Frontiers of Plant Science

A REPORT FROM THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN

IN THIS ISSUE

Taking a Closer Look at Connecticut's Drinking Water
By Claire C. Bennitt

The Connecticut Agricultural Experiment Station, the Nation's First, is 125 years old
By Paul Gough

South Central Connecticut Regional Water Authority's Claire C. Bennitt, main speaker at Plant Science Day 2000 at Lockwood Farm

Volume 53
Number 1
Fall 2000

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, founded in 1875, is the first experiment station in America. It is chartered by the General Assembly as an independent State agency governed by a Board of Control. Station scientists make inquiries and experiments regarding plants and their pests, insects, soil and water quality, food safety, and perform analyses for State agencies. Factual information relating to the environment and agriculture is provided freely and objectively to all. The laboratories of the Station are in New Haven and Windsor; its Lockwood Farm is in Hamden. Copies of this and other publications are available upon request to Publications; Box 1106; New Haven, Connecticut 06504

http://www.caes.state.ct.us ISSN 0016-2167

Taking a Closer Look at Connecticut's Drinking Water

By Claire C. Bennitt
Chair, Regional Water Authority

So I have to say first, thank you Dr. Anderson for the opportunity to talk about one of my favorite topics—Connecticut's drinking water supply and its vulnerable superior quality: It is not imported from China, not manufactured in Mexico, nor raised in California—It's home grown.

The second thing I must say is that I am not a scientist, as will be readily apparent to those of you who are. However, I have learned the language and mastered more facts than just two parts hydrogen and one part oxygen produce water.

Let me share some of the water quality and resource facts:

Fact: Connecticut receives 40 to 50 inches of rain every year, providing us with more than adequate water supplies.

Fact: Connecticut is one of two states in the country that does not allow drinking water to be taken from bodies of water that receive treated sanitary sewage effluent.

Fact: Connecticut has recognized that land use and water quality are inextricably linked.

Fact: The United States Environmental Protection Agency's policy of a multi-barrier approach to protecting drinking water quality identified source protection and water treatment as both necessary to safe drinking water, and the same can be said about Connecticut's policy for providing safe drinking water.

Fact: Connecticut has adopted water quality standards more strict than those required by EPA, and those standards have required water treatment filtration plants to be built on every surface water supply.

Fact: Twenty years ago, compounds in the water were reported in parts per million; today parts per billion and parts per trillion are routinely analyzed.

However, with all these facts, the biggest challenge confronting our water industry is water supply. It is not a scientific challenge but instead a political one.

For example, let us review how the water utility serving this area was formed. It came about because of political concerns: about one city owning the water utility that serves this south central region, about the possibility of water company land sales that could have changed the growth and financial patterns of its suburbs—some of whom had no water customers, and about the financial capability of the water utility to build filtration plants necessary to comply with the Federal Safe Drinking Water Act.

The issue of city ownership went away when compromises were made to establish the South Central Connecticut Regional Water District. However, the issues of land sales along with sophisticated and expensive water treatment processes—issues that we faced twenty years ago—are still concerns.

Talk delivered at Lockwood Farm, Hamden, Plant Science Day, August 2, 2000

With relatively clean water at the source, the EPA requires extremely expensive treatment techniques and will most likely mandate more in the future

Even with relatively clean water at the source, the EPA requires extremely expensive treatment techniques and will most likely mandate more in the future.

Before addressing the EPA regulatory situation, let's examine another hot political issue affecting our industry. The issue of land sales. All three of Connecticut's regulatory agencies that oversee water companies are involved in the land sales issue.

The Department of Health must approve changes of use or dispositions of Class I and II land, classifications established by the legislature in recognition of the relationship of land use and water quality. The Commissioner can deny applications for sales or can approve them, based on regulations adopted through the public process.

The Department of Public Utility Control decides how the proceeds of land sales are distributed, that is whether to the shareholder or the ratepayers or a combination of both. Since most investor owned utilities have viewed their lands as financial assets, sales have gone forward both to enrich shareholders and to provide capital for improvements, particularly expensive water treatment facilities.

The Department of Environmental Protection has most recently come into the picture because it now has available a sizeable amount of funds to help in the purchase of lands for open space protection and public water supply protection by municipalities, water utilities and conservation organizations.

