Mexico's "Green Revolution," 1940-1980: Towards an Environmental History

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In agriculture, Mexico was the birthplace of the modern "Green Revolution." From 1940 to 1965, agricultural output in Mexico increased fourfold. During this period, Mexico went from importing food to more than meeting its domestic food requirements. Its stunning agricultural accomplishments were widely heralded. Mexican agriculture was used as a model by the Rockefeller Foundation, the U.S. Agency for International Development (AID), the World Bank, and other agencies, to promote Green Revolution technology packages around the world.

By the end of the 1970s, however, something was amiss with Mexico's "miracle in agriculture." After a decade of sluggish growth in agricultural productivity, coupled with rapid population growth, Mexico began importing large quantities of basic food grains. Barkin proclaimed "the end of food self-sufficiency" in Mexico; others termed it "Mexico's agricultural dilemma"; and Mexico's "food crisis."
Economic and social policy dimensions of Mexico’s agricultural crisis have been widely discussed in English-language literature. There also are hints of an environmental dimension of this crisis: anecdotal accounts tell of severe water salinization, desertification, deforestation, and pesticide abuse. Such accounts point to the need for a systematic environmental history of agricultural development in Mexico. This paper takes first, modest steps towards the development of such a history, by outlining a framework for analysis, assembling empirical data from the English-language literature, and formulating provisional conclusions.

Agricultural Development

Mexico has a long, rich history of agricultural development. This paper focuses on environmental dynamics of the period from about 1940 to 1980 known as the “Green Revolution.” Before reviewing the environmental impacts of the Green Revolution, it is useful to understand its historical context, including factors contributing to its decline in the 1970s and 1980s. This part of the paper describes a very few important, long-term dynamics of Mexican agricultural development; discusses features and social impacts of the Green Revolution; and examines the rise of the “new international division of labor” in North American agriculture, which continues to exert momentous influence on Mexico through the North American Free Trade Agreement (NAFTA).

Over the last 500 years, agricultural development in what today is Mexico has been affected heavily by the region’s steppe with the world system. There have been several cycles of agrarian development, social conflict, and ecological destruction. Two important general trends may be discerned in the long-term environmental history of Mexico. Its economy, agriculture, and environment have undergone a process of “internationalization” over several hundred years. This includes periods of Spanish colonialism; U.S. invasion, occupation, and seizure of land; French colonialism; and massive investment by U.S. interests during the presidency of Porfirio Díaz, 1877-1910.7

A second trend has been the destruction of the “natural,” local economies of indigenous peoples, including the famous irrigated agriculture in the Valley of Mexico, communal rain-fed subsistence farming in the north and northeast of Mexico, and slash and burn agriculture in the Mexican tropics. This destruction began soon after the arrival of the Spanish, but continued with vigor into the twentieth century.8

During the Porfirián era, large agricultural landholdings were consolidated, many people were driven off the land, others left their land and haciendas for jobs in the cities’ booming export economy, and thousands of miles of railroads were built to move agricultural products from U.S. and Mexican-owned land in northern Mexico to the U.S. By 1910, “90% of the rural population of Mexico was landless, and only 15 percent of the indigenous communities retained possession of their traditional communal lands.”9

Guaranteed by the 1917 Mexican Constitution, some land reform took place between 1917 and 1934. However, more took place during the populist presidency of General Lázaro Cárdenas.10 When Cárdenas ended his term of office in 1940, he left more than 11,000 ejidos, endowed with more than 20,000,000 hectares of land.1 One effect of reform was to increase the amount of land in cultivation. The amount of rain-fed, arable land in Mexico increased by almost 2.5 million acres between 1930 and 1940.12 This helped boost Mexico’s agricultural production in the coming decades.

