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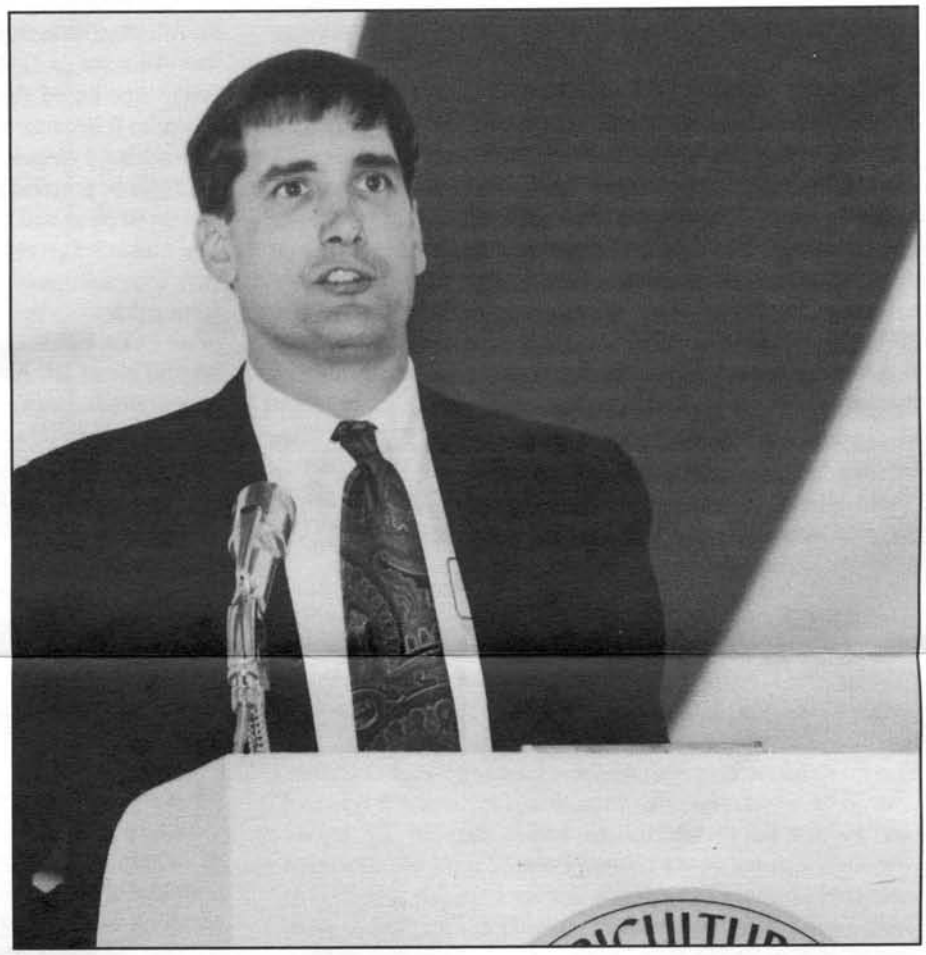

John Lyman III delivering the Samuel W. Johnson Lecture

A vision of Connecticut agriculture

Coating reduces arsenic leaching from wood

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A Vision of Connecticut Agriculture in the 21st Century: Why the Future is Bright

By John Lyman III
Samuel W. Johnson Lecture, Plant Science Day, August 5, 1998

I was very honored that I was asked to speak because in my mind this lecture carries with it a lot of prestige, primarily because of some of its past speakers. Last year we heard a great message, in fact a call to action, from Representative Bill Dyson. In previous years we have heard from former Governor Lowell Weicker, and from the late Bob Josephy, to name but a few. The lecture has often served as a launch pad for very important initiatives, a good example being when Bob Josephy used his speech to call attention to the alarming loss in Connecticut of prime agricultural land due to urbanization. This was an important step, which eventually would lead to the formation of the Farmland Preservation Trust Fund. This trust fund has of course been instrumental in securing for the State's citizens many thousands of acres of prime agricultural land for future use, whether it is farming or open-space. In a moment I'm going to present a vision of the future for agriculture in Connecticut. By the title of my talk I've already committed to telling you why it's positive. But do you know what? It really is.

