The Lawn-Chemical Economy and Its Discontents

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The daily geographies of consumption represent some of the most ecologically important and economically complex frontiers for critical research. Among these, the turfgrass lawn is perhaps the most overlooked, owing to its very ordinariness. Despite the serious risks posed to human health and ecosystem viability by high-input lawn systems, little critical scholarship has engaged the lawn, especially as a structured economic phenomenon. This paper explores the forces and political economic conditions under which the lawn is produced, promulgated, and resisted in North America. In the process, we draw attention to the deeply structured economic impetus behind the direct sale of potentially toxic chemicals to urban dwellers. Based on survey research and a review of the industry, we argue (1) that chemical demand is driven by urban growth and classed aesthetics, (2) that direct and aggressive sales of chemicals to consumers are spurred by crises in the chemical-formulator industry, (3) that the search for consumer-lawn markets is driven by declining margins in the worldwide chemical trade, and (4) that counterinstitutional struggles against high-input lawns represent a salvo against otherwise abstract and daunting cultural-economic hegemony.

In 1991, the Montreal suburb of Hudson became the first of many Canadian municipalities to entirely outlaw the use of cosmetic pesticides on lawns. Since that time, dozens of other towns have enacted similar bans, including some of the country's largest cities. A decade later, the Canadian supreme court upheld the Hudson restriction, giving local authorities across Canada the right to follow suit (*Lawn & Landscape Magazine* 2001).

This legal decision did not go unopposed by any means, however. Landscape contractors Spraytech and Chemlawn (now named Greenspace Services in Canada) actually brought the case to the supreme court, insisting that the ban was discriminatory against the lawn-care industry and that it should not be generalized to other provinces, as it is an entirely local matter. Organized under action groups with euphemistic names such as the Ontario Environmental Coalition, landscape and chemical-company trade groups formed coalitions attempting to stall efforts to enact similar laws elsewhere (Carmichael 2002).

This high-profile conflict raises a rather obvious question. If the public is struggling in some places to ban chemical applications that the industry is fighting to maintain, is it *demand* or *supply* that drives

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the prevalent and growing application of lawn chemicals—insecticides, herbicides, and fertilizers—throughout the United States and Canada? Is the tidy monocultural lawn a product of idiosyncratic regional culture—or of the pressing exigencies of global chemical capitalism? How do landscapes such as the lawn undermine the very dualisms of demand and supply, culture and economy, regional and global?

There is no question that the lawn is a deeply cultural and psychologically complex landscape system, arguably rooted in pastoral aesthetic sensibilities, the tradition of the manor house, and the demands of suburban outmigrants for private outdoor space. Whereas the cultural components and symbolic characteristics of the American lawn are well explored in other work, however, the raw (and brutal) economic details that surround lawns remain profoundly overlooked. While the lawn is, of course, a fundamental product of American landscape imaginaries—a symbol—it is also a vast economy.

Without detracting from the important cultural and symbolic facets of the tradition of the lawn monoculture, therefore, which has been outlined with great care by other observers (Bormann et al 1993; Feagan and Ripmeester 1999; Jenkins 1994; Robbins and Sharp 2003), it is our intention to here highlight the political economic conditions under which that aesthetic is produced, promulgated, and resisted. In the process, we aim to draw attention to the deeply structured economic impetus behind the direct sale of chemicals to urban citizens. We argue (1) that increased local chemical demand is driven by expansive, low-density urban growth coupled with the classed aesthetics of suburban development, (2) that direct and aggressive sales of chemicals to consumers is a recent innovation, spurred by crises in retailing internal to the chemical formulator industry, and (3) that the search for consumer markets and lawn-formulator clients for the chemical industry is further driven by contraction and declining margins in the worldwide chemical trade. Thus, the lawn is not an exceptional agrarian landscape, but rather one typical of the barriers and opportunities presented by natural systems for all capital accumulation (Henderson 1999). Finally we argue that counterinstitutional efforts against normative high-input lawn aesthetics—in the forms of neighborhood struggles, community statutes, and national law—represents a salvo against otherwise abstract and daunting cultural-economic hegemony.

The research summarized in this essay includes results of a national phone survey in the United States to explore use patterns, air photography and tax assessors' data to understand lawn coverage (Robbins and Birkenholtz 2003), and an economic survey of the chemical industry to reveal the broader pressures on production and marketing. Together, these represent a nested analysis that follows a political ecological "chain of explanation" in which local decision-making and behaviors are situated in a wider regional process (Blaikie and Brookfield

1987). Such an approach, more typically applied to explanations of soil erosion in West Africa (Warren, Batterbury, and Osbahr 2001) or deforestation in Latin America (Hecht and Cockburn 1989), is used here to explain the widespread and growing deposition of toxic chemicals in residential lawn environments, a problem overlooked as a technological risk precisely because of its ubiquity.

The Vastness of the Chemical-Lawn Monoculture

The North American lawn monoculture is rooted in English garden and manor-house landscape fads of the 18th century, themselves a product of Italian landscape painting. In these landscape designs, grassy pastoral spaces, interlaced with hedges, dominated estate horizons until their replacement by a wilder romantic aesthetic (see Stoppard 1993 for a compelling account).

Wealthy landholders introduced not only these lawn landscapes from Europe, but also many of its constituent species, which to this day continue to include a wide range of species. The dominant turfgrass species in the North American lawn are summarized in Table 1, along with their origins. With the exception of red fescue (*Festuca rubra*), all are nonnative. This fact underlines two critical features of the landscape. First, despite its profoundly North American cultural significance, the lawn is by no means an indigenous ecosystem, and as a result, the requirements for its propagation are high. Though these species are robust, the climatic demands of many regions—including the humid South, the arid West, and the frigid North—all make tremendous demands on homeowners seeking to nourish exotic monoculture. Second, this landscape, no matter how extensive and normal in contemporary cities, is a *relatively recent invention*. The key species of the monocultural lawn have, in many cases, come to North America in the last century. While some species arrived incidentally with early settlers, as in the case of Kentucky bluegrass, others were intentionally introduced only in recent years specifically for turf production, as in the case of Kikuyugrass.

