Ethics and the Food System:  
A Case Study of Heptachlor Contamination of Oahu Milk*

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In March of 1982, the majority of milk on Hawaii's most populous island, Oahu, was found to be contaminated with the pesticide heptachlor. Following this discovery, approximately 36 million pounds of milk were removed from market. The incident frightened consumers, who now live with the uncertainty that their exposure to heptachlor may have future health consequences. It damaged the image of the local dairy industry and resulted in a wide range of cleanup costs, including $8,551,515 in indemnity payments made by the federal government to dairy producers for the milk that they had to dump. It damaged the image of the government agencies who were responsible for ensuring the safety of the milk supply. It resulted in millions of dollars of legal costs for almost every conceivable actor in the case.

The Oahu case is instructive because it demonstrates the role that numerous people must play to ensure a safe and wholesome food supply. It is a natural laboratory for examining ethical issues facing a wide range of actors within the food system. With hindsight, we can go back and ask who these people were, what their responsibilities were and to whom, and what caused them to act as they did. We can ask ourselves how we might have acted in their place and how we might act in the future in similar positions of responsibility. We can learn something about what those responsibilities might be and the difficulties we might face in trying to carry them out.

A chronology of important events in the Oahu case covering the period of January 1982 to June 1983 is presented below. It describes the origin of the contamination incident and reactions of consumers, government, industry, and the media to it. The chronology is based on the Report of the Senate Special Committee Investigating Heptachlor Contamination of Milk (1983), over 500 newspaper articles and letters to the
editor in the two major Oahu newspapers, the Honolulu Advertiser and Honolulu Star-Bulletin, numerous other articles, and conversations with many individuals in Hawaii and elsewhere. The chronology reveals the difficulty of controlling a contamination incident and the legal and market consequences of this. To understand the events that occurred, some background information on milk production and consumption in Oahu is helpful. This background information is contained in the appendix.

**CHRONOLOGY OF THE OAHU MILK CONTAMINATION INCIDENT**

The story of milk contamination began in Oahu's pineapple fields. Pineapples suffer from mealybug wilt, named after the vectors which feed on the crop. Ants protect the insects from predators because ants consume the mealybugs' "honeydew" secretion. It was found that by eliminating ants, mealybug wilt could be controlled. To do this, DDT was first used, followed by mirex, and then by heptachlor. Each of these pesticides are organochlorines, and hence extremely persistent in the environment.

In the 1960s the U.S. Food and Drug Administration (FDA) set a zero tolerance for heptachlor residues in food. (A tolerance is the amount of a substance the federal government will tolerate in particular food stuffs.) An action level (the level of residue which will prompt FDA action on a product lot) of 0.3 parts per million (ppm) on a fat basis was established since no smaller quantities could then be detected. In laboratory animal tests, heptachlor has caused liver and kidney damage and is a suspected human carcinogen. It is estimated that about 90 percent of Americans carry heptachlor residues in their bodies. The EPA banned heptachlor use in 1978, but granted an exemption to the Hawaiian pineapple industry. A stipulation was that growers had to wait one year after the last application before a field could be harvested for animal feed.

Pineapple plants had been harvested as "green chop", a cheap, local substitute for imported dairy forage since 1958. With help from the Department of Agricultural Engineering at the University of Hawaii (UH), harvesting became more efficient in the late 1970s and included the base of the plant, where heptachlor apparently
accumulated. It was later found that green chop samples from April 1981 contained high heptachlor levels. Being fed to dairy cows, the pesticide was excreted in the milk.

It is now believed the Oahu milk supply contained heptachlor as early as October 1980. Violative levels were present in milk bottled in April and May 1981, and high but nonviolative levels were found in ice cream made that May. However, milk bottled in July and August was found to be below the action level. The Hawaiian State Department of Health (DOH) semi-annually checked for pesticide contamination in milk, and no violative levels of heptachlor were detected in the July 1981 tests.

On January 22, 1982, DOH Food and Drug Branch Chief, Karl Tomomitsu, received test results from a sample of homogenized milk and samples of raw milk from three dairy farms. All samples, which had been taken January 6, contained violative residues of heptachlor. Other samples taken January 13 showed no detectable heptachlor residues. Upon recommendation from the lab, Tomomitsu asked the lab to send the older samples to the FDA lab in California. Three days later, the lab sent the samples, but with no note of urgency attached. Tomomitsu did not develop an action plan in case the original results were confirmed, and did not inform his superiors. By January 22, all milk produced on January 6 and used for fluid consumption had either been sold or had expired. Some Class II products (soft manufactured dairy products such as ice cream and yogurt) could have still been for sale at the time the initial test results were received.

Thirty-five days later on March 1, confirmation by the FDA was received. Branch Chief Tomomitsu initiated an investigation to detect the source and extent of the contamination, assisted by Milk Commissioner Roy Matsuura. Neither informed their superiors. Eight farms, including the three previously tested, and both processors were sampled March 9. Two days later, Tomomitsu informed his superiors of the contamination, including DOH Deputy Director for Environmental Health Melvin Koizumi. Dean Noel Kefford of the University of Hawaii, College of Tropical Agriculture, was consulted after the UH lab confirmed the contamination. Kefford
wrote Commissioner Matsuura: "...Continued consumption of milk with the reported heptachlor epoxide residues would not appear to constitute an unreasonable hazard to the general public, even those judged to be most sensitive. More serious would be an announcement of this technical violation of a tolerance...and subsequent prohibition of the sale of milk from dairies and processors. No amount of explanation of the technical nature of the violation would expiate the damage done to the reputation of milk as a wholesome food and coincidentally to the dairy industry...(p)recipitate action which results in a perception by the public that the milk supply contains hazardous materials should be avoided." (In Hawaii Senate, 1983).

On March 15, test results indicated both milk processors (Meadow Gold and Foremost) and seven out of the eight farms sampled were in violation of the action level. The next day, Deputy Director Koizumi informed DOH Director George Yuen, an engineer. Yuen ordered more tests to determine whether contamination levels were falling. A day later, the same eight farms were retested. By Thursday, March 18, the media learned of the contamination and a report appeared about possible State action in the afternoon paper. At 4:30 p.m., before the latest sampling results were known, the DOH ordered the first of eight mandatory recalls.