First let me give you a little personal history, because I think it will help you to understand my thought process. I grew up on the family farm in Middlefield. I have three sisters and one brother. Each of us worked on the farm as we grew up. My dad, Jack (who is here today), was the head honcho, just as his dad was before him. In fact, this succession thing has been going on for a long time–eight generations to be exact. But one of the things my dad did was to start us from the ground up. We had to earn our way to career advancement at the Lyman Farm. Career advancement consisted of going from peach thinner to peach picker! Another great thing that my mom and dad did was not to pressure us to stay on the farm. In fact they encouraged us to look around and explore other opportunities if that was our wish. They were great believers in a solid education and assisted all five of us in getting college degrees. Not only that, but they stressed a good, broad liberal arts education as a way to best prepare us for whatever future challenges we were to face. So I majored in American Studies and graduated from Colby College in 1979.

It's no surprise that I wasn't ready to come back to the farm! I had a desire to travel, and secured a great opportunity to work on a Dutch apple farm. When I left I told my mom and dad that I didn't know when I'd be back. I had every intention of going for at least 2 or 3 years. I ended up spending a little over a year in Holland, having gotten a great deal of practical technical training in intensive orcharding, as well as having had a chance to do a lot of traveling throughout Europe.

The time away was extremely beneficial, and I learned a lot of valuable lessons to last a lifetime. Most people I met saw America as the land of opportunity–still in 1979! Everyone who heard about our family farm encouraged me to return to it because of what they saw as great opportunity (something I already knew in my heart). I saw intensive land-use in practice in Europe, and truly integrated landscapes of farm and city that seemed to co-exist just fine. I saw farmers frustrated by too much government intervention, especially in the market arena. I observed our country from a different perspective, and grew very patriotic. Most of all I saw that seemingly impossible situations were not impossible at all. An example of this is that I remember having discussions with Dutch friends about why we (meaning NATO) shouldn't give in to the Soviets, even though conventional wisdom held that their eventual ascension of Western Europe was just a matter of time. To think that in a little over ten years the Soviet Empire would disintegrate was beyond anyone's imagination. Amazing.

I saw intensive land-use in practice in Europe, and truly integrated landscapes of farm and city that seemed to co-exist just fine

The point of this last example is that we, meaning each of us here today, have to be careful of dooming ourselves to a limited and less-than-desirable destiny simply because we go along with conventional wisdom, or because we fail to remove ourselves from our familiar day-to-day surroundings and refuse to dream of what could happen in the future. For when we see things from a different perspective we often see that great things are possible.

When I came back from Europe I had decided to make a career on the farm, fully aware of the problems that would have to be faced but more importantly excited about the opportunities that lay ahead.

The history of the Lyman Farm is a good example of good old Yankee ingenuity. Eight generations ago, in 1741, John Lyman purchased 36 acres in Middlefield (it was part of Middletown then). This piece of land is where our farm market is located today. Over the years the size of the farm grew to over a thousand acres. Today there are 1100 acres, all contiguous in the southern end of Middlefield and a little in the northern end of Durham. For the first hundred years or so the farm was a typical self-sufficient New England farm.

Toward the middle and latter part of the 19th Century we began to specialize, raising hogs and sheep, hay for horses, and in the 1890's peaches. This was our start in the commercial fruit industry–in fact it was the start of the state's commercial fruit industry as well. The Connecticut Pomological Society was formed at this time. Right from the start the fruit growers enjoyed a close working relationship with this Agricultural Experiment Station. Connecticut was a major force in the national peach industry at the turn of the century and for the next decade and a half. But the extremely cold winter of 1917-18 dealt a deathblow to the peach industry in the state. Frost went four feet into the ground, killing peach trees outright. The response of many of the fruit growers, including ourselves, was to plant apple trees. And that's how we got into the apple business.