There are about 130,000 acres of water utility lands in Connecticut, a highly significant portion of the state's undeveloped land. Residents, municipalities and the state always have considered water utility lands to be open space forever and when land sales by water utilities have been proposed, it has been in a highly charged emotional atmosphere. Typically a water company gets an offer from a developer before offering land to the town in which it is located or to the state, as the law requires. The selling price is then far beyond available money for open space protection.

Presently one of the large investor-owned utilities is in discussions with DEP about how to preserve its lands. While new legislation requires conservation easements on Class II land before sales, failure by the parties involved to reach a satisfactory agreement may contribute to an attempt for the

Watershed land showing its beauty as well as usefulness.

public to acquire the investor-owned utility by the means of eminent domain.

Sales of Class III lands, properties not on a drinking water supply watershed held by utilities, do go on, and recently have been funded for open space protection with the new grants from the State's Open Space & Watershed Land Acquisition Grant Program. The state maintains permanent conservation easements on the lands purchased with this fund.

Not all water utilities view public drinking water supply watershed lands both as financial instruments and as a means of providing clean water. At the Regional Water Authority, source water protection is given very high priority. We own over twenty-four thousand acres of land, almost all of which is drinking water supply watershed land. We sell very little land. But, when we do, we turn to a municipality or non-profit for help in protecting the land. Working with these various groups proves that land conservation can yield multiple benefits. In many cases it protects water resources while in other cases fulfills a community's open space, park and recreational needs. Our policy is to take the proceeds from the land sales to purchase more watershed land. During the recent past, we have sold 230 acres to the Town of Orange and 16.8 acres to the New Haven Land Trust for open space preservation. Through partnerships and outright land purchases for water supply protection, we are also protecting more than 750 acres in the Towns of Haddam, Durham, Bethany, Woodbridge, North Branford, Guilford, Madison, Killingworth, and East Haven.

We do allow passive recreation, but we are extremely careful about allowing any use on the water supply lands that would be detrimental to water quality. As I stated, we have been in an active land acquisition mode for the past few years, buying watershed land threatened by inappropriate development. We even established a non-profit organization, the Watershed Fund, to help in our efforts and seeded it with enough money to provide environmental education for future consumers and decision makers, as well as to buy critical watershed lands.

We perform watershed inspections on the portions of the watershed that we do not own, looking for occurrences such as oil and chemical spills and failing septic systems. We also cooperate with constituent communities by reviewing site plans for prospective development, pointing out the need for best management practices to control storm water run off and minimize land use impacts. Other examples: we worked with the town of Cheshire to develop aquifer protection overlays to zoning regulations in spite of significant opposition from interested parties and have urged the state to implement statutes by drafting regulations to protect the state's drinking water aquifers.

Even with this attention to source water protection, surface water treatment plants are required and in some well fields, special groundwater treatment facilities are needed. The Regional Water Authority has three surface water filtration plants operating at the present time and one being designed to replace our oldest plant mothballed about ten years ago. In the north and south Cheshire well fields, aeration towers were installed at a cost of several millions of dollars in the 1980s to remove contaminants that have seeped into ground water. All of these facilities represented state of the art filtration techniques when designed and all of our treated drinking water meets EPA's and Connecticut's standards.

While scientific research goes on in every water utility, risk assessment is the prerogative of the government. Regulated compounds and microbes are identified in Washington based on information collected nationwide. Waterborne pathogens—like viruses, giardia and cryptosporidium, and a variety of chemical contaminants used in industry, agriculture and our homes are now, or are expected to be regulated before the end of the decade. Standards are or will be established and all water utilities required not to exceed them. The greater the risk assigned to the substance, the stricter the standard to be applied. Connecticut has a history of adopting the most stringent standards.

The Safe Drinking Water Act requirements implemented by EPA are continuing to evolve and are focusing very hard on disinfection and disinfection by products. In addition, the Long Term 2 Enhanced Surface Water Treatment Rule will likely require cryptosporidium inactivation or removal. New coliform bacteria regulations are also being considered. Lead and copper that can leach from household plumbing is now regulated at the consumer's tap. Today, many consumers equate the taste and odor of their drinking water with its safety. Thus, many utilities are beginning to address objectionable tastes and odors caused by algae and chlorine as they update or construct their treatment facilities.