The Recalls and Their Aftermath

Oahu residents read across their next morning's newspaper, "Toss out that milk in fridge--it contains pesticide poison." Homogenized, 2 percent, 1 percent acidophilus (for those allergic to milk), and half-and-half milk were pulled from grocers' shelves. Since heptachlor concentrates in the butterfat, skim milk was not pulled and neither were those products processors said were made with imported butterfat (ice cream and other Class II products). Imitation milk (skim milk combined with vegetable oil) was declared safe. Without announcing it, Foremost also pulled buttermilk and sour cream it believed might have been contaminated. Health Director Yuen believed this was an isolated incident and said the public was not endangered even though heptachlor levels three to
six times the action level were found. Supplies on grocers' shelves that day were deemed safe. When asked about the delay in pulling milk, Yuen answered, "It took time to determine the exact course of action to take" (in Hastings & Harpham, 3/19/82). The Department of Education switched from serving fresh to imitation milk in schools.

Both processors offered refunds for the 180,000 gallons of milk returned by consumers. Meadow Gold President Robert Milne encouraged the public to call his company with any questions. Dr. James Koshi, former dairy specialist with the UH and general manager of the 50th State Diary Farmers' Cooperative, assured the public, "We're out to produce the best product" (in Hastings & Harpham, 3/19/82).

Within 36 hours of the recall announcement, acceptable milk supply was only more than half of normal supply. Both Meadow Gold and Foremost cut half-and-half production, with Meadow Gold supplying normal levels of whole and 2 percent milk. Meadow Gold's estimated loss from dumped milk and milk refunds was $250,000 (Harpham, 3/20/82). Foremost, whose supply was more drastically affected, increased production of imitation milk. Governor George Ariyoshi and health officials assured the public that it was not endangered, and most, but not all, medical experts who were quoted agreed. Lack of consensus of heptachlor's health effects was constant throughout the incident. Criticism of the DOH's delay began to be voiced, as well as dairymen's anger that they had not been informed of the problem.

Supermarkets reported heavy returns and initially brisk sales of powdered and canned milk before consumers learned that imitation and skim milk, in plentiful supply, were safe. Neighbor Island milk sales were down, even though contamination was limited to Oahu. Calls to hospital emergency rooms increased. Meadow Gold was flooded by telephone inquiries but continued to invite such calls, saying "We feel people have the right to know" (in Harpham, 3/20/82).

Meadow Gold dumped so much milk down the storm drain and not into the sewer system as directed by the DOH that the channel into which it emptied became
deoxygenated. Tens of thousands of fish died in milky waters and attracted newspaper photographers.

Dairy cow slaughter was halted until pesticide tests were performed, which later showed heptachlor levels above the action level. Headlines on Tuesday, March 23, reported that two of the three acceptable dairy farms supplying Oahu were actually in violation of the action level. Hence, it was possible that unacceptable milk had been consumed over the weekend. It was later suspected that Meadow Gold knew some of its supplies were probably contaminated. Foremost's only fresh milk supply was imported from Hawaii and Maui. No milk was recalled, but one supermarket voluntarily pulled milk from its shelves. Some stores had posted signs saying the milk was safe, and several store managers were now confused about milk safety. The DOH allowed the processors to use contaminated milk to make skim milk, and most milk available was skim, imitation, and recombined. Consumer refunds continued. Senate Health Committee Chairman Benjamin Cayetano heightened criticism of Health Director Yuen, just stopping short of calling for his resignation.

Less than a week after the first recall, the DOH ordered Meadow Gold 2 percent milk pulled as a precaution for violative heptachlor levels. Meadow Gold offered a refund. Some stores reported milk stock-outs by closing time, but many others reported no milk, even skim and imitation, was selling. Sales of condensed milk were up, and runs on powdered milk were reported. Comments by store managers reflected the situation: "Consumers are confused--they just don't know what's safe now" (in Harpham & Hastings, 3/24/82). "People...have kind of lost confidence and think no one really knows what's happening. So they're staying away until things are sorted out...Recent events have set back the dairy industry 10 years" (in Kakesako, Gomes, & Morita, 3/25/82). "The state really blew it" (in Watanabe & Morita, 3/24/82).

Two small dairy farms were cleared, but the other 14 dairy farms with 95 percent of Oahu cows were contaminated. The Chairman of the UH Department of Animal Science,
Richard Stanley, stated that one bad batch of green chop fed for two to three weeks in December was responsible for the incident. It was a "one-shot incident" (in Harpham & Hastings, 3/24/82). Meadow Gold joined Foremost by importing milk from other islands; total March imports were 8,250 gallons. The DOH announced that test results were needed before a recall could be ordered, a policy not followed for the first recall. The Health Director said the DOH lacked adequate lab facilities, but that it was trying to increase the frequency of testing and improve internal communications.

A week after the first recall, Governor Ariyoshi, Health Director Yuen, and UH officials again tried to assure the public that milk was safe, the recalls were precautionary, and that there was "no evil force at work" (in Kakesako, Gomes, & Morita, 3/25/82). UH Dean Kefford explained that the action level is a regulatory level and does not necessarily indicate a health threat if violated. But Senator Cayetano began publicly questioning the use of raw contaminated milk to make skim milk and asked the Attorney General to investigate its legality.

Ten days after the first recall, Foremost milk distributed in Waikiki was pulled for heptachlor levels above the action level. The milk came from a farm previously cleared by the DOH, and Foremost President Paul Heckenlively declared, "If they (the DOH) don't get their act together, the milk industry will be destroyed" (in Ong, 3/28/82). Dairymen also blamed the confusing DOH test results for causing confusion in the marketplace. The State agency announced it would try a new sampling procedure "because some of what (the DOH has) gotten up to now has not been representative" (in Harpham, 3/30/82).

March went out like a lion. The fourth recall in less than two weeks was announced, together with Health Director Yuen's immediately effective resignation and the appointment of his successor. The DOH pulled Meadow Gold cultured buttermilk, and the Attorney General began investigating whether the company knowingly used milk of an unknown, and so possibly contaminated, origin. Again, Governor Ariyoshi declared the
safety of milk, but processors had more milk than could be sold. Supplies were low, but
demand was apparently less. Ample supplies of imitation and recombined milk were
available. Yuen cited personal reasons, and not the milk crises, for leaving. He partly
blamed the dairy industry for the crisis and accused the media of accentuating the
negative. Senator Caytano, unsure if milk on the shelves was safe, claimed Yuen's
resignation was the first step toward restoring public confidence. That confidence had
been shattered, and former Superintendent of Education Charles Clark, with no public
health background but a reputation as an efficient administrator, was chosen by the
Governor to succeed Yuen as Director of the Department of Health.