In the 1920's we began to specialize in dairy farming as well, and over the next 40 years built a purebred Guernsey herd. That was back in the days when high butterfat milk brought a premium in the marketplace. That began to change in the late 1950's, and the Holstein breed began to be preferred because of their higher milk production yields. Even though that milk was lower in butterfat, the market preference was shifting to this as well. We began to phase out of dairy business in the 1960's.

> We have changed over the years, but our main asset continues to be the land

Over the years the Lyman family had a number of entrepreneurs that tried their hands at non-agricultural endeavors. In the 1850's and 60's it was clothes wringers and in the later 1800's it was the rifle peep sight. Lyman Gunsight was born during this time, and was the most lucrative part of the family business through the first half of the 20th century. So it wasn't any surprise that the family would be open to another line of non-agricultural business in the 1960's as we were phasing out the dairy business. Thus Lyman Orchards Golf Club was built on the old dairy pastureland first 18 holes in 1969, then another 18 holes in 1994.

The orchard has continued on roughly the same amount of acreage (400) over the years. In the early 1960's we got into direct marketing in a big way, building a seasonal retail fruit stand on the end of our packinghouse. We enjoyed great patronage and had outgrown the facility by the end of the decade. In 1971 we opened our Apple Barrel farm market, with a scratch bakery and other expanded product-lines. It became a year round venture at this time. In addition to the retail marketing we also have developed a direct line of sales with a 5-month pick your own business. And we press apple cider, as well as sell our fruit through wholesale channels.

So Lyman Orchards today consists of an Orchard (with a vertically integrated marketing program), a Retail Store, and a Golf facility. We have changed over the years, but our main asset continues to be the land. While we may not appear to some a typical farm, we are still tied to the agricultural industry, and perhaps we represent what Connecticut agriculture is destined to become in the years ahead. In fact, many other agricultural enterprises in Connecticut are responding to the changing marketplace in ways similar to ours. The mix is different, but the concept is the same.

> The family farm, although different in look and make-up, is stronger than ever

What does Connecticut agriculture look like today? First let's take a look at where we've come from. The last half of this century has seen a dramatic change in Connecticut's agricultural landscape. We have gone from a rural state to very much an urban state. Many farms have gone out of business and have become housing developments or industrial parks. The make-up of the remaining farms has changed as well. Connecticut agriculture once was predominantly dairy and poultry farms. While these two commodities remain important, the number one commodity today is the green industry–primarily landscape ornamental trees, shrubs and flowers. Another fast growing component is the horse industry, primarily for leisure riding. These two industries and the rise in their importance makes sense when put into the context of the urbanization of the state. And if you consider the golf industry a form of agriculture, that too has become a major component. It's interesting that all of these industries do not produce food, which is what the average person associates with agriculture.

That's not to say that food-producing agriculture is weak or unimportant. In fact, it has experienced a renaissance in the last decade or so. Specialty, niche crops are some of the ways Connecticut's farmers have been adjusting in the marketplace. The aquaculture industry offers a good example as well as the wine industry. And tobacco, so important in the 1940's and 50's, is experiencing a revival. So Connecticut agriculture is diverse, dynamic, and ever-changing. Contrary to conventional wisdom, Connecticut agriculture is alive and well in 1998. That's not to say that we don't have our problems–we do. But out of every difficult situation comes a new way of looking at things, and thus a new opportunity. And as Connecticut agriculture has been adjusting to new realities, this trend must continue into the next century.

Now to get a vision of the future, let's jump ahead to the year 2025. To help complete the transition, look at me and realize that I am now 68 years old. Pretty well preserved, don't you think? Well I want to survey with you the Connecticut agricultural landscape and where we have come over the past 27 years.