By the end of the Cárdenas presidency, agricultural policy began to change from supporting both commercial and collective farming to favoring agribusiness only.13 This was accomplished through “a massive program of capital-intensive agricultural development. The primary emphasis of this program was on extending the agricultural frontier through irrigation projects and the diffusion of biochemical (land-saving) technologies.”14

During the 1940s, Mexico had an opportunity to “seize the chance to initiate national development during a contraction in the world market.” Mexican development in this period was characterized by an import substitution industrialization (ISI) strategy,15 led by a “triple alliance” of the Mexican state, domestic, and foreign capital.16 Mexican agricultural policy continued its shift from the dual agrarian orientation of the Cárdenas years to one favoring large-scale commercial landholders. Mexican industrial capitalists allied with large landholders against the peasantries and rural smallholders.17

In control of the Mexican state, industrialists were able to finance industrialization through the transfer of resources from the agrarian sector to industry. They did this by manipulating foreign exchange rates, terms of trade, and domestic agricultural prices. Centralized management of export transactions was used to provide subsidized access to foreign exchange, for the purchase of the capital goods necessary to build Mexico’s industrial base.18 During the
The "Green Revolution" in Mexican agriculture began in the early 1940s, initiated, financed, and supervised by the Rockefeller Foundation. It promulgated fertilizer-responsive, hybrid seed varieties, developed in laboratories in the U.S. and Mexico, and integrated with farm management practices based on biocides and modern farm machinery. These technology "packages" were designed for use on large-scale, irrigated, landholdings.

Initially under the Green Revolution, Mexican agricultural development was extensive, bringing new lands into cultivation through land reform, the expansion of rain-fed agriculture, and extensive irrigation. Between 1947 and 1964, through the River Basin Development Program, the Mexican government spent 3.3 billion pesos building dams, electrical-generation facilities, roads and other rural infrastructure. Four river basins were developed during this period, in part to provide water for irrigation. The amount of irrigated land in Mexico increased almost 50% in Mexico, from more than 28 million acres in 1930 to more than 41 million acres in 1960. The government allocated about half of the new water resources to the more concentrated commercial agricultural sector, the other half, at least formally, to the ejidal sector. The amount not only of irrigated but also of rain-fed arable land also increased between 1940 and 1950. This is attributed to the Mexican government setting high price controls on basic foods, giving both commercial and peasant farmers an incentive to increase production.

In the late 1950s, the 1960s, and the 1970s, agricultural development was more intensive. In this period, Mexican agriculture produced more than ever before. (See Figure 1.)

With significant annual variation, the increase in agricultural production was dramatic. Corn production increased from 1.6 million tons in 1940 to 14.1 million tons in 1985. The production of beans increased from nearly 97,000 tons in 1940 to a peak of nearly 1.5 million tons in 1981. Wheat became one of the largest crops, with production growing from 464,000 tons in 1940 to over 5.2 million tons in 1985. Sorghum production increased from 200,000 tons in 1950 to 2.7 million tons in 1970. Through most of the 1970s, Mexico produced sufficient food for its own people, even while exporting agricultural products.

How was this accomplished? Not only through the great expansion of rural infrastructure described above, but also through the rapid industrialization of agriculture. Tractor usage in Mexico increased six-fold—from 17,000 in 1947 to 125,000 in 1981. "Mexico became one of the countries with the highest concentration of agricultural mechanization in Latin America." Even more explosive was the growth in consumption of petrochemical-derived fertilizers in Mexico, from 2.8 thousand metric tons in 1940 to 1,067 thousand metric tons in 1978/79—an increase of over 350 times. (See Figure 2.)
The means of the Green Revolution's accomplishments were very important from both social and environmental standpoints.

![Figure 2. Relative increase of Selected Mexican Agricultural Inputs](image)

The benefits of this spectacular development did not accrue equally to all segments of the population. The agricultural development strategies embodied in and carried out through the Green Revolution and River Basin Development projects increased social inequality in Mexico. The beneficiaries of Mexican agricultural development were the urban industrial capitalists, who benefitted from unequal terms of trade between agriculture and industry, and large, commercial, agricultural landholders, who benefitted to the detriment of private and ejidal smallholders and agricultural laborers. Control and ownership of land in Mexico were concentrated as a result of the Green Revolution. Hewitt de Alcántara argues that "land was the ultimate resource transferred from smaller to larger farmers during the course of the technification of the Mexican countryside." Large landholders, those with easy access to loans and materials, were better able to take advantage of these new agricultural inputs. In addition to unequal access to loans and materials, and the absence of economies of scale, many of the ejidal grants of the 1930s had been on remote and marginal land; ejidarios were unable to effectively utilize the new technologies.