My reason for stressing these potential new requirements is simple. It was the fatal 1993 outbreak of cryptosporidium that challenged America's reliance on technology. Before Milwaukee's crisis was over—the disease hit over 400,000 residents. Over 100 people died.

Cryptosporidium, a tiny parasite, like giardia, has only recently been isolated and identified as a human pathogen. It is carried by cattle, beavers and sheep and other wild and domestic animals, and of course humans. It can be introduced into a water supply through sewage or from watersheds on which the animals live. In the case of Milwaukee, the source water intake for the drinking water treatment plant is less than a half-mile from the sewage treatment plant outfall. The outbreak occurred because the water treatment plant failed to adjust the treatment process to account for impaired source water quality brought about by early spring runoff. Had the drinking water plant been working perfectly, the incident would have been avoided. Unfortunately, there was a breakdown in the drinking water treatment process and contaminated water entered the distribution system. Correcting this mistake was expensive—not only in terms of loss of public trust, but financially. Milwaukee spent over $50 million to rebuild the drinking water treatment system.

Because of incidents like what happened in Milwaukee, the federal government has been taking active measures to ensure safe drinking water for U.S. citizens. Utilities like ours issue water quality reports that explain in plain language what is in the drinking water, where it comes from and whether it meets federal standards. It is likely that additional safety requirements will be established in the latter part of this decade. They will introduce most of us to new language—dissolved air flotation, ozonation, and ultraviolet disinfection. New filtration schemes will likely use membrane technology or biologically active carbon filters to retrofit existing or construct new treatment plants.

While safe water is something we all agree on, we recognize that there will be huge costs associated with complying with these regulations. Surveys conducted by the Regional Water Authority show that customers appear willing to pay more for drinking water. Water quality is of the highest priority for most. Currently, water is relatively cheap in Connecticut as compared to costs across the country. As water rates rise, the willingness of water customers to pay higher rates is likely to change and the financial value of water conservation will come into play.

It interests me that although we often times view ourselves as frugal Yankees, there is really not much of a conservation ethic in Connecticut—at least as far as conserving water is concerned. If we were to pay for water according to its value to our social and economic structure, there would be a significant cry for saving our resource—instead of a ho-hum attitude about water saving faucets and toilets.

This brings me to my final point. Connecticut is blessed with an abundant supply of fresh water and none have done more to put it to productive use than the citizens of the state

While safe water is something we all agree on, we recognize that there will be huge costs associated with complying with these regulations

have. Still, we have problems—we have disputes over water because Connecticut has a confusing policy on water allocation.

There are competing interests for water sources. Water is allocated through a polyglot of unrelated regulations that affect some water users and not others. As an example, someone on one side of the street can use his private residential well to water his tomato plants in the garden while someone else on the other side of the street who is connected to the public water supply may not have that choice. Current regulations affect some people but not others. We need to work together with diverse groups in cooperation to protect this vital resource. Two things—public health and the environment—must never be seen in conflict. For when they are—we pay a terrible price. The first to suffer is public health and the second is the environment.

Our state General Assembly, during the last session, considered establishing a task force to look into water allocation issues. While the initiative was defeated, there still is a need to resolve these issues. We need a plan so there is enough water available for people, for the farms and the natural environment. Shocking, as it may seem, until we have effective public policy, the courts will be making decisions that rightfully belong to the residents of the State.

To ensure that our legacy of abundant water resources continues into the future, we need to build strong coalitions in order to achieve a balanced approach to the issues before us. Think about it. It is how the Regional Water Authority was formed, how we have been successful in the preservation of open space in so many communities of our region and successful in starting initiatives to protect the quality of the region's water resources.

Defining appropriate uses of the state's water resources that equitably address the concerns of everyone involved remains a challenge which can only be addressed by a coalition which is able to balance all of the issues that I have discussed.

I encourage you to think about the issues. Think about where your water was last night and where it will come from tomorrow. And become involved in your community's water issues.

The web address of The Connecticut Agricultural Experiment Station has been changed to:

www.caes.state.ct.us

Experiment station pioneer institution applying scientific methods to farming

By Paul Gough

The Connecticut Agricultural Experiment Station was created in 1875 to put science to work for society. The Station, the Nation's first, was the result of years of agitation by scientists and farmers led by Samuel W. Johnson, a graduate of the Sheffield Scientific School at Yale.