The high-input chemical management system is even more recent. As late as the 1930s, lawn-maintenance texts insisted that toleration of weeds was reasonable, that hand-pulling and the keeping of chickens were the most practical solution for weeds and grubs, and that use of chemicals might detract from many of the lawn's functions, including the source of edible greens (Barron 1923; Dickinson 1931). It was only in the post–WWII era that the quantity of lawn coverage and the intensity of its management began to accelerate (Jenkins 1994).

In the last few decades, moreover, the coverage of the lawn has increased greatly, as a survey of lawn coverage reveals. Based on a combination of tax assessors' data and air photography analysis for Franklin County, Ohio, a typical urban/suburban region encompassing

Table 1: Most Common North American Turfgrass Species and Their Origins

Warm-Season Grasses	Origin	Cool-Season Grasses	Origin
Bahiagrass *Paspalum notatum*	Central or South America	Annual ryegrass *Lolium multiflorum*	Europe
Bermudagrass *Cynodon spp.*	Africa	Colonial bentgrass *Agrostis tenuis*	Eurasia
Kikuyugrass *Pennisetum clandestinum*	Africa	Creeping bentgrass *Agrostis palustris*	Europe
St. Augustinegrass *Stenotaphrum secundatum*	Mediterranean and Caribbean	Kentucky bluegrass *Poa pratensis*	Eurasia
Zoysiagrass *Zoysia spp.*	East Asia	Perennial ryegrass *Lolium perenne*	Eurasia/Africa
		Red fescue *Festuca rubra*	North America, Africa, Eurasia, and Iceland
		Tall fescue *Festuca arundinacea*	Europe

Columbus, Ohio and its satellite communities, the proportion of total urban land under private turfgrass—not including parks, golf courses, or other public turf spaces—is conservatively calculated to be 23% of the total (Robbins and Birkenholtz 2003). With urban land in the United States having expanded by 675 thousand hectares per year between 1982 and 1997 (Natural Resources Conservation Service 2000), this means an increase in lawn-grass coverage by more than 155,000 hectares annually. This analysis further reveals that the proportion of private land given over to lawn coverage—as opposed to the footprint of the residence, shrub/tree cover, sidewalks, and driveways—is higher in more recent dwellings than in older construction. The coverage of lawn is increasing with every housing start, and in increasing proportion (Robbins and Birkenholtz 2003).

Beginning in the postwar era, methods of management also began to change. As early as 1962, Rachel Carson noted that

> suburbanites—advised by nurserymen who in turn have been advised by the chemical manufacturers—continue to apply truly astonishing amounts of crabgrass killers to their lawns each year. Marketed under trade names, which give no hint to their nature, many of these preparations contain such poisons as mercury, arsenic, and chlordane. Application at recommended rates leaves tremendous amounts of these chemicals on the lawn. (Carson 1962:80)

The inputs into lawn management have only expanded in the intervening years. In an analysis of national water quality, the United States Geological Survey [USGS] (1999) reveals that 99% of urban stream samples contain one or more pesticides and that insecticides were detected more often and at higher concentrations in urban watersheds than in nonurban systems. Though these chemicals are coming from a range of urban sources, lawn care is an important contributor.

US households spend US$222 each on lawn-care equipment and chemicals annually ($8.9 billion total), and the use of these inputs has continued to rise. In 1999, consumer lawn-care-input purchases reached an all-time high of $8.9 billion, with 35% of all houses spending more than $500 each on lawn care; 55% of households applied insect controls, while 74% applied fertilizer (National Gardening Association 2000). Thus, even while national aggregate pesticide consumption has decreased, especially in industrial and commercial sectors, pesticide use on private lawns remains high, and pesticide use continues to climb steadily (USGS 1999).

Based on an Environmental Protection Agency (EPA) survey, the most commonly used home pesticides (both insecticides and herbicides) are shown in Table 2. The deposition of these chemicals is largely unregulated and has been identified as a serious ecosystem risk in both the United States and Canada (Fuller, Shear, and Wittig 1995). Indeed, many of the same chemicals for which registration and training are required in the agricultural sector are sold over the counter to lawn owners in unregulated quantities (Guerrero 1990).

Uncertainties prevail with regard to the risks associated with many of these chemicals. Experimental research in the field of analytic chemistry, however, increasingly reveals that lawn chemicals:

1. are commonly tracked into homes, where they represent ongoing exposure risks (Nishioka, Burkholder, Brinkman, and Hines 1999);
2. are far more persistent than previously thought in indoor environments (Nishioka et al 1996);
3. accumulate in house dust and on surfaces and carpets, where small children are placed at disproportionate risk (Lewis et al 1991; Lewis, Fortmann, and Camann 1994; Nishioka, Burkholder, Brinkman, and Lewis 1999);
4. lead to persistent contamination through deposition on clothing (Leonas and Yu 1992); and
5. may be far more dangerous to children in chronic exposure (especially the neurotoxins, such as chlorpyrifos) than has been generally accepted to date (Zartarian et al 2000).