Paid less than living wages, rural workers in the capitalist agricultural sector were forced to supplement their income. They did this through engaging in subsistence farming, by having their children work for wages in the fields and by having unmarried family members go to other regions of Mexico and to the U.S. and send money home. Having larger families was part of this survival strategy—more family members meant more people to contribute to the food basket. Families in Mexico's ejidal sector also had to do such things to survive, as they were increasingly subsumed into a cash economy.

This agrarian structure—part capitalist, part smallholding—is what de Janvry has termed functional dualism. Functional dualism has meant sustained profits for agricultural and industrial capitalists and increased poverty and social dislocation for smallholders and agricultural workers. "As late as 1960, 83 percent of all the farmers of the country could maintain their families only at a subsistence or infra-subistence level." Functional dualism had other consequences for Mexico's rural environment.

The New International Division of Labor

In the 1960s and 1970s, Mexico's ISI strategy faltered due to the high cost of imported capital goods necessary for industrialization, a slowdown in the rate of increase of productivity in domestic production, and an increase in both domestic and foreign demand. Mexico's industrialization strategy became export-led. Mexican agriculture became more integrated with the North-American agro-food complex, resulting in a trend known as a "new international division of labor" in agriculture.

This new international division of labor (NDL) involved aspects of production, consumption, distribution, and supply. Production for export of luxury fruits and vegetables greatly increased. The livestock and livestock-feed sectors of Mexican agriculture also expanded. However, production of basic food grains failed to keep up with demand, forcing Mexico to import corn, beans, and wheat from the U.S. Large-scale, commercial agriculture in Mexico benefitted from NDL. However, these changes also resulted in a further increase in poverty and inequality in both the countryside and the cities.
in the abandonment of millions of hectares\(^4\) of rain-fed agricultural lands.\(^4\)

During the late 1960s and the 1970s, transnational agroindustry increasingly dominated Mexican agriculture. The investment of U.S.-based corporations in the Mexican food processing industry increased "steadily," from $107 million in 1966 to $229 million in 1978.\(^2\) Cockcroft notes that:

Between 1965 and 1975, about 10 percent of U.S. manufacturing investment in Mexico went into the food industry, while profits doubled.... Some twenty-five TNCs, eighteen of which were U.S.-owned, monopolized the largely intermediate-and upper-class internal market and, for occasional foods like strawberries, frozen vegetables, and certain fresh vegetables, the external market as well.\(^4\)

Not coincidentally, during this same period a major shift occurred in the importance of different Mexican crops. With an expanding U.S. market and advances in refrigeration and transportation systems, the production of luxury fruits and vegetables in northern Mexico became highly profitable. Transnational corporations produced for export commodities such as strawberries, asparagus, and broccoli.

Transnational agroindustry also reshaped Mexican agricultural production through helping change the food tastes and consumption patterns of millions of Mexicans, especially the rapidly expanding middle class of the 1960s and 1970s. Mexicans consumed more flour tortillas, baked goods, and other wheat products than ever before. Wheat became more widely cultivated. Mexicans also consumed more meat, resulting not only in the raising of more livestock, but also in increased production of animal feed-grains such as sorghum, soybeans, and oil seeds.

Many of the new crops were Green Revolution crops, scientifically designed for responsiveness to chemical inputs, ease of mechanical harvesting and industrial processing. In production both of luxury foods for exports and new grains for domestic consumption, transnational corporations tightly controlled agricultural practices through strict contractual agreements with growers.\(^4\)

At the same time, less and less land went into growing of corn and beans, as government "cheap food" policy kept prices for these crops low, making them less profitable for agriculturalists than feed-grains, whose prices were unregulated.\(^5\)

The "Livestocking" of Mexican Agriculture

The livestock industry grew rapidly in Mexico during the 1950s, 1960s and 1970s. This was facilitated by a variety of factors, including privileges cattle-raisers obtained from the Mexican state, price-control disincentives for basic food crops, the profitability of cattle-raising and pork and chicken production, and changing consumer tastes in Mexico and the U.S.