April began with much media attention given to the poor handling of the situation by
the State. Senator Cayetano criticized the Governor for failing to take action and
blasted the DOH for slow action, which he claimed eroded public confidence in
government. He accused the DOH and the dairy industry of putting economic
considerations before protection of public health. The Senator was also appointed
Chairman of the Senate Special Committee to investigate the incident. Acting Health
Director Charles Clark, was endorsed by the Honolulu Advertiser, which editorialized,
"Many people will be understandably skeptical about the milk situation for a
while...despite assurances from some in government, including Yuen and medical people
that milk was safe to drink all along" (4/1/82). Also in early April, Health Department
tests cleared yogurt, cottage cheese, and Meadow Gold ice cream, even though the ice
cream was unexpectedly found to have heptachlor at the action level. The DOH had
previously believed only mainland butterfat was used in its production, so no heptachlor
should have been present. No recall was ordered since the action level had not been
violated.

Milk sales remained sluggish. Chairman Jack Suwa of the Board of Agriculture said,
"(Milk) is on the shelf and it is up to the milk industry to convince (people) it is
safe...This whole thing (the milk crisis) wasn't handled according to the consumer angle
and that is why we have this fuss." (in Harpham & Burris, 4/2/82). Safeway of California offered to import milk, but did not press the matter given ample milk supplies.

On April 5, recalls extended beyond fluid products to other dairy products. Meadow Gold voluntarily recalled some of its ice cream for suspected contamination. Meanwhile, the UH Pesticide Hazard Assessment Project tested mothers' milk from six women and found all six with heptachlor levels four to ten times those found two years earlier. One sample was above the action level.

The next day, Acting Health Director Clark introduced an improved sampling procedure by saying, "We think we have made our last recall" in Harpham, 6/2/82). With the cooperation of the Agriculture Department, both processors, and the UH, milk would be tested three times: upon delivery to processors, in their holding tanks, and in finished products. FDA experts were requested to help improve DOH testing. Meadow Gold and Foremost would hold products until cleared. Clark praised both processors for their cooperation, and the Attorney General cleared Meadow Gold of intentionally using possibly contaminated milk. Human error on an employee's part was blamed. Skimming contaminated raw milk was still of questionably legality, but it seemed the situation was finally getting under control.

Clark's blitz to restore public confidence was undercut the next day, when Meadow Gold voluntarily pulled yogurt. (Yogurt had previously been cleared). Worse, the yogurt sample in which excess heptachlor was detected was not an "official" sample but part of a DOH employee's lunch who asked that it be tested "for the hell of it" (in Harpham & Hastings, 4/8/82). Clark admitted that the DOH had to trust processors to ensure all contaminated products were pulled. "Low sales figures, ample supplies of state-cleared milk at the processing plants and in the stores and rising sales of competing products such as milk powders or imitation milk already make it abundantly clear that all whole milk released to market is wholesome and safe and cleared of heptachlor." (Lynch, 4/8/82).
Senator Cayetano criticized the DOH for considering the economic future of the dairy industry instead of public health. Meadow Gold was blamed for the last recalls because its officials told DOH that only mainland cream was used in the recalled products when actually some Oahu cream was used. The Senate investigating committee later learned that Meadow Gold quietly pulled ice cream other than that previously recalled.

A telephone poll of consumers conducted for Foremost Dairies showed whole milk consumption was down 73 percent, 2 percent milk down 75 percent, and imitation milk sales up 169 percent. About 16 percent said if the crises ended they would buy a lot less milk, 8 percent said a little less, and 70 percent said they would resume normal consumption.

Mid-April brought the fifth DOH recall, this time of some Meadow Gold low-fat cottage cheese with heptachlor residues more than twice the action level. The company's production practices and ethics were questioned, and the company voluntarily pulled all its cottage cheese. Clark again blamed the processor for misleading the State into believing no raw Oahu milk was used in some Class II products. Both Clark and Senator Cayetano called for a second investigation of Meadow Gold, which the company president welcomed. Cayetano claimed the DOH had "put misplaced trust in Meadow Gold" (in Harpham & Hastings, 4/15/82). He again questioned the legality of making skim milk from contaminated raw milk. To avoid further recalls, Clark ordered the processors to reject all violative milk and not use it for skim. Meadow Gold complained about the order, and in his response, Clark questioned why the company had not conducted independent lab tests as had Foremost. Where the DOH had previously concentrated its testing on fluid milk, it expanded its tests to Class II products, including some from the mainland. Again Clark assured that no violative product would reach the shelves but had to qualify that by adding, "that is, assuming my orders are followed" (in Kakesako, 4/14/82).
Meadow Gold officials claimed that the recalled cottage cheese was made from the same mix used in a batch previously cleared of contamination. Clark expressed confusion over how a product made from acceptable milk could contain unacceptable heptachlor levels. The "skim milk syndrome" received attention as a possible explanation. Research found that by skimming contaminated milk to remove heptachlor in the butterfat, the fat remaining had a higher heptachlor concentration than the fat removed. The FDA suggested that the EPA re-evaluate the heptachlor action level.

On April 19, the FDA banned Meadow Gold milk from interstate travel because samples taken three and five days earlier showed unacceptable heptachlor levels. Clark requested an expanded Attorney General probe because supposedly the milk had been tested before delivery. The next day, despite test results showing acceptable heptachlor levels, Clark recalled all Meadow Gold products made from Oahu milk and banned its further use of Oahu milk. The armed forces likewise halted purchases of Meadow Gold's fresh and imitation milk. Foremost, whose profile during the whole incident had been low, accepted milk usually sold to Meadow Gold but was careful to avoid a recall. It held the milk until testing was completed, resulting in a fresh milk shortage for a few days. Meadow Gold responded by revealing its offer to allow DOH personnel to monitor the plant 24 hours a day, but that the DOH declined. The company indicated it would sue the State and seek a temporary restraining order to block State action.

When asked if Foremost could meet the increased demand for its milk, its new president, Donald Bender, said his production could increase, but Foremost did not have a large enough market. "We're at a point where consumers are so confused and concerned that they're avoiding anything in the dairy case except for certain products....We've enjoyed a tremendous increase in imitation milk and juice sales have just skyrocketed." (in Watanabe, 4/22/82)

Two days after its ban against Meadow Gold, the DOH allowed the company to process Oahu milk. The processor agreed to improve its tracing and testing procedures
to lessen the chances of violative products reaching store shelves. Oahu-supplied Meadow Gold products were again available a week after the ban. In attempts to restore sales, the company announced the expanded testing measures, a consumer-information program, and plans to import about 500 cows from the mainland and other islands.