The impact of lawn chemical deposition on the broader ambient ecology is also significant, though again largely understudied. Insofar as the lawn represents a permeable surface, it is sometimes championed as an ecologically sound alternative to the paved surfaces of high-density urban development. Chemicals and other inputs on lawns have been demonstrated to have severe and detrimental ecological effects, however. Beyond direct chemical deposition, with its serious implications for ambient insect, fish, and bird populations (Table 2), lawn management has been associated with the degradation of air quality through the use of two-stroke engines with higher emissions per unit fuel than diesel farm equipment (Christensen, Westerholm, and Almen 2001; Priest, Williams, and Bridgman 2000; Sawyer et al 2000). The fragmentation of the landscape in lawnscapes also adversely effects reproduction, survivorship, and dispersal of bird species. Restoration ecologists increasingly recommend a decrease in lawn coverage in commercial and residential development (Marzluff and Ewing 2001).

In sum, the lawn represents a vast landscape across North America, demanding and receiving increasing quantities of inputs per unit land. We wish to suggest here, however, that the expansion of the lawn and the increasing intensity of its ecology occurs at appreciable expense

Table 2: Pesticides Used on US Lawns

Pesticide	**Mlb Active**[a]	**Type**[b]	**Toxicity (EPA)**[b]	**Environmental Toxicity**[b]
2,4-D	7–9	Systemic Phenoxy Herbicide	Slight to high	Birds Fish Insects
Glyphosate	5–7	Nonselective Systemic Herbicide	Moderate	Birds Fish Insects
Dicamba	3–5	Systemic Acid Herbicide	Slight	Aquatic
MCPP	3–5	Selective Phenoxy Herbicide	Slight	N/A
Diazanon	2–4	Nonsystemic Organophosphate Insecticide	Moderate	Birds Fish Insects
Chlorpyrifos	2–4	Broad-spectrum Organophosphate Insecticide	Moderate	Birds Fish
Carbaryl	1–3	Wide-spectrum Carbamate Insecticide	Moderate to high	Fish Insects
Dacthal (DCPA)	1–3	Phthalate Compound Herbicide	Low	Birds Fish

Following Robbins, Polderman, and Birkholtz (2001).
[a] Millions of pounds of active ingredient used in the US (US EPA 1996).
[b] EXTOXNET.

and represents the end of an extensive commodity chain, with political-economic pressures for its development exerted at multiple scales. Pressures for the development of the lawn monoculture are most evident at the local scale, where the economy of urban development assures a steady supply of spaces for management and an enforced demand for normative lawn aesthetics.

Community Political Economy of Green Grass

Many local forces act to produce the increasing use and prevalence of lawn chemicals throughout North America. Instrumental and noninstrumental logics at the local scale converge to create an enforcement of the aesthetic within and between households.

The abstracted profile of those individuals most likely to use lawn chemicals, based on logistic regression of results from a national survey of American lawn owners conducted in 2001, is shown in Table 3. The results reveal a highly classed phenomenon, with users of chemicals coming from higher-value homes and neighborhoods in urban areas throughout the census regions of the US South and Midwest (rather than in the Northeast or West). More clearly, however, use of do-it-yourself chemicals—those applied directly by the lawn owner—is highest in older, middle-income urban populations in the same region, while use of a lawn-care company is again associated with higher housing values, though more common amongst women responsible for lawn care.

The regional variation suggests both environmental and cultural influences. The aridity of the West, for example, is likely less pesticide-intensive than the humid East, while lawn traditions in the Midwest

Table 3: Profile of Lawn Chemical Users Based on Probabilistic Summary of Logistic Regression

	Use Chemicals	Use Do-It-Yourself Chemicals	Use Chemical Lawn-Care Company
Housing value	$150,000+	–	$150,000+
Income	–	$50,000–100,000	–
Age	–	60+	–
Metropolitan characteristic	Nonrural	Nonrural	Nonrural
US region	Midwest and South	Midwest and South	–
Gender	–	–	Female
Interest in neighborhood	–	Very interested	–
Perceived environmental impact of neighbor's lawn practices	Negative	–	–

Note: Survey conducted in 2001. $n = 587$.

are perhaps historically stronger than in the Northeast. The aggregation of the study to census regions, however, provides little direct purchase on regional explanation. The role of housing values is less ambiguous. Property values are clearly associated with high-input green-lawn maintenance and chemical use. Many lawn owners further explicitly reported protection of their property values to be an important motivation for high-input lawn care (Robbins and Sharp 2003). But simple instrumental logic is only a small part of the normative pressure that enforces the lawn locally. In many ways, the production of the lawn is a performance of normative class identity, which prevails even where it contradicts the ecological ethos of well-educated North Americans. Most revealing, however, were the social attitudes of chemical-using respondents, who were more likely than those who reported no chemical use to look upon their neighbors' lawn-care practices as environmentally harmful. "Do-it-yourselfers" were also significantly more likely to "take an interest" in the goings-on around the neighborhood.

Together, these demographic and attitudinal results suggest more subtle forces at work in the enforcement of the lawn aesthetic. Open-ended interviews with lawn-chemical users consistently revealed a conscious knowledge of their possibly harmful externalizing implications. Respondents commonly reported, moreover, that they felt obligated to maintain their lawns for the sake of neighborhood cohesion, and lawn-chemical users were more likely to know their neighbors by name. Moreover, lawn-chemical users typically associated moral character and social reliability with the condition of the lawn, suggesting that the lawn represents a *public* statement about proper *private* behavior in a neighborhood context (Robbins, Polderman, and Birkenholtz 2001). The performance of class values in urban middle-class neighborhoods is clearly as important as instrumental property values for explaining local pressures for high-input lawn ecologies.

