Rural Latrine Systems, A Pilot Project in the Ryukyu Islands

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UNIQUE conditions in the Ryukyu Islands were considered in planning and developing a sewage disposal system for rural areas. Planning was influenced by geographic location, variation in geologic structure, cultural and regional desires, and availability of sufficient funds for improvement.

The population of the Ryukyu chain, approximately 1 million (*1*), is distributed over 47 islands. Of the inhabited islands, 30 have populations of less than 1,500 people. The per capita income in 1969 was US$653, but the amount available for capital improvement at the home level is variable.

Two factors have been primarily responsible within the last decade for initiating and developing the rural latrine system. First, chemical fertilizers have been used increasingly instead of human excreta, and no effective ways have been found for disposing of accumulated human wastes. The other factor relates to health conditions on the islands. Intestinal parasitic infections have been increasing among the rural people. Kato (*2*) found hookworm infections in more than 50 percent of the groups he surveyed. Outbreaks of gastroenteritis in rural communities have occurred regularly. Investigations by the Preventive Medicine Section of the U.S. Civil Administration and the Government of the Ryukyu Islands have incriminated inadequate disposal of human waste products as the factor frequently responsible.

Materials and Methods

The basic design of the rural latrine was obtained from a project in India that was sponsored by the India Ministry of Health and the Ford Foundation (*3*). The design features a trap with a shallow ¾-inch water seal, and flushing can be accomplished with only 1 to 2 liters of water.

Certain features of the design were thought to be inadequate for the Ryukyu Islands, and two

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This material has been reviewed by the Office of the Surgeon General, Department of the Army, and there is no objection to its presentation and/or publication. This review does not imply any indorsement of the opinions advanced or any recommendation of such products as may be named.

principal modifications were made: (*a*) three septic tanks, connected in series, were added to provide primary treatment; and (*b*) to control the effluent from the third tank, a terminal oxidation pond was attached. The three-tank system has a normal liquid capacity of 1,850 liters (approximately 500 gallons). The number of tanks may vary, and the terminal portion may be either an oxidation pond or a drainage field. Where soil conditions permitted, a gravel drainage field replaced the pond (figs. 1 and 2).

Construction materials for the latrines were obtained locally, with the exception of the imported prefabricated porcelain commodes. The septic tanks were modified precast concrete tanks, produced in the past as a village cottage industry to store rainwater collected from building roofs. They are used at homes to catch rainwater. Cost of the materials for the basic system, excluding the shelter, was about US$125. The system can be constructed by a homeowner (with the help of neighbors) in 40 to 60 hours.

Results

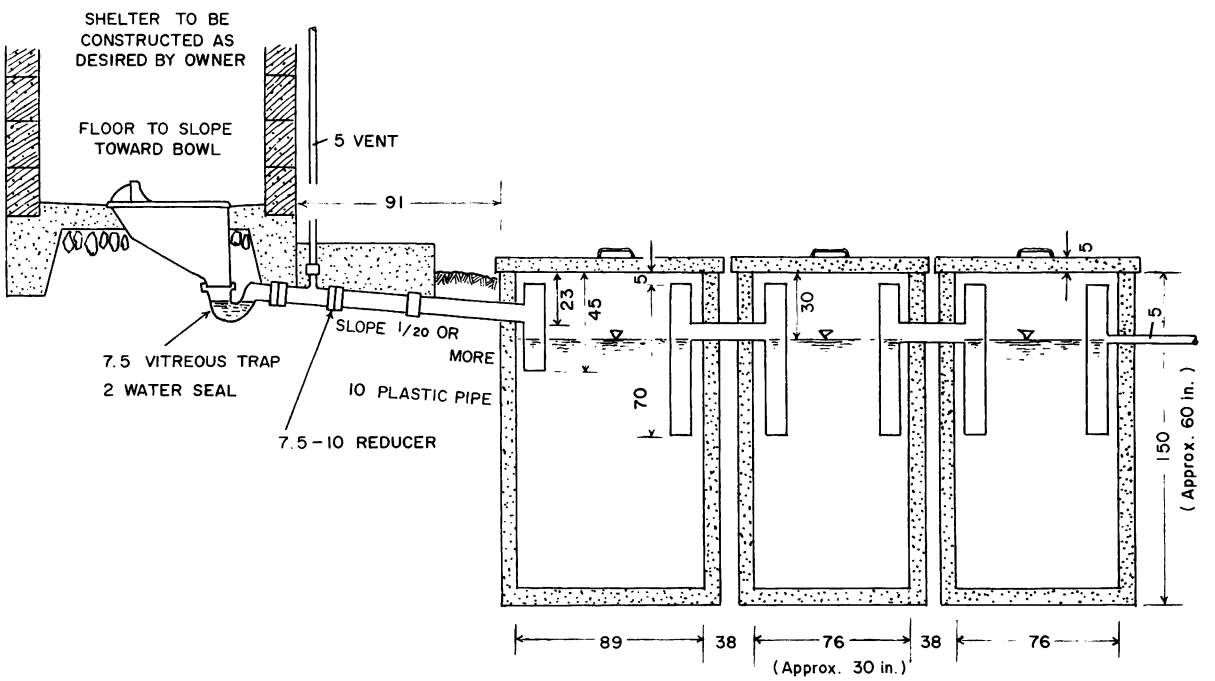
Seven pilot systems have been used for periods ranging from 4 years to less than 1 year. Periodic observations have been made of their efficiency. Tests were performed by staff of the hygienic laboratory of the Government of the Ryukyu Islands and of the Tybase water quality laboratory of the U.S. Army.