Because of public concern over Oahu-produced milk, Foremost shipped in milk from Hawaii. Total April 1982 imports by both companies were 12,733 gallons. Skim and 2 percent milk were not being produced on Oahu. The pace of events slowed in May. The Senate investigation continued, and for one week, the Navy flew in five milk shipments for its commissaries. Meadow Gold flew in cows from California with much publicity and dropped its milk prices for about two weeks. Losses to dairymen from dumped milk exceeded $600,000 ("Dairy Farmers' Loss," 5/14/82), and the Governor declared an economic emergency so they could receive aid.

By mid-month, processors claimed that public concern was still depressing sales. Health Director Clark claimed before the Senate investigating committee that Oahu milk was safe to drink and explained precautions being taken to ensure milk safety. He admitted that the DOH, the Department of Agriculture, the University of Hawaii, and the FDA were unprepared to deal with the crisis. "There was a breakdown", he said (in Harpham, 5/21/82). Deputy Health Director Koizumi said, "What we were not prepared for was the need to get information out to the public....We were hesitant, we didn't know how to handle it. Had we been more aggressive in getting information out, there would have been fewer problems" (in Harpham, 5/21/82). From the hearings, it seems Foremost took more precautions than Meadow Gold. The situation for Meadow Gold improved when the FDA ended the ban on interstate shipments of its products and the military resumed purchases. Dairymen expressed concern that consumption habits may have changed due to the crisis.

By month's end, seven of the island's 16 dairy farms were cleared, skim milk returned to store shelves, public confidence was slowly returning, but imitation milk
sales were still up. Supply and demand were about balancing out, but the period of peak demand and supply did not always coincide. Some spot shortages were reported. The discovery of contaminated green chop as early as April 1981 initially attracted little attention but was to later develop into a new phase of the controversy—determination of the duration of public exposure to heptachlor.

Early June brought another recall, this time a federal recall of 1.5 million cans of tuna packed in Honolulu for improper canning. By mid-June, nine out of 16 dairy farms were cleared, and while sales were lower than usual, the milk commissioner felt consumer confidence was returning. Attention began shifting to the Department of Agriculture and the supply situation rather than the Health Department and milk safety.

Another farm was cleared in July, and supply exceeded consumption. The milk commissioner anticipated financial problems for Oahu dairymen in August or September if sales did not improve.

As the Senate investigating committee held hearings, more about the crisis was revealed. Cayetano accused Meadow Gold of deliberate use of contaminated cream and other illegalities. The company harshly criticized the tactics used in the committee's investigation. Foremost was praised for voluntarily pulling products and halting the skimming of unacceptable milk. Both processors claimed the DOH advised them such skimming was permissible.

Renewed Controversy Over Duration of Exposure and Appropriate Action Level

The controversy entered a new phase in late July. Gubernatorial candidates tried to use the incident to their political advantage as evidence of the incumbent's poor leadership. Lt. Governor Jean King disclosed a UH report indicating unacceptable heptachlor levels in milk as early as April 1981. She claimed that Health Director Clark tried to cover it up and that the Attorney General kept it from Senator Cayetano's investigation. Clark denied such an attempt, but length of exposure became an issue
since the DOH originally believed milk was contaminated only four months before the
first recall.

In the first half of August, milk sales began to rise, despite heavy newspaper
reporting on the length of exposure and possible lowering of the action level. The
political aspects of the issue became less salient as questions of milk safety were again
raised. The EPA and an independent lab confirmed the UH finding that Oahu milk
contained unacceptable heptachlor levels in 1981. Originally, officials believed the
exposure was only short-term, and ill effects were downplayed. Now, the serious effects
and cumulative build-up of heptachlor in the body were reported. With the finding that
Oahu consumers, especially children, were exposed for about a year, subchronic liver
damage was considered a real possibility, and the EPA considered lowering the action
level.

The findings of longer contamination were an embarrassment to the Health
Department, which detected no violations in its July 1981 tests. Clark attacked the
findings and defended the DOH lab, generating more publicity about the contamination.
Five months earlier, a consumer had informed Senator Cayetano that she had found some
frozen milk bottled in July and August of 1981 in the bottom of her freezer. The Senator
referred her to the Health Department, but only in late July did the DOH test the milk
and find no violative heptachlor residues. Confusion resulted since milk was apparently
contaminated in April 1981 and January 1982, but not in July 1981. To add to this, the
FDA confirmed that acceptable heptachlor levels were present in the July milk, though
three times higher than the DOH found. It was later discovered that the DOH knew in
April 1982 that Meadow Gold ice cream made in May 1981 had heptachlor residues very
close to the action level. Cayetano criticized the Department for not disclosing such
findings to help determine the length of exposure.

The question of the appropriate action level was further highlighted when EPA
officials visited Oahu in mid-August. After meeting with Clark, EPA Director of
Pesticide Programs Edwin Johnson tried to calm public fears about heptachlor, though he still expressed concern for infants. Johnson acknowledged that a determination of the action level would include consideration of the economic repercussions on the dairy industry. The DOH said it would follow the action level set at the federal level. To resolve the question of contamination in milk bottled in April 1981, the EPA submitted its sample to another independent lab which later confirmed the contamination. In the meantime, 12 dairy farms met the action level of 0.3 ppm, but sales had not reached pre-recall levels. Dr. James Koshi stated that "The public has yet to be convinced that the milk is now safe to drink" (in Watanabe, 8/2/82). To help restore consumer confidence, Meadow Gold, now under Raymond Jarman, established a new milk hotline, a speakers bureau, and an informational brochure, but refused to disclose to the Senate committee how its ice cream was made.

On August 17, after releasing findings that Oahu infant livers were unaffected by heptachlor, Clark officially declared the end of the heptachlor crisis. He again assured the public that milk was safe, that monthly monitoring of milk for pesticides would continue, and that 95 percent of milk products contained less than half the permissible level of heptachlor. Cayetano disagreed with Clark's decision to close the issue. Some health experts recommended that consumers still refrain from milk consumption. As August closed, attention began to shift to possible federal aid for the dairymen and the political implications of the incident. The Honolulu Advertiser released results of its poll taken mid-month when the EPA-DOH dispute was publicized and the appropriate action level was debated. Fifty-four percent of those sampled felt "pretty sure" that milk was safe, but 40 percent were not sure. Thirty-five percent said they were drinking less milk; milk sales were down by 20 percent.

Schools opened in September serving fresh 2 percent milk as usual. Papers reported the anticipated EPA recommendation to lower the action level and its effect on island milk supplies. No shortages were expected since sales were still below normal and
acceptable milk was being dumped. All but one of the dairy farms were cleared, and both processors were careful to only accept milk sufficiently below the action level to minimize the possibility of a recall. As a result of the Department of Agriculture's pesticide use/misuse investigation, the State cited Del Monte and issued a warning to Dole for premature harvest of fields sprayed with heptachlor.