The agricultural industry in 2025 is very strong. It enjoys a high profile and a very positive image. It is one of the top growing industries in the state, and it offers an attractive career to the state's best and brightest students. In fact, new job creation is among the highest of all Connecticut's industries. And it truly is an equal opportunity employer, hiring more of the nation's new immigrants and racially diverse citizens than any other. The entrepreneurial spirit, in complete concert with the traditional American dream of opportunity, is alive and well in agriculture. The state's citizens see it as an essential component of what makes the

standard of living in Connecticut the highest in the nation. Instead of preservation of open space, the mindset of the public is that of agriculture being a productive and positive use of open space. Concerns of agriculture being a major polluter have been replaced with the State and towns encouraging agriculture as a means of solving many of their pollution concerns. The family farm, although different in look and make-up, is stronger than ever. Our diets have never been better because people are eating more healthy, fresh agricultural products. Connecticut is a major supplier of these products in the Northeast corridor, as well as a major exporter.

> After years of being on the defensive and looking like a dying industry, it took charge of it's own destiny

It's been a most amazing transition over the past 27 years. How did it happen? In looking back, there were a number of watershed events. At the time, while important primarily because each posed a major threat to agriculture's survival, they didn't appear to be the seeds, or catalysts for such a remarkable outcome. But what wasn't counted on at the time was the amazing resiliency of the human spirit, and the fact that throughout our nation's history that spirit has demonstrated the ability to rise above any obstacle and create greater opportunities than previously existed.

Two very important events happened one year after another, in 1996 and 1997. These were the attempts to merge the Department of Agriculture into another department, and the attempt to close The Connecticut Agricultural Experiment Station. Both were seen as cost cutting moves. In the debate that followed, long-latent support for agriculture within the public was awakened. But more importantly, the agricultural industry was forced to take a hard look at itself, and after years of being on the defensive and looking like a dying industry, it took charge of its own destiny.

In 1999 an Agricultural Summit was held. The outcome of this one-day event was that leaders in the industry developed a strategic plan for Connecticut agriculture in the 21st Century. It wasn't too specific, but it focused on where agriculture needed to go, and it identified the obstacles in the way. It then developed a specific action plan to positively remove those obstacles and to develop a culture in which agriculture could thrive. Now, 27 years later we can see that this plan was successful. We should explore some specific initiatives that resulted from this strategic plan.

Four key areas were identified as creating obstacles. However if these areas could be modified it was felt that they would become a catalyst for positive change. These were Government's Effect, Labor, Crop Productivity, and Markets. Each was analyzed for what their present negative influence was, and then for what corrections were needed.

GOVERNMENT'S EFFECT was a general lack of regard for the importance of agriculture to the State's economy; attempts to close the Department of Agriculture and the Experiment Station were just two examples. To positively address this, the agricultural industry convinced the Governor and the legislature to have Agriculture added as a major business cluster to the 1998 Cluster Initiative for Economic Development. Thus Agriculture joined Financial Services, Telecommunications and Information, Health Care Services, Manufacturing, High Technology, and Tourism as the major business clusters in Connecticut. While not nearly as large as the other industries in terms of gross revenues, the importance of Agriculture to the quality of life was cited as the major reason to include it. Quality of life factors included holders of a major amount of open-space acreage inviting the public to experience the farm through pick your own activities, shopping at the farm stands, tours of farms, walking and hunting privileges, the positive impact to the atmosphere of plants, and the positive visual landscape.

Once included as a major cluster, phenomenal change began to take place in the agricultural industry. Linked to the major movers and shakers in Connecticut industry and government circles, agriculture experienced major modernization similar to that seen in the telecommunications industry. There were cross-links developed among the clusters, such as between agriculture and tourism. Public policy included agriculture in research initiatives (and the Experiment Station was a major beneficiary of these research dollars), as well as work-force training and biotechnology initiatives. Instead of fearing what each new legislative session would bring against it, agricultural enterprises were encouraged because their industry, Agriculture, was seen as a positive contributor to the new Connecticut, and thus given priority by the government in solving its problems.

