltration of surface water as a result of improved soil tilth, and (2) displacement of sodium and salts by breakdown products of the organic residues. If both benefits were realized, this saline-alkali Willows clay could be a much more productive and versatile soil than formerly.

Permeability tests run at six locations were highly variable, even though the profile appeared identical at all locations. Generally, soil at the 24-, 30-, and 36-inch depths was quite permeable—greater than 1-inch per hour. This corresponded with the lower density zones and with the transition from clay to fine sand. Soil at the 12 inch depth was the least permeable, with a permeability of 0.1 inch per hour, or less at most locations. Nevertheless, it appears that in a normal rainfall year, water would be able to percolate through the profile to the perched water table.

Any permanent improvement in the sodium and salinity status of this soil will require drainage of the perched water table which fluctuates from near the 2 ft level to near the 9 ft level, depending on time of year and amount of annual rainfall. The perched water is too saline for plant utilization and poses a constant salinity threat to the soil above it. Paradoxically, the physical characteristics of this soil that prevent the achievement of maximum agricultural benefits from the applied wastes may be the same characteristics that make it a desirable location for the recycling of these wastes.

In 1971 initial testing indicated a positive plant growth response—after applications of both mixed fruit and tomato wastes at the rate of 150 tons of wet waste material per acre—the nominal standard application of the commercial operation.

An experimental plot occupying 10 acres was established in 1971 to evaluate the effect of various application rates of two kinds of cannery wastes on plant growth. Application rates varied from 0 to 770 tons of wet waste material per acre for tomato wastes and from 0 to 1,420 tons of mixed fruit waste per acre.

The entire experimental area was planted to Anza wheat in the fall of 1971. A single harvest of wheat forage was made in the spring of 1972 to measure the plant growth effects of the applications. Applications of both types of waste gave a positive response but the responses to two types differed. For the range of application rates studied with fruit waste, a significant linear response was obtained. The results for the range of tomato waste application rates studied showed a significant curvilinear response with a decline in yields at the higher application rates. The predicted maximum growth response from tomato waste occurs with an application rate of 550 tons per acre.

The regressions obtained from analyses are shown in the graph. No positive explanation for the differing responses to the two materials can be given at this time. Over the range of application rates which were common to the two materials, the tomato waste gave the greatest plant growth response.

Data are not available on cumulative long-term effects of soil incorporation of cannery wastes on plant growth. The highest application rates used in the test plot area are, however, approximately equivalent to 6 or 7 years of application at the normal 150 tons per acre per annum rate. By inference, these data suggest no adverse long-term effects of normal application rates of cannery wastes on subsequent plant growth.

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