September 10 brought EPA's recommendation to the FDA to lower the action level to 0.1 ppm. This level was thought to provide adequate protection for persons older than four months. Less than 1 percent of mainland milk would have been unacceptable under this new standard. An action level of 0.05 ppm would provide adequate protection for all persons, but about 2 percent of mainland milk would exceed the level. Health Director Clark said he would act after the FDA accepted the recommendation, but that no recall would be issued. It was unclear whether commingling of acceptable and unacceptable milk would be allowed; it was not in April 1982. One editorial noted that commingling could increase doubts about milk safety. The EPA also revealed that low-level contamination of Oahu milk was likely from October 1980, or 18 months before the first recall. The possibility of subchronic liver damage again received attention.

Around mid-month, another failure by the DOH to protect the public was disclosed. A few months earlier, violative levels of the pesticide endosulfan were found in Oahu watercress after the crop had been sold. The DOH gave the public no notice of its findings.

On September 21, the FDA lowered the action level to 0.1 ppm, claiming the length, not just the amount, of heptachlor exposure was the problem on Oahu. Both processors acted immediately, and the DOH lowered its action level the next day upon receipt of the FDA's official notice. Milk sales were still below supply; milk from two dairy farms was not being processed because of inadequate demand. The DOH stepped up testing.

No commingling was allowed, and this apparently surprised the processors who had earlier predicted no shortages. By September 24, Foremost was unable to meet demand,
and by September 27, with some of its milk diverted to Foremost, Meadow Gold, too, had trouble supplying adequate amounts of milk. Schools were supplied with imitation milk. Clark quietly acknowledged that milk was contaminated in April 1981, after the EPA tests showing such contamination were confirmed. By September's end, more watercress was seized for endosulfan contamination, and a well was closed for contamination by dibromochloropropane (DBCP).

Principal October news events included a recall of Tylenol in Hawaii and the Senate investigation hearings. The State claimed the pineapple companies allowed premature harvest of their fields. It was announced later that even four years after application, heptachlor residues could be detected in green chop. Most damaging to Foremost's reputation was the revelation that on March 25, 1982 it did not recall possibly contaminated yogurt, but quietly sent salesmen to all outlets to buy it back. Senator Cayetano criticized the company for not publicly recalling the product. Citing the attitude taken to the discovery of cyanide in Tylenol, Cayetano said, "What we hope to get is that kind of attitude to any contamination" (in Harpham, 10/6/82). The press again reported the Senator's criticism of the DOH for its lack of promptness and good management in handling the situation and that economic considerations were of greater concern to it than the public interest.

No related items were reported in the November newspapers. After importing about 1,800 gallons of milk in October, none was imported in November. The milk crisis was not a sufficient embarrassment to Governor Ariyoshi to prevent his re-election. Shortly before Thanksgiving, Hurricane Iwa struck and Oahu suffered substantial damage.

Subsequent Contamination

On December 8, antibiotics were detected in unacceptable amounts in Meadow Gold milk. About 6,000 gallons of skim and recombined milk were "voluntarily" recalled before the DOH ordered it. No further shortage resulted as safe milk supplies were quickly restored. The next day, Meadow Gold whole and 2 percent milk were found to
contain excess antibiotics but had already been pulled from the shelves. The DOH investigated the incident, especially trying to determine how recombined milk, supposedly not made with any Oahu ingredients, could contain antibiotics. Meadow Gold President Jarman claimed the contamination occurred in the plant's milk lines. Foremost, with a better testing program than Meadow Gold, dumped contaminated milk before it entered the plant. Despite DOH clearance of Foremost, the company still received many calls about the contamination and anticipated lower sales. Milk sales had yet to recover to pre-heptachlor-contamination levels.

By December 11, antibiotics were cleared from the milk supply, but Meadow Gold continued to face close State scrutiny. DOH officials considered further penalties against the processor but thought the recall probably hurt the company more than any fine. The incident was kept alive in the press since the contamination source could not be identified. To Meadow Gold's chagrin, it was finally determined to be its own farm.

Near the holidays, it was discovered that nonviolative levels of heptachlor had been detected in Meadow Gold imitation milk in mid-November. Skim milk could be used in imitation milk, so the DOH began consideration of label changes for the product. Health Director Clark also recommended that fines for violators of the State's milk regulations be stiffened from a maximum of $500 to a minimum of $2,500 per violation and that each violation be considered a criminal offense, not a misdemeanor. The Health Director suggested the processors be required to test milk before it is received into the plant. Milk Commissioner Roy Matsuura, later accused by the Senate committee of compromising his duty by his dealings with Meadow Gold, retired. The new year brought increased milk supplies. Schools resumed serving fresh 2 percent milk, but consumer confidence had yet to be restored. The proceedings of the Senate hearings were reported throughout January 1983. Sharp criticism was directed at State officials and Meadow Gold for not making public health their highest priority. Milk on the island of Hawaii was
recalled once for antibiotic contamination. On January 29, a small article announced that Safeway, Inc., had applied for a milk distributor's license to import milk.

Assigning Responsibility

In February 1983, the Senate investigating committee released its findings, which were critical of both federal and State agencies and the milk processors, among others. The FDA and EPA allegedly failed to ensure public health by allowing heptachlor use in Hawaii without specific tests to determine the possible health effects from its use on the pineapple crop. The pineapple companies were found negligent for not monitoring heptachlor application and harvesting of fields. The DOH was accused of being more interested in avoiding recalls and public criticism than in protecting the public. Allegedly, it failed to quickly develop a plan of action, was too slow in its recalls, and sometimes waited for test results before pulling products known to be made from contaminated milk. The DOH was criticized for allowing processors to use contaminated milk to make skim milk. Clark did not plan to discipline DOH officials criticized in the report because they helped the State through the crisis. The committee accused Meadow Gold of engaging in illegal acts, including the intentional use of contaminated milk for products beyond just skim milk, and the destruction of pertinent production records. The company denied some charges and claimed others were based on "unverifiable assumptions" (in Watanabe & Mayer, 2/3/83). The Attorney General was charged with poorly conducting its Meadow Gold investigation and was accused of justifying the health department's mistaken advice allowing contaminated milk to be skimmed rather than correctly interpreting the law. In general, "Although the heptachlor contamination crisis may have been caused in large measure by the activities of State officials, much of the blame for its intensity and duration must be placed on the private sector, particularly Meadow Gold" (Hawaii Senate, 1983).