> Agriculture, was seen as a positive contributor to the new Connecticut

LABOR, and the adequate supply of it, had long been an obstacle to Agriculture's growth. The greatest shortages often occurred during the seasonal periods around harvest. Due to these labor restrictions, which held back the growth potential of agricultural enterprises in total, more year-round agricultural employment was restricted. Other industries responded to similar situations in the early and mid-20th Century by automating many tasks. However, many segments of Connecticut's agriculture were never able to utilize this technology. But thanks to the technological advances of the latter part of the 20th Century and early part of the 21st Century this changed. Sophisticated robotics began to perform tasks such as harvesting and packing, and greater productivity at these critical stages allowed many of the state's agricultural enterprises to expand, hiring on a net basis more employees than they replaced by automation.

CROP PRODUCTIVITY had many constraints as measured by the systems of pest control, soil fertility and yields. Pest control was shifting to more biological controls by the turn of the 21st Century, but the majority of it was still accomplished with synthetic pesticides. However, the advanced plant engineering which bred into plants resistance to many

major pests and effective natural pesticides now make bio-control of pests a reality on most of the crops grown in Connecticut in 2025. This has had the added benefit of increasing consumer confidence in the food we produce, and that has led to more demand.

> The increased yields did not happen by luck, but by a conscious and consistent effort to push for higher yields

Soil fertility, and loss of it, was a largely unknown phenomenon 27 years ago. Yes, we knew the basics of nutrient requirements, but what we didn't fully understand was the value of continuing to build organic matter back into the soils. Other than spreading manure onto fields, or growing cover crops, standard agricultural practices did not stress the value of building soils. Once the value, or necessity, of building up soils and the need to develop a cost effective means of doing it became apparent, it didn't take long to see that the problem of bulky waste could be solved with an effective composting system and that the compost could then be incorporated into our soils. The cost of waste management was drastically reduced for taxpayers, thus enabling some of these savings to go to the farmers to help defray the cost of incorporating the compost and building up the soils led to higher yields. It's amazing how this one issue created a bond between the state's towns and the farmers.

Crop yields, which seemed acceptable in 1998, increased dramatically in the past 27 years This has allowed agriculture to become a profitable business for most of the good producers in the state. This in turn has led to many talented individuals getting into agriculture, which has led to Connecticut's agriculture being one of the strongest in the world. It's funny how no one realized 27 years ago how much potential yield was not being realized. The increased yields did not happen by luck, but by a conscious and consistent effort to push for higher yields. Better plant engineering, better plant variety selection, more efficient production through better mechanical technology, and better soil health and fertility led to these higher yields.

MARKETING had long seemed to be the farmers' nemesis. Often in the late 20th Century it seemed that prices for agricultural products didn't keep up with increases in production costs. There were a few good years interspersed with the difficult years, but the trend was decreasing margins. If agriculture was to survive and truly become a viable industry in the 21st Century this trend needed to be reversed. Farmers had to be better marketers, understand what their customers needed and what they might want. They had to identify niche opportunities. They had to stop taking for granted the great market that we have here in Connecticut. In fact, even today we may have the best market in the world when one considers number of people, level of education, and level of income. Certainly our competitors from other states and international regions were after this market as well in 1998.

Some of the ways that farmers changed their marketing fortunes were to positively respond to consumer concerns by assuring the safety of their products, to offer a local alternative to products shipped great distances (and thus offer a fresher alternative), leveraging the positive feeling people had for agriculture in their community into buying the products produced by those farms, and producing products that filled market needs as opposed to producing for saturated markets. In addition, an interesting outgrowth of the greater ability to measure dangers in food was the discovery and better understanding of the good and healthy attributes present in that same food. Once all this information became known, the agricultural industry was able to greatly reduce or eliminate the dangers while at the same time accentuate the positive aspects through better bio-engineering and production methods. The result was greater consumer demand and a better market for the agricultural producers.

So what we have in 2025 is a very supportive Government which assists rather than disrupts, Labor as a cost of sales at much lower levels (which makes agriculture comparable with other manufacturing industries), Crop Productivity at much higher levels than ever dreamed of, and a Market which favors Connecticut's farmers and their products. It doesn't seem possible when one considers how far we've come since 1998. That's a lot of change in 27 years. Many thought such change was impossible, but to put it into perspective, consider the changes that took place in the computer industry between 1971 and 1998. Or consider the change in the aerospace industry between 1955 and 1983. Or consider the change in the automobile industry between 1930 and 1957.