Johnson, as most students of science did in his day, pursued advanced studies in agricultural chemistry in Germany. There he saw a government-sponsored institution that applied science to the benefit of farmers. This institution at Moeckern was called Landwirtschaftliche Versuchsstation, literally agricultural experiment station. The scientific experiments produced new information often not obtainable except through the trial and error of the years, decades, and centuries that produced the knowledge of farmers of the 1850's when Johnson entered Yale.

Upon his return to America, Johnson described the experiment station he saw in Germany in the *Cultivator* and *Country Gentleman*. Then, as a Yale professor, he built support for one in Connecticut by offering farmers practical information about the composition of fertilizer, based on scientific analysis rather than often fraudulent claims of manufacturers and the resulting disastrous crop failures.

Although a bill was finally drawn up for the legislature to create an agricultural experiment station in 1874, it was tabled. The following year Orange Judd, a trustee of Wesleyan University in Middletown and publisher of agricultural books, offered a laboratory at Wesleyan, the services of a chemist, and $1000 to start an agricultural experiment station. On July 20, 1875, the legislature accepted this offer and appropriated $2800 "for the promotion of agriculture by scientific investigation and experiments," making the Connecticut Station the first in the New World. Wilbur O. Atwater, chemist at Wesleyan and former student of Johnson, became the first director. Two years later, in 1877, the legislature passed a new law creating a Board of Control, which appointed Johnson to serve as director. The Station moved to Yale, and, in 1882, to its present location on Huntington Street in New Haven.

Some of the Station staff in 1888. From left, first row, A.L. Winton, Thomas B. Osborne, second row, E.H. Farrington and Edward H. Jenkins. Top, Hugo Lange.

By 1896, the Station had pioneered analyses of foods

By the late 1880's, the Station was employing scientists to investigate problems to provide new knowledge, not simply providing analyses of various agricultural products.

The 1894 Annual Report stated: "The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut."

In the 1897 Annual Report, Johnson reviewed the first twenty years: "During this time, the adulterated or fraudulent fertilizers, that for twenty-five years previously, were common in our markets, have practically disappeared, and, as respects them, the intelligent farmer has been efficiently protected from deception and fraud."

By 1896, the Station had pioneered analyses of foods, publishing a 79-page report of the examination of 848 articles of food, 30 percent of which were adulterated.

In 1909, Thomas B. Osborne, who was Johnson's son-in-law, began collaborating with Lafayette B. Mendel of Yale to study the nutritive properties of proteins Osborne had prepared from seeds of all the ordinary crop plants. They found that albino rats fed diets deficient in protein or low in the amino acid lysine were stunted, but the rats began to grow immediately after lysine was added. This experiment showed that some essential amino acids must be supplied by food because animals can produce little on their own.

Osborne and Mendel found that when they added butter to the diets of rats that were declining on protein-free milk diets, recovery was almost immediate. Thus, they reported in 1913 that it appeared "as if a substance exerting a marked influence upon growth were present in butter." Those words reported the discovery of what would later be called Vitamin A. The discovery of vitamins led to the conquest of scurvy, rickets, and beri-beri. The finding by Osborne and Mendel that Vitamin A was in cod liver oil also saved the eyesight of thousands of children. Osborne and Mendel also showed that chickens could be raised to maturity on an artificial diet that contained the vitamin, providing the foundation for the present-day poultry industry.

In 1910 the Station Board of Control used proceeds of the Lockwood Trust to begin purchasing land for what ultimately would be a 75-acre research farm in Hamden. The Trust, a result of a bequest by William R. Lockwood of Norwalk, also purchased land in Windsor for the Tobacco Substation, now the Valley Laboratory.

Donald F. Jones arrived at the Experiment Station in 1914 to continue corn breeding work begun by Edward M. East. Jones crossed two hybrid lines which originated from four distinct inbred lines. The resulting “double cross” plants from “single cross” parents produced a greater vigor and yield than the parent and grandparent plants. This discovery produced a doubling of the yield of this premier feed grain. Because seed production was too complicated for the average farmer, Jones successfully campaigned for the adoption of this technique by commercial seed producers.