Among other recommendations, the committee suggested that the State Legislature:

-- stiffen penalties to deter pesticide misuse,
require better pesticide-use records from applicators,
-- transfer responsibility for pesticide monitoring from the Department of Agriculture to the DOH, and
-- provide the DOH the authority to acquire pertinent information concerning possible food contamination.

The Governor was exhorted to direct State agencies to:
-- review business contracts with Meadow Gold and offer State contracts to more reliable suppliers,
-- appoint a special prosecutor to prosecute Meadow Gold for use of contaminated milk and Foremost for using contaminated milk to make skim milk, and
-- obtain legal advice from the Attorney General and not offer uniformed legal options.

It was recommended that the DOH:
-- impress on its staff its primary responsibility to protect public health, not industry,
-- review and improve its testing program,
-- routinely test animal feeds treated with pesticides, and
-- announce all recalls ordered by the DOH.

Also in February the findings of the UH Pesticide Hazard Assessment Project on samples of breast milk from 166 mothers were released. Almost 90 percent had heptachlor levels too high for infants under four months, and about 60 percent had levels over the 0.1 ppm action level. The State Legislature tried to prevent future occurrences of feed contamination by giving the Agriculture Department authority to test all animal feed. The DOH requested the power to inspect or seize records of a company suspected of producing an adulterated or mislabeled product.

With the completion of the Senate investigation and Safeway's bid to enter the market in the background, the public health aspects of the issue began to fade. First, though, Oahu consumer and environmental groups sued both processors for $250 million each for breach of contract by selling contaminated milk. Among other demands, the
groups sought a register of infants born from October 1980 to October 1982 and their health monitoring until the age of 18, a medical expense fund for children's illnesses due to heptachlor exposure, punitive damages of $1,000 per milk purchaser, and weekly publication of heptachlor levels in the processors' products.

In mid-March, Real Fresh, Inc., a California producer of sterilized milk, won the right to a federal court hearing to challenge Hawaii's authority to restrict interstate milk trade. The legislature killed a bill mandating an eight-day shelf life for fluid milk which was introduced to help restore consumer confidence. The bill would have effectively killed any attempt to ship fresh fluid milk from California since the transit is five to six days. Oahu processors voluntarily set shelf life for their fluid products at 10 and 12 days. Milk sales, growing slowly, were still down, and acceptable milk was being dumped when Meadow Gold unveiled its fluid promotion campaign. As part of a national marketing program introducing a new carton, the company placed full-page advertisements in the papers for four weeks.

Toward the end of March, Safeway's application received more attention. As the two processors were threatened with a union strike, Safeway officials admitted they applied for the license in part because of the contamination incident and said they would offer Lucerne brand milk for 10 to 15 percent less than local milk. They foresaw supplying about 10 percent of Oahu's needs.

The Safeway Controversy

The Board of Agriculture infuriated many consumers by announcing its intent to deny Safeway's application because it was "not in the public interest" (in Harpham, 3/31/83). The Board cited destructive competition and claimed the market was adequately served since acceptable milk was still being dumped daily. The number of milk-related letters to the editor of both papers jumped from zero in the period of November 1982 through March 1983 up to 17 in April 1983, overwhelmingly in favor of Safeway imports.
In response to the Board's intent to deny the license, Safeway requested a public hearing. Despite reports of traces of DDT in Oahu milk, and heptachlor in island wildlife, Governor Ariyoshi asked Safeway to use Oahu milk in its Lucerne brand. With milk sales still low, Ariyoshi asked the processors to operate more efficiently. Foremost considered importing milk from California and introduced gallon containers for whole, 2 percent, and imitation milk, and orange juice. Fresh milk specials were offered, cutting prices from $1.68 per half-gallon to $1.54. By the end of April, specials continued, but so did dumping of acceptable milk. When an organization named Friends of Oahu Children asked the Governor to allow milk importation for health reasons, Ariyoshi tried to "dispel the notion that Mainland milk is clean and local milk is not" (in Harpham & Oshiro, 4/20/83). He also offered to make DOH test results public on a regular basis. The legislature voted to fine those responsible for food-safety violations a maximum of $10,000 and gave the DOH power to seize records pertinent to possible food contamination or mislabeling.

May brought news that milk from all dairy farms were below the action level, but dumping continued. The Hawaii Consumers' League was formed and began petitioning to pressure the State to approve Safeway's application for reasons of health, price, and freedom of choice. Seventy-five people attended its first meeting. Of the 32 relevant letters to both papers, two to one favored Safeway. The League's president wrote: "Few of that segment of the public (about 27 percent) which has lost so much confidence in the local milk industry as well as in the government's ability or willingness to protect the consumer interest will ever buy the local product again--even in a redesigned package. However, many will tell you they are tired of powdered milk and want an alternative fresh source." (McMurdo, 5/6/83)

Foremost introduced "Dairyland", a private label for Foodland stores, with a price 5 percent less than Meadow Gold or Foremost milk. Milk specials continued and merited mention in an editorial.
The Fresh Milk Industry of Hawaii, consisting of dairymen and processors, took the offensive against Safeway by placing an advertisement, not in Hawaiian papers, but in the newspapers of Oakland, California, where Safeway's headquarters are located. The ads questioned Safeway's conscience for trying to destroy the Hawaiian dairy industry. Dr. Koshi, now executive director of the dairy organization, claimed Safeway's imports could lead to the industry's demise, leaving the islands solely dependent on an uncertain supply from the mainland. Other stores also applied for licenses to import milk if Safeway were allowed. Koshi claimed the market was adequately supplied because dumping of acceptable milk continued.

By mid-May, an initial $6.4 million in federal aid from the Dairy Indemnity Program was made available to Oahu diarymen, who had lost an estimated $8.5 million due to milk condemnations. Later in the month, Safeway ran a full-page ad in the Oahu papers asking, "Who's milking the Hawaiian consumer?" and implying a tradeoff between 500 jobs and 5,000 babies. A poll conducted for Safeway revealed that 62 percent favored Safeway's application although more than half believed that local milk was safe. Of the 32 relevant letters to the editor printed in both papers, more than two to one were in favor of milk imports.

June was appropriately designated "Dairy Month" by the Governor since the controversy over who would supply milk was discussed in the papers almost every day. The Fresh Milk Industry of Hawaii began a series of weekly ads to answer consumer questions about milk safety, milk supplies, and the need for local industry protection. Several dairymen sued Safeway for $4.5 million for false and malicious claims about the Hawaiian industry. Despite rumors of heptachlor and mention of salmonella in Californian milk, the Hawaii Consumers' League gathered 12,000 signatures in five weeks. Before the first week of June ended, though, the unions employed at Safeway went on strike through June and into the summer. The local dairymen's claim of uncertain supplies seemed confirmed. A study by the Hawaii Department of Planning and Economic
Development was released which estimated costs to the islands of $33 million if importation were allowed. By month's end, the Hawaii Consumers' League, the Libertarian Party, the 50th State Dairy Farmers' Cooperative, the Oahu Dairy Cooperative, and the U.S. Justice Department requested permission from the Board of Agriculture to participate in the Safeway hearings.