> Connecticut's agricultural community made a very important decision in 1998–it decided to grow

No one could have predicted the exact changes that took place in these industries in these 27-year periods, but those involved were optimistic and ready for change. And as the great advancements took place they were accelerated even more by the talents and dreams of additional new players. Holding onto the status quo, or limiting the industry to a small and finite (or shrinking) group, no matter how talented, would never have gotten such dramatic results.

Connecticut's agricultural community made a very important decision in 1998–it decided to grow and that it was going to need the best and the brightest people. It also decided that they would not be limited by their individual ideas and dreams, but would look to soar with the collective dreams of many. All they needed to do was to better organize themselves within the industry and to identify areas of common concerns and desired results. Next, a plan of action was formulated, followed by very effective and extremely coordinated execution. The rest, as they say, is history.

Arsenic from CCA-treated wood can be reduced by coating

By David E. Stilwell

Chromated copper arsenate (CCA) is widely used as a wood preservative due to its excellent fungicidal and insecticidal properties. Because of potential toxicity to humans, animals, and plants, and its widespread use, we have investigated the amounts of copper (Cu), chromium (Cr), and arsenic (As) in soils located under CCA treated wood structures. We also have determined the amounts of arsenic dislodged from CCA treated wood surfaces.

During pressure treatment up to 250 liters of CCA solution per cubic meter of wood is applied, resulting in (Cu), (Cr), and (As) concentrations in the range of 1000-5000 mg/kg. In the United States more than 10 million cubic meters of CCA treated wood is produced each year to make picnic tables, decks, highway sound-barriers, telephone poles, docks, and similar structures.

Laboratory studies have shown that high percentages of CCA can be released from the wood in acidic aqueous solutions. These findings imply that Cu, Cr and As could be leached from outdoor use of CCA treated wood structures since the pH of "acid rain" is between 4.1-4.5 in the Northeast. Accordingly, we conducted a field study to determine if CCA preservative could leach from the wood.

A total of 85 soil samples were collected in polypropylene containers from under a total of seven decks built with CCA pressure treated lumber. Decks are ideal for the study of the effects of weathering due to rain and solar radiation on the wood. The wood is above ground and there are large amounts of horizontal surfaces so that any preservative leachate tends to flow directly to the soil below. The decks ranged in age from 4 months to 15 years. The size of the individual decks ranged from 18 to 50 square meters. One, (Deck #7) had been coated with paint since construction. The soil samples were collected in a grid at a frequency of about one sample per 2 sq. m of deck area. Control soils were acquired at a minimum distance of 5 meters from the decks and at least 4 m apart. All soils were classified as sandy loam (Typic Dystrochrept). Soil samples were a composite of the upper 5 cm soil layer and averaged 100 g. The dried soil samples were prepared for analysis by microwave digestion. The Cu, Cr, and As contents were determined by atomic spectroscopy.

The range and average As contents in the soil under each deck are given in Table 1. The overall range and average for Cu, Cr, and As are given in Table 2. The values were based on the average result between duplicates.

At each site, the average Cu, Cr, As content in the soil samples taken beneath the deck was elevated with respect to the average in the control soils. In all cases, except for the Cr content for deck 2, this elevation was statistically significant ($p<0.025$). Moreover, in the vast majority of samples (100% for Cu, 88% for Cr, and 99% As), the analyte in the soil beneath the deck was greater than the largest value in control soil at that site.

Table 1. Range and Average Arsenic Concentrations (mg/kg dry weight) in Soil Samples.