The state is also implicated in lawn propagation at the local scale, through the enactment and enforcement of "weed laws." While such laws exist at the state and federal level and are designed with the stated objective of protecting local ecologies from harmful plants, especially invasives (Rappaport 1992), municipal restrictions are specifically aimed at maintaining lawn appearance for development value, with some references to public health. Minimally, most urban municipalities have formal rules restricting tall lawn growth or other "degradation" of front yards, including "six-inch" and "eight-inch" rules restricting nonmanicured growth in municipalities (Rappaport 1993). While these laws are not reported as the most important motivation for high-input lawn care, they are commonly explained as a barrier to lawn alternatives by people opposed to chemical inputs. Coupled with instrumental logics for lawn production, as well as normative class aesthetic performance, these statutes help to form the local political economy of green-lawn production.

But local enforcement is by no means the only force at work directing high-input ecologies, and the lawn is not a strictly “demand-driven” phenomenon. Indeed, where local restrictions on chemical use are created and enforced—as in Canadian municipalities—it is the chemical industry that responds in protest, rather than lawn-chemical users (Carmichael 2002). This is because localized demand is the obvious end of a much larger dynamic in which formulator and chemical producer firms have turned to the municipal market in an effort to sustain otherwise collapsing profit margins. This political economy of supply, though more deeply obscured, is the engine for local chemical use.

Declining Margins and Consumer Chemical Sales

The marketing of lawn-care products through direct sales is a largely recent phenomenon, representing a revolution in industry strategy. Over the last two decades, formulator firms—those companies that purchase raw chemical inputs to combine them for retail sale—have turned to new and aggressive techniques under the rubric of “pull” marketing. In the traditional “push” marketing typical of the postwar industry, formulators made bulk seasonal sales to small retail stores, which, in turn, marketed to consumers on an informal basis (Baker and Wruck 1991; Williams 1997). “Pull” marketing, on the other hand, involves the branding of chemical products and direct marketing through mass mailing, company representatives placed in stores, and door-to-door sales (Cimperman 2000; *Journal of Business Strategy* 1989; Robbins and Sharp 2003).

The difference in strategy is twofold. First, it means, for the first time, the devotion of significant budgetary resources towards market research and the investigation of household chemical habits, with the specific goal of changing them. Second, it requires massive increases in direct advertising costs—in television, radio, and print advertising directed to creating consumer demand. These media are supplemented by toll-free hotlines, in-store sales representatives, Web pages, and email lists (US Securities and Exchange Commission 2001).

This change in strategy is notably recent. Since it was first practiced in the late 1980s by the Scotts Company (the industry leader, with 52% of market share), it has been received by the trade as revolutionary, innovative, and crucial for industry survival. Nor is the switch without significant cost increases and difficult changes in firm structure and priorities. After purchasing a pesticide line, Scotts commonly spends twice as much as traditional firms to advertise the product. Formulators, moreover, spend millions of dollars on television advertising, where traditionally retailers shouldered such expenses (Jaffe

1998; Scotts Company 2003a, b). The burden of these costs was long shunned by the formulator industry, and this risky shift hints at driving forces that are redirecting business practice. These take several forms, but all reflect narrowing margins in the industry that have created an imperative to expand the number of chemical users and the intensity of chemical use per lawn.

First, the industry has come to be increasingly reliant on mass-discounting stores and home-improvement warehouses (Bambarger 1987; Cook 1990). This is primarily because small hardware stores and other traditional retailers shun the standing warehouse stock required for seasonal industries such as lawn care (Williams 1997). A handful of North American retailers now account for most formulator pesticide sales; as a result, mass sales and bulk wholesaling reduce formulator industry receipts (Scotts Company 2002).

Second, industry consolidation has created a pattern of aggressive and capital-intensive product acquisitions in recent years (Baker and Wruck 1991; *Chemical Week* 1998). These have, in turn, resulted in reduced credit ratings for many firms, stock-share price declines, and —most importantly—significant standing debts (Cimperman 2000). This debt is further aggravated by closed facilities, severance packages, and product recalls. In a prominent example, Scotts spent $94 million on interest payments in fiscal 2000 (a figure inflated by the high interest rates of that year), placing tremendous pressure on cash flow (US Securities and Exchange Commission 2001).

These kinds of increased expenses and reduced receipts have been coupled with the rising direct costs and opportunity costs associated with the difficult patenting systems associated with pesticides. The relatively short patent life for these products requires ongoing and increasing research and development costs in pesticide production, since many keystone product chemicals can be quickly lost to generic competitors (Scotts Company 2001).

Regulation increases other costs. Active ingredients in lucrative formulations are sometimes pulled from the market under re-regulation (US Securities and Exchange Commission 2001). So, too, environmental violations from waste disposal, asbestos, and other hazards at production facilities have become an increasing fact of life for formulator firms (English Nature 2002; Scotts Company 2002).

The environment itself poses further complications. The seasonality of expenses and receipts is an economic stress on formulators as well as applicator companies. Lawn products sell most vigorously in spring and summer, while highest expenses tend to come in fall and winter, well before annual earnings arrive. In the case of highly leveraged firms, even making minimal debt-service payments is extremely difficult during low seasons (Scotts Company 2002). Wet years slow fertilizer sales, dry ones decrease pesticide sales, and cold seasons retard sales overall (US Securities and Exchange Commission 2001).

Taken together, the picture that emerges of the formulator industry is one of tight and decreasing margins, constant consolidation, and debt. It is this business climate that drives the revolution in high-expense, high-risk direct marketing. So, too, it has created an impetus towards a more global market, to hedge against climate variability and consumer-spending changes. This marketing revolution has proven successful. Consumer spending on lawn chemicals has increased in many markets, and has remained steady overall despite declines in other areas of herbicide and insecticide sales (National Gardening Association 2000).