Cattle-raisers have had strong ties to the Mexican government.\(^3\) Cattle-raising was largely exempted from land reform. "Since 1937 a presidential decree...protected between six and nine million hectares of cattle land from the land-reform programme."\(^2\)

Cattle-raising in Mexico is highly profitable. Ranchers have been able to turn great profits within a few short years, in part by "mining" agricultural land and tropical moist forests of their nutritious value. Similarly, agro-industry has found pork and chicken production increasingly profitable.\(^3\)

Meat consumption in Mexico increased considerably during the 1960s and 1970s with the growth of Mexico's middle classes and the changing of food tastes. Most of the meat produced in Mexico is consumed domestically. The consumption of red meat in Mexico grew from an estimated 12 kg per person in 1960 to 17.6 kg in 1978. White meat grew from 6.6 kg per person to 11.5 kg per person during the same time period.\(^4\)

The export of livestock also grew rapidly during this period. Calves were bred and raised in Mexico and shipped across the border to the U.S. for "finishing." Boxed meat was also shipped to the U.S., especially to fast-food and institutional buyers.\(^3\) "Since the initial exports [in 1964], the number of head of cattle exported live for fattening with cheap grain in American feedlots rose rapidly so that by 1978 it had reached 850,000 head of young cattle in addition to more than 65 million dollars in processed meat."\(^5\)

The amount of land directly and indirectly devoted to livestock in Mexico increased dramatically from 1940 to 1980.\(^3\) This occurred through the "take-over" of prime agricultural land in the north as well as tropical moist forests in the south. Barkin suggests that, together, these various dynamics have resulted in the "ganaderización"\(^3\) of Mexican agriculture.\(^5\)

The production of basic food crops by peasants through rain-fed agriculture on ejidal and private plots was neglected by government policy makers in the 1970s. Not only were government agricultural loans less available to smallholders, but price supports for basic food
grains were kept low in favor of urban workers to the detriment of rural producers, especially smallholders. The rain-fed, peasant agricultural sector, which had been one of the sources of expansion of agricultural production in the 1940s, 1950s, and 1960s, and a significant contributor to Mexico's food self-sufficiency, faced crisis.

With a rapidly increasing population, a decrease per capita in the amount of food produced and a surplus of petro-dollars from the oil boom of the late 1970s, Mexico imported large quantities of basic foods for domestic consumption in the 1970s and 1980s. Although amounts varied annually, import levels of corn, beans, wheat, and rice were unprecedented in the 1970s and 1980s. Peak imports included 4.6 million tons of corn in 1983, 490,000 tons of beans in 1981, 170,000 tons of rice in 1984, and 12 million tons of wheat in 1979.41

In the early 1980s, in the final years of the López Portillo presidency, Mexico attempted to re-establish food self-sufficiency through the Mexican Food System (SAM) project.42 This program also was financed with earnings from Mexico's domestic oil profits and cheap petro-dollar loans. Also to boost agricultural production, in 1981 the Mexican government legalized the sale of ejidal lands for the first time since land reform in the 1930s. With the shock of the second oil crash of 1983 and facing a $90 billion foreign debt, the Mexican government soon ended the SAM project, and declared an end to land reform.

Under the leadership of President Salinas de Gortari, Mexico has been moving quickly to become even more integrated with the world economy. At the time of this writing, the Mexican government has completed a preliminary North American Free Trade Agreement. It has also been pursuing similar accords with other Latin American countries, and has been attempting to attract Japanese investment.43

Environmental Impacts

Not only the rural poor suffered as a result of modern agricultural development in Mexico, so too did the rural environment. The processes of environmental degradation as a result of Mexico's Green Revolution were both direct and indirect. They ranged from overuse of chemical fertilizers and pesticides, to overuse of subsistence plots, and rural outmigration.44 This part of the paper assembles evidence from the English-language literature, and analyzes it with regard to three different agro-ecosystem types—irrigated, rain-fed, and tropical-humid—each with distinct social and ecological dynamics. Also included in this part of the paper is a review of indirect social and environmental effects of agricultural development in Mexico.