During World War II, in words perhaps written by Jones himself, the 1942 Annual Report stated: “With food rationing the order of the day, corn becomes increasingly important since it is a principal ingredient in the dairy cow’s ration, and is used in the feeding of poultry, sheep, beef cattle, hogs and horses, not to mention man. The nation’s corn crop was estimated this year at 3,175,154,000 bushels. This is the highest annual yield on record and was produced on a smaller acreage. This result may be attributed in part to the extensive use of hybrid corn as well as a good season.”

The Experiment Station curtailed some activities to contribute to the war effort. Hubert Vickery worked part-time on blood plasma at the Harvard Medical School; staff worked with Yale to produce a conversion burner to allow houses to be heated with wood rather than precious oil; the Station experimented with a Russian dandelion as a substitute for rubber; scientists tried fertilizer made with spent sulfuric acid from production of high octane gasoline; and Station staff worked with those producing food in “Victory Gardens.” The Station shared the results of research on commercial food crops with home gardeners. Forty thousand copies of Circular 155, “Controlling Pests of War Gardens,” were requested during 1943 alone.

The “Connecticut Straight Neck” and “Yankee Hybrid” squashes, the “Windsor” Pepper, and Corn hybrids bearing names such as “Spancross,” “Marcross,” and “Carmelcross,” are among the products of plant breeding at the Station.

B.H. Walden spraying a tree on December 19, 1902

This discovery produced a doubling of the yield of this premier feed grain.

Beginning around 1940 scientists at the Experiment Station, including James Horsfall, George Zentmyer, and Albert Dimond, developed organic fungicides that quickly replaced fungicides containing toxic elements such as mercury, lead and arsenic. Some of these organic compounds are still used to control plant diseases sixty years later. Diamond also worked on ways to inject fungicides into trees to control plant diseases. Using mainframe computers and thousands of punch cards, Paul Waggoner and Horsfall published *Epidem*, the first computer simulation of a plant disease in 1969. This was followed by *Epimay*, a computer simulation of southern corn leaf blight, which threatened and severely reduced the Nation’s corn crop in 1972.

Chestnut blight had a major impact on Connecticut starting in the early 1900s. Although the large dominant trees are killed by the disease, clumps of chestnut sprouts have continually grown through cycles of the disease. Starting in the 1930s, the Station produced hybrid chestnut trees. During the early 1970’s Sandra Anagnostakis imported strains of the blight pathogen that seemed to inactivate the virulent form of the disease-causing fungus. Now, as the year 2000 draws to a close, an engineered form of hypovirulent fungus has been released into a forest as a biological control and its slow spread is being carefully monitored. Theodore Andreadis and Ronald Weseloh discovered a fungus that attacks gypsy moth caterpillars. This fungus was largely responsible for averting an anticipated major defoliation due to the gypsy moth during the early 1990s. Research has shown that the fungus remains viable in the forest for seven years, and the fungus is now a new weapon available to fight an insect nemesis that has caused periodic defoliations since it reached Connecticut in 1904. Another biological control developed at the Station is a lady beetle predator of the hemlock woolly adelgid imported from Japan by Mark S. McClure and released in 1995. Many thousands of these lady beetles have been reared and released in Connecticut and the Northeast and the Middle Atlantic States.

Much effort has been directed towards controlling the ticks that carry Lyme disease and other pathogens and towards finding new methods of detecting diseases such as Lyme disease, ehrlichiosis, and babesiosis. The Experiment Station was the first to isolate the Lyme disease pathogen from wild mammals and has developed tests to detect the pathogen. Mosquitoes and West Nile virus became a prominent threat to man, birds, and horses throughout the state as the Millennium drew to a close. The Experiment Station was the first to isolate the West Nile virus from mosquitoes in North America and continues to survey the entire state for the virus in mosquitoes, birds, and mammals.

Hundreds of discoveries, both large and small, have resulted from the dream of Samuel W. Johnson. They were anticipated even at the time of the first Annual Report (1876) which stated: “It has been felt from the first, that more

Milestones in Experiment Station History

Analytical Chemistry

1875 Samuel Johnson and Wilbur Atwater began The Station's work by analyzing agricultural fertilizers and feeds.
1952 Analysis of nitrogen in feeds and fertilizers by percentage by the Kjeldahl method.
1963 Gas chromatography was used for determination of pesticides on agricultural produce in parts per million.