Beyond increasingly high-pressure sales in formulation and application, this shift in the economic environment is further reflected in changes at the production end of the lawn-chemical commodity chain. Here, agrochemical firms, which supply raw chemical materials to the formulator and applicator industries, also face increasing pressure to find, produce, and exploit household chemical markets.

Agrochemistry and the Search for Markets

In discussing the agrochemical industry, we specifically refer to those relatively few, large, diversified general chemical companies that manufacture the active ingredients in pesticides and fertilizers. Like their counterparts in the formulator industry, these firms and their respective markets have undergone dramatic recent changes.

Pesticide and fertilizer manufacturing is largely an outgrowth of military technology developed during World War II. The insecticidal properties of the pesticide DDT were discovered in 1939 and used by the US military to fight typhus and malaria on the front. Other chemicals were developed in the search for chemical warfare agents (Whitten 1966). In 1944, scientists working in Britain and the United States independently discovered the herbicidal properties of 2,4-D and MCPA, the first organic weed-killers (Aldus 1976; Anderson, Kanaroglou, and Miller 1996). These discoveries showed that pesticide production could be cost-effective, and pesticide and fertilizer production increased dramatically after the war.

Postwar conditions made pesticides very profitable. Agricultural land prices were rising, farming was profitable, farm labor was scarce, and growing middle-class affluence meant people were willing to pay more for food with no signs of pest damage or disease. In addition, the baby boom in North America and Western Europe encouraged increases in food production (Stephens 1982). Farmers in North America and Europe, encouraged by the invention of cheap and reliable tractor-drawn spray equipment, quickly adopted inexpensive, easy-to-use farm chemicals (Green, Hartley, and West 1987). The new petroleum industry was also creating a variety of organic chemical by-products, and petrochemical companies entered pesticide manufacture as a way to market their by-products. Use of farm chemicals also increased through active promotion by academic researchers and extension agents (Young, Westfall, and Colliver 1985), resulting in the steady growth of pesticide and fertilizer production through 1975 (Green, Hartley, and West 1987).

Following the energy crisis of the 1970s, the US farm crisis of the mid-1980s, and the concurrent economic recession, however, a contraction of farm chemical markets began. After 1985, there were fewer acres in crops, and economically strapped farmers became more discerning customers of farm chemicals. By the 1980s, pesticides had already been developed and marketed for all major pests and crops in North America and Europe. By 1985, over 90% of all US cropland was already treated with pesticides (US Department of Commerce 1985). Demand for farm chemicals began to drop as the market became saturated (British Medical Association 1992). Demand continued to remain low throughout the 1990s (Eveleth 1990; Zimdahl 1999). The fortunes of the pesticide industry largely rely on the health of the agricultural economy in the global North. In spring 2000, analysts predicted that continued depression in commodity prices would mean a continued reduction in the market for and drop in the price of agricultural chemicals (Reich 2000).

In addition to a contracting market, pesticide manufacturers currently face several challenges specific to pesticides. The costs of raw materials, solvents, and other chemicals needed for the reactions and purification processes have climbed in recent years. This pattern reflects the general rise in costs of materials associated with chemical manufacturing as a whole (British Medical Association 1992).

Perhaps the largest cost associated with pesticide production is the cost of research and development, which has risen dramatically over the last few decades. About 15,000 new compounds must be tested to yield one marketable pesticide, and it takes eight to ten years to bring a pesticide from the stage of initial synthesis to the commercial market. There are various estimates of the cost to develop a single new pesticide, ranging from \$20 million to \$50 million (Rao 2000; Zimdahl 1999). Research and development costs as a percentage of sales are much higher in the pesticide industry than in manufacturing as a whole (Reich 2000).

The rising costs of research and development come from several sources. Most pesticides are developed using the "empirical method," in which miscellaneous chemicals are reacted together, with the resulting compounds applied to plants and insects to determine their impact. This method requires propagating vast colonies of insect and weed pests. Companies must also invest considerable time and money testing a pesticide for effectiveness under a bewildering variety of situations. Even the most generic pesticide will work quite differently under the vagaries of disparate soil, climate, weather, and cultivation systems around the world. Applying for a patent for a new pesticide requires extensive toxicological and environmental safety trials. The extent and cost of these trials have risen to prohibitive levels as regulation and scrutiny of pesticides have increased over the last decade (Pepper, Gerba, and Brusseau 1996; Van Dijk, Brussaard et al 2000; Zilberman, Schmitz et al 1991).

All pesticides sold in the US must be registered with the EPA under the Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA] (US EPA 2003a), as well as with a local environmental or agricultural agency in the state in which they are sold (Anderson 1996). In addition, pesticides must pass Food and Drug Administration (FDA) tests for the amount of residue allowed on food through the Federal Food, Drug, and Cosmetic Act [FFDCA] (US Food and Drug Administration 2003). Meeting regulatory conditions for new pesticide approval became more difficult in 1996 with the passage of the Food Quality Protection Act [FQPA] (US EPA 2003b). Under the FQPA, all pesticides that had previously been declared safe were subject to review by the EPA (Hess 2000). Industry analysts say that the FQPA makes registration for new pesticides more difficult to obtain (Hanson 1998; Thayer 1999).

A new patent must be applied for before EPA and FDA tests begin. Because the research and application process takes so long, a new pesticide will not show profit until about ten years after patent application. Most patents in the North America and Europe last for about 20 years. Therefore, the manufacturer must absorb a decade of loss from pesticide development and then gain only ten years of profit before the patent expires. Pesticide makers must constantly have new pesticides in the development stage to take over the role of profit-maker when older pesticides lose their patents (Whitten 1966).