		(mg/kg, dry weight)			
Deck #	Age/Yrs	Beneath Deck		Control	
		Range	Avg.	Range	Avg.
1	0.3	3-19	9	2.2-3.5	2.6
2	2	7-91	34	3.6-5.2	4.2
3	5	34-99	61	2.5-8.3	4.9
4	7	44-333	139	2.5-8.3	4.9
5	7	57-215	113	2.2-3.9	2.7
6	8	50-350	138	3.5-5.3	4.4
7	15	6-80	40	1.3-2.4	1.9
Overall		3-350	76	1.3-8.3	3.7

Table 2. Overall Range, and Average Cu, Cr, and As contents (mg/kg, dry weight) in soil samples.

	Beneath Deck		Control	
	Range	Avg.	Range	Avg.
Copper	17-410	75	10-30	17
Chromium	16-154	43	11-30	20
Arsenic	3-350	76	1.3-8.3	4

Evidence indicating that the Cu, Cr, and As was leached from the wood can be obtained by calculating the relative amounts of Cu, Cr, and As expressed as the Cu /Cr /As ratio (by weight) in the soil samples beneath the decks, after subtraction of the background amounts in the control soils. The ratio obtained was overall 1.0 / 0.4 / 1.2 and ranged 1.0 / 0.3-0.6 / 0.4-2.1, with the relative amounts of As and Cr tending to increase with deck age. Deck 7, which was painted 1 year after construction and again about 3 years later, was an exception. The weight ratio of Cu: Cr: As in new treated wood is 1.0 / 1.7 / 1.5. Thus, the relative amounts of Cr, and to lesser extent As, in the soils are less than those normally found in new treated wood, suggesting that these elements are bound more effectively in the wood than is Cu. This finding is consistent with the results of simulated leaching studies where Cu was released most readily, followed by As

Figure 1. David Stilwell with test "coupons".

and then Cr. The ratio analysis, as well as the observed trend of increased Cu, Cr, and As in soils as function of deck age is consistent with leaching of the CCA, as opposed to other mechanisms, such as sawdust generated during construction, and/or physical wearing off of wood layers.

To gain perspective, the average contents of Cu (75/mg/kg), Cr (43 mg/kg) and As (76 mg/kg) were compared to EPA standards for land application of biosolids and Connecticut standards for remediation of contaminated soils. The As content exceeded both the EPA (41 mg/kg) and Connecticut (10 mg/kg) standards by substantial amounts. Both the copper and chromium contents in the soils were well below the guidance levels.

A controversy exists as to the extent of arsenic exposure due to physical contact with CCA wood surfaces. Studies have shown that virtually no inorganic arsenic is absorbed through the skin, but is readily taken up by ingestion. Thus, the potential exposure is hand to mouth. Therefore, children are considered the most vulnerable to this potential risk, especially from playground equipment, decks, and picnic tables built using CCA-treated wood. We investigated this vulnerability by analyzing the Cu, Cr, and As in wipe samples from a variety of CCA-treated wood surfaces.

The wood surfaces were tested using polyester cloth attached to an 8 x13 cm wood block. The cloths were dampened with 1.5 times their weight of deionized water and stored in polypropylene containers. To minimize the effects of wood surface irregularities, the bottom of the block was cushioned with rubber, and sealed with polypropylene tape. Prior to sampling, a 1.25 kg weight was placed on top of the block. A wipe sample was taken by pulling the weighted assembly back and forth across 28-30 cm of the test surface five times. The wipe was then digested in 10% nitric acid solution for 2 hours at 60 C for later analysis by atomic spectroscopy. Although this method was designed to be consistent and reproducible for meaningful comparative measurements, it does not mimic hand to mouth exposure.

For this study, seven sets of eight-foot CCA pressure treated boards were purchased from three lumber yards over a period of one year. Each set consisted of 3-4 boards. Each board was cut into 1 or 2 foot piecess. These pieces are referred to as coupons. Between 2 and 4 coupons from the interior portions of each board was tested. All boards had been treated, nominally, to a level 0.4 pounds of CCA preservative (Type C formulation) per cubic foot. Three of the sets consisted of pine treated with both CCA and a water repellent. These water repellent (WR) CCA boards are commonly used for decking (5/4 x 6 inches). The coupons were placed on racks at Lockwood Farm (Figure 1) and are being periodically tested to determine the effects of weathering. The results summarized in Table 3 are for coupons weathered for one month (nominal).