Comparisons of the total suspended solids with the expected amounts of waste generated after 1 year of use showed that the volume of solids was reduced approximately 96 percent.

An oxidation-stabilization pond was sampled monthly for coliform determinations. Over 1 year, the effluent in the second compartment of the pond showed an average coliform count of 8,800 per 100 ml. The average reduction in coliforms between the first septic tank and the terminal portion of the oxidation pond exceeded 99.5 percent. Comparisons of coliform count in the terminal compartment of the oxidation pond with existing levels in raw water sources in the Ryukyu Islands revealed that the pond coliform level was consistently below the raw-water coliform level. No viable eggs of intestinal parasites were found in the third septic tank. Viable hookworm eggs were found intermittently in the second septic tank.

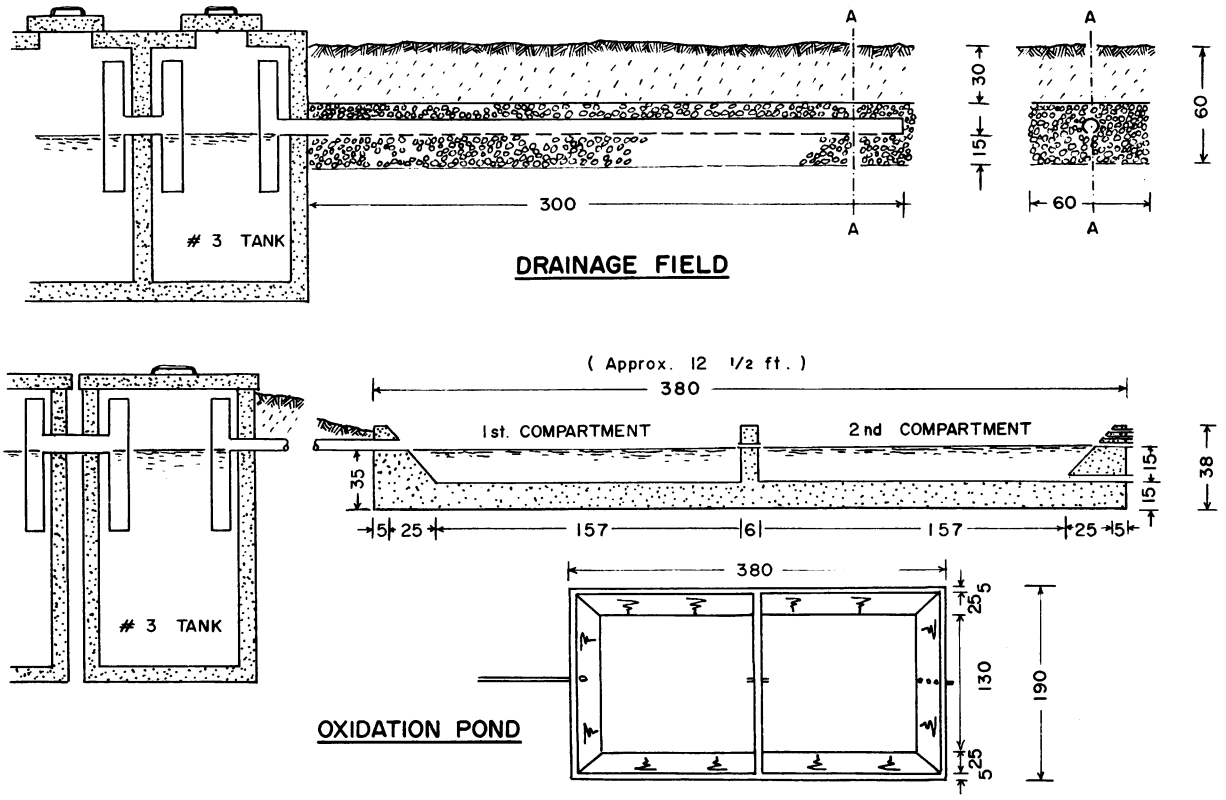
The pilot projects have been relatively free from major maintenance troubles. The families using the system have been urged to clean the septic tanks yearly; those families with a terminal oxidation pond are required to have it cleaned every 2 months. The water is generally used to