A new pesticide passing regulatory muster once, however, does not guarantee profits for the next ten years. Under the FQPA, any current pesticide can lose its EPA registration. For example, in 2000 the EPA banned the production of chlorpyrifos, a common pesticide for farm and household use—a decision raising an outcry from the chemical and agricultural industries, but applauded by environmental groups (Hess 2000). Since the passage of the FQPA in 1996, the potential profit of any new pesticide is tempered by the possibility that it could be outlawed at any time by the FQPA, despite an investment of ten years and up to $50 million in research and development.

The development of resistance to pesticides by insects and weeds poses a further ecological barrier for the industry. Industry analysts estimate that pests usually develop effective resistance to any new pesticide in less than ten years (Engel, Harnish, and Staetz 1990). This means that new compounds must constantly be researched and sent through the EPA registration process to replace those active ingredients that become useless, in addition to those that lose their patents or are banned by the FQPA.

The rising costs of research and restrictions of patent law have fueled the intense concentration of the pesticide manufacturing industry. In the mid-1980s, the patents on several major herbicides expired, driving a series of mergers and acquisitions by chemical companies (British Medical Association 1992). Pesticide makers must be quite large to afford the costs of research and development, and quite diversified to absorb a decade of negative cash flow during the years of regulatory testing (US Department of Commerce 1985). As a result, pesticide manufacturing is now dominated by a few large chemical companies with familiar names such as DowElanco, du Pont, and Ciba-Geigy.

In sum, the agrochemical industry of the early 21st century must deal with a saturated agricultural market, rising costs of materials, the expense and lengthy time requirements of research and development, extensive and retroactive regulatory requirements, patent expiration, the growing problem of pest resistance, and the intense competition of a highly concentrated industry. Profits from agricultural pesticides have been low for years as a result of these pressures, and agrochemical manufacturers are increasingly turning away from conventional agriculture and seeking new markets (Zimdahl 1999).

After the worldwide collapse of the agricultural economy in the 1980s, some chemical manufacturers sought new farm-chemical markets in the global South, particularly in rapidly developing countries such as Brazil and India (British Medical Association 1992). However, marketers have had difficulty breaking into the very diffuse world of unfamiliar crops, cultivation patterns, and knowledge systems of southern producers (British Medical Association 1992; Zimdahl 1999). So far, attempts to sell pesticides to the developing world have been largely unprofitable, despite hopes that population growth (which increases the demand for food) and rapid urbanization (which decreases the availability of farm labor and so creates chemical demand) will rise (US Department of Commerce 1985).

Biotechnological applications are another new opportunity for agricultural chemical makers—with their own drawbacks. Because biotechnology research is expensive, smaller firms are usually taken over by larger, better-capitalized firms, hastening the concentration of the industry. In addition, the expansion of genetic modification strategies has increased competition among nonenhanced products, as all other manufacturers clamor for the remaining portion of the market, increasing the ferocity with which non-biotechnological manufacturers must compete (Thayer 1999).

What *has* proven successful is the cultivation of the North American yard as a site for pesticide and fertilizer use. Agrochemical companies are increasingly finding that yard-chemical formulators are their most reliable customers. Formulator companies have increasingly developed agreements with chemical manufacturers to secure exclusive access to pesticide and fertilizer active ingredients (US Securities and Exchange Commission 2001). Contracting margins in the agrochemical industry mean that chemical manufacturers will continue to seek out relationships like these, which, in turn, strengthen the ability of formulators to develop new marketing plans and increase the ranks of chemical-using lawn managers. Changes in the broader economy of agricultural chemical manufacturing have paved the way for increases in the sales of lawn chemicals.

As a result, raw, *nonagricultural* pesticides represent a worldwide market currently worth $7 billion that is growing at 4% per annum—a rapid increase relative to contraction in the agricultural sector. Forty percent of these sales represent US household consumption. Proportions committed to lawn care are difficult to determine, but the turf-care market for raw chemicals is itself about one billion dollars, and is increasing annually (Agrow Reports 2000). Total chemical sales of turf-care products dedicated to lawn care also vary regionally, but in urban areas, this sector dominates as a sales outlet. State-level studies are illustrative. According to the Human Health Technical Work Group (HHTWG) of the New Jersey Comparative Risk Project, over 500,000 pounds of lawn-care chemicals are applied annually in New Jersey, as compared to 63,000 pounds for mosquito control and 200,000 pounds for golf courses (New Jersey Department of Environmental Protection 2002).

In sum, an increasingly constricted industry is the central engine for the expansion of chemical commodity markets and the invention of new arenas for the consumption of toxins. It is ultimately the *supply* of pesticides, herbicides, and fertilizers that directs the imperatives for chemical demand.

Nor is the lawn unique as a land-cover economy. Indeed, its features parallel those of capitalist agriculture more generally. Following other research in agrarian studies, the lawn mimics the problem of intensive agriculture in that it represents an attempt to sustain industrial growth under conditions of environmental variability and adaptation, an effort to overcome those variabilities through diversification, and a struggle to take advantage of environmental limits in order to advance sales.

Environmental variability and adaptation—including highly variable precipitation and temperature regimes and adaptive insects and diseases—has long been recognized as representing a serious barrier to accumulation in agriculture (Mann and Dickenson 1978). This is certainly true for turf and chemical firms, the profits of which rise and fall intra-annually and the expansion of which is checked by scarcities of water, sun days, and variable soil conditions. So, too, however, the strategies used by firms noted previously—including international diversification of lawns and the chemicals that support them, credit and sales efforts to overcome seasonal shortfalls, and marketing strategies to overcome patent rotations—all reflect more generally the opportunities agrarian capital may have for the advancement of its goals. The fact that seasonality plagues lawn production, for example, actually becomes a driver for new types of credit, marketing, and finance, just as Henderson (1999:29) adroitly observes for agriculture: "[N]ature shapes opportunities for the investment of money capital for precisely the reasons that industrial capital may shy away from the farm." In this way, investment in toxins today and biotechnologically advanced lawns tomorrow is an economic solution as much as a cause of an environmental problem.