After June 1983, events have evolved more slowly. In late August, the Board of Agriculture granted Dairymen, Inc., a license to import UHT milk. In early September, before its court case challenging Hawaii's restriction of interstate milk trade, Real Fresh, Inc., was granted a similar license. The constitutionality of Hawaii's Milk Control Act was still unresolved. From September 28 to October 17, the Board of Agriculture heard testimony regarding Safeway's application. Just as the local industry claimed imports would lead to dependence on uncertain external milk supplies, unions at both processors went on strike. Dumping and spot shortages occurred as management tried to operate the plants. According to one industry official, it was only in December 1983, 22 months after the first recall, that milk sales returned to pre-contamination levels.

Early in 1984, Chairman Jack Suwa of the Board of Agriculture surprisingly announced he favored granting Safeway's request. Apparently the controversy was re-ignited, and the hearings were to be re-opened. Before they were, though, a federal judge in Hawaii ordered the State to grant Safeway a distributor's license, and in May, fresh California milk was available to Oahu consumers. The Governor was considering signing legislation mandating a 10-day shelf life. The Oahu milk controversy is far from settled.

Legalities After the Incident

The legalities surrounding the incident reflect the confusion stemming from it. One group of consumers sued the State and the processors for ill effects supposedly suffered from heptachlor exposure. Another sued the State, Governor Ariyoshi, and Health Director Clark to enforce the zero heptachlor tolerance level, while another group sued
the two processors for half a billion dollars for selling contaminated milk. The dairymen sued the pineapple companies for selling contaminated feed, the State for causing confusion in the market, and the heptachlor manufacturer (Velsicol Chemical Corp.) and its distributor (Brewer Chemical Corp.). The pineapple companies sued the State and Velsicol, and counter-sued the dairymen's Green Feed Cooperative. The company that insured Green Feed against such lawsuits sued the Cooperative to escape liabilities. Meanwhile, Real Fresh, Inc., had taken the State to court challenging the constitutionality of the Milk Control Act, and Safeway was sued for defaming Oahu dairymen. As of June 1983, just about every party involved faced legalities. As of the end of 1984, Foremost agreed to notify Hawaiian residents that it had agreed to contribute $1 million toward research on the health effects of the heptachlor incident on milk consumers and two of the pineapple companies agreed to pay $28.4 to 13 Oahu farmers. The results of the other lawsuits are still to be determined and total awards could be over $620 million. Value of sales from Oahu dairies were about $25 million the year before the crisis. Greenchop is no longer used for feed for dairy cattle in Hawaii.

APPENDIX

I. Milk Production in Hawaii

Milk is the only major food for which Hawaii is self-sufficient. Of the 25 herds in the State with ten or more cows, 16 operate on Oahu to produce about 80 percent of the State's supply. A similar percentage of the State's population resides on the island.

In 1980, Hawaii had the nation's largest average herd size of 520 cows per dairy with mostly Holsteins in drylot operations (Koshi, 1980). Since at least 1968, all production has been of Grade A quality. Monthly Oahu production averaged about 9,893,140 pounds over the 1977-1981 period. Average 1982 output fell 8 percent to about 9,116,060 pounds and was the lowest in six years (Hawaii ARS, 1983). Production varies monthly, usually peaking in late spring and bottoming out in the fall. Since at least the early 1960s,
production has been kept 10 percent above "normal demand" to handle fluctuations (Mollett, 1961).

The cost of milk production in Hawaii is the highest in the country (Cohen & Eisenstat, 1983). Chief problems as seen by the industry are high feed costs and low reproductive rates (Morison, Kefford, & Harada, 1981). Without pastures on Oahu, all feed must be purchased and much must be imported. Reliable feed supplies are sometimes precarious since only one firm transports feed from California and feed storage facilities are lacking. Imports of prepared animal feed, mostly from the mainland, averaged 108,000 tons per year from 1977 through 1981. Starting in 1958, these supplies were supplemented by green chop, a cheap local substitute made from ground pineapple plants. Because of its role in the heptachlor contamination incident, green chop is no longer used, thus requiring more imports of feed.

Further adding to high costs is unionized dairy farm labor earning an average of $7.30 per hour (Hawaii DPED, 1983). Dairy cow replacement costs also boost production costs. Replacement calves are shipped to the Outer Islands to be raised, and then returned to Oahu.

Despite the problems they face, Oahu dairymen earn a relatively favorable return on investment. The 1979 average return for 12 dairy operations was 10.77 percent (Donoho, 1980). This was only slightly below the 1979 prime interest rate of 10.91 percent. Conscious of possible mainland competition, the industry has pressed the State and University of Hawaii to investigate means to reduce costs. At least one dairy cooperative was trying to use a local grass hay by 1980 (Koshi, 1980).

II. Milk Processing

A duopoly at the processor level has existed on Oahu since at least 1958. The larger of the two processors, Meadow Gold Dairies-Hawaii, is a subsidiary of Beatrice Foods and has operations on other islands. It received 59.5 percent of milk produced on Oahu prior to the contamination announcement (Hawaii Senate, 1983). Foremost Dairies, Hawaii, a
subsidiary of Foremost-McKesson, handled 40.5 percent of production prior to the contamination incident (Hawaii Senate, 1983). In addition to island milk supplies, Meadow Gold imports dry milk fat from the mainland while Foremost imports it from New Zealand (Harpham, 4/20/83). Processors supply homogenized, 2 percent, 1 percent, skim and flavored milk; buttermilk, half-and-half; ice cream, ice milk, and ice milk mixes; yogurt, cottage cheese, and sour cream. Both are heavily involved in fruit juice processing. Local production accounts for all fresh fluid and 75 percent of ice cream consumption (Morison, Kefford, & Harada, 1981).

Like costs of milk production, processing costs are higher than those on the mainland. (Information for this discussion is mostly from Harpham, 5/12/83). Labor, utilities, transportation, and packaging costs are greater. Likewise, since processors pay a higher price for raw milk, the 1.5 percent shrinkage (the same experienced on the mainland) costs more. In a pocket economy, processors cannot achieve the economies of scale possible on the mainland. One Honolulu plant with 60 employees processes 17,000-20,000 gallons daily, while a mainland plant could employ 70 and process seven to nine times as much. The same Honolulu plant could increase production four times to reduce per gallon costs, but demand does not warrant increased production.