In all cases measurable amounts of arsenic were dislodged from the test coupons. The standard deviation shows high variability both within a particular set as well as between sets. There were no statistical differences between the amounts of arsenic dislodged from the surface of wood coupons containing both water repellents and CCA (sets 5-7) and those containing CCA only (sets 1-4). The levels of arsenic dislodged from the wood surfaces reported here are similar to those found by a Consumer Product Safety Commission study on CCA wood purchased from lumber yards.

Table 3. Arsenic Dislodged from CCA Wood Coupons.

		Arsenic Dislodged ($\mu g/100\ cm^2$)		
Set	Number	Range	Median	Avg./Std. Deviation
1	8	15-31	18	21±5
2	8	6-33	30	25±10
3	6	56-122	60	79±33
4	6	15-26	23	23±8
Sets 1-4	28	6-122	26	35±28
5	12	29-54	36	38±8
6	6	46-71	56	57±9
7	6	24-87	56	51±23
Sets 5-7	24	24-87	45	46±15
All	52	6-122	34	40±24

We also surveyed wooden playscapes at three municipal parks which were built using CCA-treated wood. A total of 45 wipe samples were taken from horizontal deck plank sur-

faces, and the results are summarized in Table 4.

The average amount of arsenic dislodged on the wood surfaces on the playscapes (8.8 µg/100 cm^2) was considerably less than the average reported for test coupons (40 µg/100 cm^2, Table 3). The reasons for the lower values on the surfaces of boards actually in use are not clear, but they could be due to differences in their wear and weathering history. In other experiments, we found that repetitive physical contact of the same surface (such as could be expected on the playscape surfaces) will result in significant decreases of arsenic dislodged as a function of repetition.

Table 4. Arsenic Dislodged from Municipal CCA Wood Playscape Surfaces

Playscape	Number	Arsenic Dislodged (µg/100 cm^2) Range	Median	Average
1	14	2-45	8.0	10.5
2	16	2-17	7.6	7.8
3	15	3-22	7.9	8.2
All	45	2-45	7.6	8.8

In addition to the horizontal surfaces tested at the municipal playscapes, a total of twelve samples were taken from vertical poles supporting the structures (when testing vertical pole surfaces hand pressure was substituted for the block and weight). The amounts of arsenic dislodged from these pole surfaces ranged from 5-632 µg/100cm^2 and averaged 105 µg/100 cm^2. Though these values were much higher than those observed on the horizontal surfaces, these results should be taken as indicative, as the testing method for the horizontal and vertical surfaces were not the same.

Finally, the effectiveness of coatings in forming a surface barrier for arsenic was tested. Four coatings were applied to four coupons each. The coatings were (1) polyurethane deck and porch enamel, (2) a latex acrylic solid color stain, (3) a spar varnish, and (4) a semi-transparent oil stain containing alkyl resins. The amounts of arsenic dislodged was determined before, after, and up to 1 year after coating.

Application of these coatings dramatically reduced leaching of arsenic over the 1 year test period. Compared to the precoat values, there was more than a 95% reduction in the arsenic dislodged from the CCA wood surfaces coated with polyurethane, acrylic, or spar varnish. The percent reduction with the oil based alkyl resin ranged from 80-97% and averaged 90%. This test, however, did not determine how well these coatings stood up to wear and tear. A paint dealer could help determine which coating would be most appropriate for a given use, such as high foot traffic areas.

Our tests show that metals, especially arsenic, leach from CCA-treated woods, but coating with varnish or paint can dramatically reduce leaching. Potential risk of exposure may also be reduced by not allowing children or animals to play under treated decks; limiting deck size; and using alternative materials such as cedar, composite woods, plastic timber, or pine treated with preservatives containing no arsenic, such as copper-based ACQ or CDDC.

The Connecticut Agricultural
Experiment Station
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