Resistance and Counterinstitutionalization of the Lawn

But as the toxic tail continues to wag the turfgrass dog, there are signs of resistance from individuals and communities at local, regional, and national levels. Movements by individuals, organizations, and states have begun to collectively challenge the high-input lawn, and efforts at counterinstitutionalization are gaining momentum.

At the local level, this resistance is most commonly realized as direct and conscious violation of "weed laws," those municipal restrictions setting maximum lawn height and the proliferation of non-grass species. On many occasions, individual homeowners will plant tallgrass perennials or xerophytic species, or simply allow secondary succession to establish diverse local herbaceous, shrub, and tree species on the lawn (Crumbley and Albrecht 2000). This form of localized resistance has generally met with legal success. Municipalities commonly drop such cases (Long 1996). This is especially true where weed statutes are based in public-health policies and no credible risk can be demonstrated (Crumbley 2000a). So too, these US efforts commonly address and defend such counterinstitutionalization by stressing private property rights.

Successful criminal cases, however, do not necessarily pave the way for conflict-free institution of nonlawn environments. The predominant source of pressure is commonly not the municipality, but rather the neighborhood. In many cases, it is a neighboring household that alerts enforcement authorities to the violation of weed laws. Moreover, even where the city may rule in favor of a non-monocultural lawn, neighbors may seek civil proceedings and suits to force mowing and weeding. In the most dramatic cases, irate neighbors have themselves entered the property of lawn "dissidents" and mowed the grass and pulled up saplings and shrubs (Crumbley 2000b). Failure to adhere to local yard norms, therefore, often represents an explicit struggle for homeowners with alternative aesthetics.

Neither is all of this local resistance ad hoc. Formal organizations such as the Wild Ones and the National Wildlife Federation Backyard Wildlife Habitat Program have become increasingly prominent in Canada and the US, acting to reform municipal weed laws, encourage biodiverse home spaces, and provide and distribute information about low-input alternatives. In addition, these organizations are active in drafting model municipal ordinances and amending ordinances that encourage native plant communities in public (nonlawn) landscape design. This has further extended alternative designs in xeriscaping, where low-water-input plants and rock gardens come to displace turfgrass entirely, an increasingly popular option in the West.

At the municipal scale, more proactive efforts are apparent, especially in Canada, where more than 50 municipalities have banned pesticides. Most such bans begin with public lands, including schools and other public buildings, later expanding to include private lawns. Manufacturer responses to these bans are only beginning to be mobilized, but chemical-industry representatives have increasingly been in attendance at municipal/city council meetings, vocally contesting chemical bans where they are debated, organizing a "grassroots" industrial response to public action (Carmichael 2002).

Some evidence of municipal-level action has also begun to appear in the United States. In a prominent example, the lawn-dominated suburbs of Long Island in Suffolk County, New York are beginning to shift towards experimental alternatives. Working through alliances between county water-quality agencies and local grassroots organizations, organic lawn practices are finding their way into some of the most affluent communities in the country. The Suffolk County Water Authority has joined forces with the Long Island Organic Horticultural Association, the Long Island Neighborhood Network, and the Long Island Groundwater Research Institute at the State University at Stony Brook. Together they have instituted a half-million-dollar, three-year program to compare chemical lawn care with organic alternatives. Unlike the route of municipal legislation favored in Canada, these US community efforts operate on a more volunteer basis, though in coordination with state agents (Paquette 2003:1531).

At the federal/national scale, lawn-chemical controls have been slower to emerge. In the United States, the EPA has testified on numerous occasions concerning the underregulation of household and lawn pesticides and herbicides, especially relative to controls enforced in the agricultural sector (Guerrero 1990). In the last few years, however, the EPA has been more active, issuing cancellation orders for a range of pesticide registrations, most recently including those products with the active ingredient chlorpyrifos (*Pesticide & Toxic Chemical News* 2000), the sixth most commonly used pesticide on home lawns (Table 2).

This recent effort has been resisted most visibly by pesticide manufacturers (Hess 2000).

Canada has also acted to reform pesticide laws, including those for home lawn application, with more stringent registration mandates and some chemical bans and phase-outs in currently pending legislation (Bailey 2002). Past efforts to ban specific agricultural pesticides in Canada, however, have resulted in lawsuits under the "national treatment standards" of the North American Free Trade Agreement's chapter 11, raising legal questions about the prospects for sustained legal resistance (*Crompton Corp v Government of Canada* 2001). Even so, these joint national, regional, and local efforts represent a sea change in the relationship of consumers and regulators to the agrochemical economy.

The differential power and potentiality of counterinstitutionalization between the United States and Canada is notable. Where, institutionally and ideologically, the Canadian state is more corporatist than that of the United States, culture and law in the US tends to privilege private property rights more directly. It is unsurprising, then, to see greater regulatory activity in Canada. This need not mean the absence of environmental action in the United States, where grassroots efforts can potentially appeal to private property rights as an ideological lever against weed laws and other ordinances. While the lawn is resisted across North America, therefore, the difference in the way counterinstitutionalization occurs in the US and Canada reveals a kind of regional geography of dissent.

Alternatives to Capital in Your Own Back Yard

In sum, the propagation of the high-input lawnscape is structurally enforced by economic forces at many scales, with a synergy of production logics that facilitate the expansion of an expensive, high-maintenance, ecologically unstable environment (Figure 1). As such, the lawn is a political ecology not unlike that of other industrial agrarian systems, both in the challenges it faces and in the opportunities it exploits. This suggests the general applicability of political-ecological approaches for explaining landscapes outside the traditional rural development context: in the global North, in consumer environments, and in cities and suburbs (McCarthy 2002; Robbins 2002).