Figure 1. Cross section of rural latrine system in the Ryukyu Islands, 1970



NOTE: measurements in centimeters unless otherwise indicated.

Figure 2. Terminal drainage field and oxidation pond of rural latrine system, Ryukyu Islands, 1970



NOTE: measurements in centimeters unless otherwise indicated.

supplement irrigation of the family garden. The families are instructed to irrigate the plots during or immediately after a period of sunshine; that is, after a high-level oxidation treatment.

The systems have been free of any disagreeable odors. Observation of the pond studied has shown no mosquito breeding, which supports the observations of Porges and Mackenthun (*4*).

Discussion

This human waste disposal system appears to be effective, inexpensive, and particularly suitable for rural areas; specifically, for families with low incomes and inadequate water supplies who are not within the geographic limits of waterborne sewage systems of urban areas.

Use of a terminal drainage area is preferred to an oxidation pond because the pond requires too much land, and accidents to children playing near the ponds are possible. Where an oxidation pond is used, it is recommended that a fence be placed around it.

From the public health point of view, the rural latrine system is a substantial improvement over existing conditions on the islands. This system is technically superior to the night-soil holding containers being used. Its major treatment process greatly reduces the coliform level and removes a large amount of solids. In addition, it effectively prevents infectious material from entering the springs and underground water catchments.

Hookworm disease is the leading intestinal helminthic infection in the Ryukyu Islands. The system is effective against it and other parasitic infections. *Entamoeba histolytica* apparently does not present a threat. Amebiasis and its complications are infrequently reported in the Ryukyu Islands; the cysts are deactivated by a combination of temperature and detention time in the septic tanks. Theoretically, the eggs of *Ascaris lumbricoides* can survive under unfavorable conditions and could be a problem, but the Okinawa Anti-Parasite Association has reported that this parasite was found in less than 1 percent of people examined (*5*). A more efficient way to remove human excreta from the environment plus

additional facilities for handwashing would further reduce the risk of infection by *Strongyloides stercoralis, Trichuris trichiura, and Enterobius vermicularis.*

Despite the technical and medical effectiveness of such a latrine system, the ultimate factor determining its success is acceptance by the user. As the program has developed, acceptance has received detailed attention. The toilet was designed with the cultural habits of the people in mind and built along accepted designs. Community leaders were chosen to sponsor the first toilets to add "status" to the system. Mayors and community elders were given the chance to evaluate the program, and the support of private organizations was obtained. The effectiveness of the system in reducing hookworm disease particularly appealed to the Okinawa Anti-Parasite Association.

The rural sewage disposal system offers a significant improvement over existing practices in selected semitropical areas for the disposal of human excreta. The system is effective and within the economic reach of rural dwellers. Its long life has demonstrated that such a program is feasible. Concurrent health education efforts have helped to convince the people that the existing methods are inadequate.

REFERENCES

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A latrine system has been modified for rural use in the Ryukyu Islands. The latrine features a shallow, ¾-inch water seal and can be flushed with 1 to 2 liters of water. The three-tank system has a normal liquid capacity of 1,850 liters (approximately 500 gallons). Tanks are precast concrete produced in the past as a village cottage industry to store rainwater collected from building roofs.

The system, as innovated, provides a high degree of treatment. Suspended solids are reduced 96 percent, and coliform counts are decreased approximately 99 percent. In selected semitropical areas, this latrine offers advantages over the night soil receptacles usually used. The system is adaptable to variable site conditions. The number of tanks may vary, and the terminal portion may be either an oxidation pond or a drainage field. The system can be constructed by the homeowner, with the help of neighbors, in 40 to 60 hours. Cost for materials in the Ryukyu Islands was US$125, excluding the shelter.