Biochemistry and Genetics

1888 Biochemistry research began with Thomas Osborne's study of plant proteins.
1905 Edward East began studies of protein content and hybrid vigor in corn.
1913 Osborne and Lafayette Mendel discover Vitamin A.
1917 Donald Jones published his theory of herterosis to explain hybrid vigor.
1919 Jones invented double cross hybrid seed corn production leading to hybrid corn throughout world.
1930s Hubert Vickery investigated the metabolism of organic acids in plant leaves.
1971 Israel Zelitch discovered inhibitors for wasteful photorespiration and control of leaf pores.

Entomology

1900 Experiment Station began inspecting nurseries to prevent spread of insects and pathogens
1901 W.E. Britton becomes the first State Entomologist.
1927 Britton and Philip Garman began raising parasitic wasps for biological control of insect pests.
1965 David Leonard and Charles Doane developed the first artificial diet for gypsy moths, which led to the discovery of the gypsy moth pheromone and viral control.
1967 R. Prokopy pioneered novel strategies of pest control based on insect behavior.
1983 John Anderson and Louis Magnarelli isolated the Lyme disease pathogen from ticks, mice and raccoons.
1984 Magnarelli and Anderson developed antibody tests for Lyme disease in collaboration with Yale University and the Communicable Diseases Center.
1989 Theodore Andreadis and Ronald Weseloh discovered a fungus that caused the collapse of gypsy moth populations.

Forestry and Horticulture

1905 Walter Mulford, the first State Forest Fire Warden, made the first state laws combating forest fires.
1927 Henry Hicock established research plots to monitor forest change and succession.
1968 Paul Waggoner and James Horsfall developed the first computer simulator of a plant disease.
1974 Station Forester George Stephens related tree mortality to insect defoliation.

Plant Pathology and Ecology

1890 The fungus causing potato scab was isolated by Roland Thaxter.
1903 The first "spray calendar" guide was published to help Connecticut farmers minimize pesticide use.
1940 James Horsfall discovered the first organic fungicide.
1949 Albert Dimond developed the technique for chemotherapy-by-injection for control of Dutch elm disease.
1972 Sandra Anagnostakis imported a hypovirus for biological control of the chestnut blight.
1982 Donald Aylor published a computer model of long-distance aerial transport of plant disease spores.

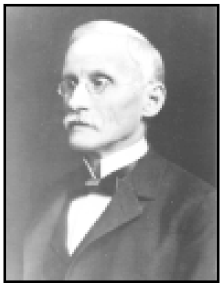
Soil and Water

1934 M.F. Morgan developed the world's first test for rapid analysis of soil fertility.
1946 Sewage sludge compost was shown to improve soil.
1967 Charles Frink described nutrient budgets for Connecticut lakes.
1970 David Hill published a soil survey of coastal wetlands.
1990 Joseph Pignatello used the Fenton reaction to inactivate pesticides.
1999 Anderson, Andreadis, and Charles Vossbrinck were the first to isolate the first West Nile virus pathogen from mosquitoes in North America.

Valley Laboratory

1900 Tobacco was planted under cloth for the first time in Connecticut, revolutionizing the tobacco industry.
1929 M.F. Morgan installed a lysimeter to study losses of plant nutrients through leaching.
1995 Mark McClure released a lady beetle predator imported from Japan to combat the hemlock woolly adelgid.

Hundreds of discoveries, both large and small, have resulted from the dream of Samuel W. Johnson



Samuel W. Johnson, Director 1877-1900

proper, but also the most widely and permanently useful work of an Agricultural Experiment Station. Such an institution will be worthy of its name in proportion as it carries on accurate and thorough investigations and experiments in agricultural science."

Johnson would be proud of the achievements of the Connecticut Agricultural Experiment Station.

The architects rendering of The Johnson-Horsfall Laboratory. The addition is to the right and the existing laboratory is to the left.

BULK RATE
U.S. POSTAGE
PAID
NEW HAVEN, CT
PERMIT No. 295

The Connecticut Agricultural
Experiment Station
P.O. Box 1106
New Haven, CT 06504-1106