An equally fundamental lesson of the lawn is the degree to which such self-evident and relatively noncontroversial landscapes are the ones *most* configured by socioeconomic force relations, their very uncontroversial nature belying the convergence of the power-laden elements that naturalize the ecologies of daily life. The happy optimism of individualist green volunteerism, therefore, where "50 simple things" can save the planet (Lamb 1991), seems a somewhat inadequate solution in the face of pressures that direct the status quo.

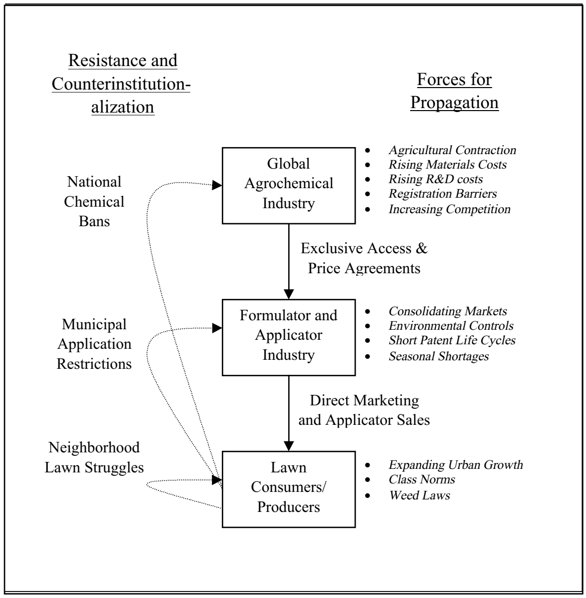

Figure 1: The Political Economy of Lawn Chemical Struggle

Where individuals remove themselves from the chemical treadmill, for example, they commonly fall afoul of not only social scrutiny and carefully enforced aesthetic norms, but also legal and neighborhood restrictions and property configurations enforced by state authority.

Technological solutions appear equally compromised. Consider the possibilities, for example, of genetically engineered turfgrasses, which require reduced human labor (less mowing) and longer seasons, growing over difficult, dry, or cold periods. Envisioned under the same crushing imperatives of production, however, these lawns must either be bred to demand increasing chemical inputs, like their high-yielding counterparts in modern green revolutionary agriculture, or else be designed to require periodic reproduction, activation, or propagation, like the "terminator" variety of new crop seeds. While prominent lawn-care companies vociferously suggest a role for genetically modified lawns in the future (Barboza 2000), therefore, to date none of them has suggested lawns that reproduce in perpetuity or that demand fewer purchased chemical inputs. Any truly sustainable alternative is, put simply, bad for business.

Even so, community and grassroots action has begun to challenge the hegemony of the lawn in its current form, setting the stage for alternative urban landscapes in the future. Struggles with capitalism do indeed seem to begin in the back yard, and the skepticism of some green materialism notwithstanding (Foster 2000), environmental consciousness may yet provide a promising stepping-stone towards radical action. This is perhaps because, in their realization across multiple scales, environmental struggles offer alternative accounts of *what is connected to what* and *by whom* (Latour 1998). In struggles over apparently apolitical lawngrass, the immediate ecological struggle in the neighborhood is explicitly linked to the larger pressures of the chemical economy, the complicity of classed aesthetics, and the role of law in producing landscapes. In this way, the epistemological eclecticism (and agnosticism) of anti-lawn activism dissolves the discursive modern boundaries required for the perpetuation of capitalist modernity: those erected between public and private space (home/neighborhood/self/community) and human and nonhuman actors (agrochemical companies/grasses/consumers/weeds).

These increasingly well-organized antichemical, anti-monocultural lawn movements, organized at a range of scales, may still seem like a sideshow in worldwide contests around the fate of the environment, especially when omnipresent and serious threats to livelihoods of the world's poor are considered, in the form of forest loss, soil erosion, and water-supply crises. The reverse, however, must be argued. In pursuing polycultural, low-input lawns, otherwise abstract political economic struggles are experienced in all their immediacy within neighborhoods and on a daily basis. The counterinstitutionalization of the lawnscape is, for many consumers, a far more honest and direct intervention into labor/nature relations than "wilderness" preservation and other environmentalisms that, in many cases, represent neocolonialism in a green guise (Neumann 1998).

So, too, in challenging the lawn, householders in the United States and Canada cannot avoid examining and inverting the cultural norms of "neighborliness" and "appropriate aesthetics," transforming them from hegemonic tools that reproduce accumulation and environmental degradation into springboards for socially and ecologically rich and engaging alternatives. This represents a contest with real emancipatory possibilities in that it does not reject and dismiss consumer culture (as bourgeois, vulgar and misled) with the high-handed elitism typical of some traditional forms of cultural critique, but instead embraces it as potentially responsible and humane. By engaging specific and daily products and commodities (such as lawns and their alternatives) as articulations of place (following Molotch 2002), moreover, a critical geography of consumption emerges that might hold as its object things that we are already "involved in (re)constructing everyday" (Gibson-Graham 1996:251), a place-making exercise that takes seriously what people want—communities, neighborhoods, and green stuff—rather than simply scolding consumer taste.

In the institutionalization of alternatives, therefore, using legal, normative, and aesthetic revisions of current practice, future urban landscapes can be imagined that are truly green and sustainable. Struggle over the lawn, *in its very ordinariness*, underlines the deeply structured reality of daily life but also, therefore, the most promising areas of resistance—collective action, systems thinking, and progressive law, which harness the reasonable desire for livable and green places.

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