In early 1983, Oahu dairies and processors employed 574 people (350 in processing/distribution and 214 on farms); total State dairy industry employment was 720 workers. Directly and indirectly the industry supported about 1,900 jobs or a little more than 0.4 percent of total Hawaiian employment in 1981 (Hawaii DPED, 1983).

III. Coordination of Milk Supplies

Beyond government involvement to ensure a safe milk supply, the State regulates production, transportation, processing, storage, distribution, and delivery of milk under the Milk Control Act. The Division of Milk Control establishes quotas and minimum producer prices. Similar to mainland markets, producers are paid a blend price based on utilization for fluid and manufactured products. The 1967 Act was passed in an
atmosphere of violence and milk dumping. Producers felt they were not receiving a fair price from the two processors who had not increased producer price for 15 years (Lynch, 9/29/83). The two milk sheds of Honolulu and Hawaii were created. (Operations are fully integrated on Maui and Kauai; five producers sell to two processors on Hawaii.) Only with a license granted by the Board of Agriculture may a firm import fluid milk. Military commissaries are not subject to the Act and may import whatever they wish.

The Division of Milk Control and two Oahu dairy cooperatives help achieve horizontal coordination among producers. Raw milk supply is regulated by quotas set by the Division for each producer. Of non-integrated producers, five account for about 40 percent of the island's quota and form the Oahu Dairy Cooperative. Eight others, producing 27 percent, are members of the 50th State Dairy Farmers' Cooperative.

Mechanisms to improve vertical coordination exist at two levels. At the producer-processor level, the State market order helps ensure dairymen a market, even though neither producer cooperative has any processing capacity. Both cooperatives and the University of Hawaii's herd supply both processors which are themselves fully integrated. Based upon quota allocations, Meadow Gold's farm is the second largest on Oahu, and accounts for 17 percent of island production. Foremost Farms ranks third with 15 percent.

Shipment of milk between islands is infrequent since each island is basically self-sufficient. The last milk shipment from Oahu to Hawaii was in 1980. Milk was shipped from other islands to Oahu after the contamination announcement in March, April, May, June, October, and December 1982. Approval for such shipments is granted by the State's Milk Commission.

At the farm input level, most Oahu dairymen joined the Green Feed Cooperative to harvest and distribute green chop. The pineapple companies allow the dairymen to cut and harvest pineapple plants which would otherwise be burned and removed.
V. Consumption

Per capita Oahu milk consumption has been declining. In 1962, per capita annual fluid consumption averaged about 214 pounds, but fell to 160 pounds by 1971 (Hogg, 1974). By 1981, consumption was about 152 pounds per year per person or about 80 percent of that on the mainland (Morison, Kefford, & Harada, 1981). Ethnic origin influences consumption; the Caucasian population consumes more than other racial groups (Consumer Nutrition Center, 1981). In 1962, Scott (1967) found that Caucasian adults and children drank milk more because they liked it than for its nutritional value, while other groups (mainly Japanese, Chinese, Hawaiian, and Filipino) consumed it more for its nutritive value than taste. Caucasians account for 33 percent of the Oahu population, followed by Japanese (25 percent), Filipino (13 percent), and Hawaiian (11 percent) (U.S. Census, 1982).

Raw milk is utilized in several ways. Milk used for whole, 2%, and other fluid milk is known as Class I milk. Class I-A is skim milk used to make filled or imitation milk. Class II milk includes soft manufactured dairy products such as ice cream and yogurt. Salvaged milk is raw milk from which the cream is skimmed and used in some Class II products; the skim milk is then discarded.

Class I utilization approximates the quantity of fluid milk demanded at least over the pre-contamination period. Seasonality is evident in its demand. During the school year, about 20 percent of fluid consumption is purchased by the Department of Education (calculated from Harpham, 9/25/82). Fluid consumption falls with the summer recess of school and rises with September school openings. In the past, troop movements in and out of the State significantly affected consumption, but it is unknown how important a factor this is now. It is known that military-related sales have accounted for 12 to 15 percent of fluid milk consumption, and tourist-related sales have been about 10 to 12 percent over the last five years. In general, Class I-A and Class II utilization rises in the summer, only to decline (often to zero) when schools open. However, summer Class I-A
and Class II utilization does not always rise enough to counter the fall in fluid consumption. "Traditionally, the Honolulu Milk Shed experiences its greatest loss through dumpage during the summer months" (cited in Cohen & Eisenstate, 1983).

There are several fresh milk substitutes available on Oahu. The milk processors produce filled, or imitation milk, and recombined milk. The same year the Milk Control Act was passed, processors introduced filled milk. This is made "by adding vegetable oil in place of butterfat to either fresh skim milk or reconstituted skim milk" (Hawaii Senate, 1983). Its market share had fallen from 20 percent in 1967 to 7 percent in 1981 (Renaud, 1971; Morison, Kefford & Harada, 1981). Filled milk prices are less than that of fresh milk. In July 1983 (latest month for which data are available), the filled milk price was $1.39 per half gallon compared to $1.68 for whole milk. Recombined milk "is a product which results from the combination of nonfat dry milk, dry cream, (and) milkfat with potable water" (cited in Hawaii Senate, 1983). Ultra-high temperature (UHT) milk was allowed to enter the Hawaiian milk market with licenses granted in the fall of 1983 to Dairymen, Incorporated, and Real Fresh, Incorporated, a California firm. Other milk substitutes include powdered and nonfat dry milk, neither of which is produced locally. Dried milk and cream imports from 1977 through 1981 averaged 647 tons per year, ranging from 750 tons in 1977 to 611 tons in 1981 (U.S. Army Corps of Engineers, 1977-1981).

VI. Summary

The Oahu milk market is high-cost, imperfectly competitive, and confronts the seasonal demand of consumers, many of whom do not drink milk for taste alone. Government regulation limits the entry of new dairymen as does the duopoly at the processing level. Further, fresh fluid milk supplies from sources beyond the State were, until very recently, limited by logistical problems of shipping a perishable product over great distances (2,500 miles from California) and by the State's Milk Control Act. However, such protection may have been necessary to preserve the islands' milk self-
sufficiency, and even before the contamination incident, Oahu dairymen were concerned about possible competition from outside sources. Per capita milk consumption is below the U.S. average, reflecting the racial differences in tastes for milk. The insular nature of the Oahu milk market makes it a prime market to study the roles that key actors play in ensuring the safety milk supplies.
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