Development in Mexico's capitalist agricultural sector has affected the environment in ways similar to that of modern agriculture elsewhere, such as in the western U.S. Generalized technological, chemical, and mechanical inputs have been imposed on variegated micro-ecologies for short-term gain, in disregard of long-term social and environmental impacts. The rural environment has been greatly altered by a new rural infrastructure, overuse and contamination of water supplies, new agricultural technologies, and misuse of agricultural chemicals.

Great new dams, irrigation works, roads, and electrical power-generating facilities were constructed throughout Mexico. The greatly increased agricultural production was only possible "within the framework of a federal investment programme which poured billions of pesos into irrigation works, roads, storage facilities, electricity, and railroads...the 'green revolution'...was thus bought with public funds at a very high price."45 Tens of thousands of people were displaced, including many indigenous peoples using centuries-old, traditional, sustainable agricultural techniques. Forests also were destroyed.46

Where irrigation has depended upon groundwater supplies, water availability has also become a significant issue. "In Hermosillo, the large private farming sector...[drew] up such quantities of water from underground sources...that the region is now threatened with the total exhaustion of its water supply...this is what some observers would call a 'mining' mentality."47 In the U.S.-Mexico border area, agriculture competes with both industrial and residential demands on water. A combination of chemical contamination and groundwater depletion has seriously threatened all water availability in some locations. The El Paso/Ciudad Juárez area "is projected to run out of groundwater by the year 2000."

Over time, intensive irrigation with improper drainage of formerly arid or semi-arid soils leaches out salts and heavy metals, leading to problems of water salinization and contamination.48 In the U.S.-Mexico border region, for example, "if agriculture is to continue as an economically viable industry...then, short of interbasin water transfers of previously unimagined scales, the sociology and technology of agriculture must undergo substantial change."49

Irrigation systems can be important vectors of public health problems: "No effective measures have been taken in the face of the recognition of the mortal danger of waste from hog raising to the
whole population because of cistéricos invading fruits and vegetables through irrigation systems." In the Mexicali area, water quality is affected by agricultural waste compounded with pollution from industrial and human sources. "The New River drains a major agricultural valley in Mexico and already contains high concentrations of salts and pesticides before reaching the Mexican border town of Mexicali. At Mexicali, industrial chemicals, slaughterhouse wastes, and municipal sewage are dumped into the river ... the highly polluted river poses a severe health hazard..."  

Once established, irrigated agricultural systems used increasingly “modern” agricultural inputs: hybrid seed varieties, fertilizers, pesticides, herbicides, and farm machinery. The intense use of these new technologies led to severe social and environmental problems, while traditional, more socially and environmentally sustainable, agricultural technologies were ignored, at least until recently.  

While Mexican agriculture has become increasingly mechanized, soil conditions are not always appropriate for use of tractors. Mechanical plowing and intensive irrigation has led to topsoil loss in areas with fragile soils. In turn, this has required greater use of chemical fertilizers.  

Wright exhaustively documents the problem of pesticide abuse in Mexican agriculture. The mono-cropping promoted by Green Revolution technology is particularly vulnerable to insect infestations. With repeated application of pesticides, pests develop resistance, leading to the use of increased amounts, concentrations, and toxicities of pesticides.  

One significant aspect of chemical agriculture in Mexico which Wright and others document is the significance of Mexican parastatal industrial corporations, particularly Fertinex, in promulgating chemical fertilizer and pesticide use. Fertinex is the largest producer of chemical fertilizers in Mexico.  

Through subsidies, the Mexican government maintains “a major commitment of the Mexican state to pesticide dependent agriculture and to the growers, domestic firms, and transnational corporations that profit from pesticide use.” To government officials, “reduction of pesticide application dangers and costs is not as important as maximizing revenues.” The Mexican government has only recently shown interest in promoting sustainable agro-ecological systems at agricultural universities such as Chapingo.  

Not only the Mexican government, but also transnational agribusiness is involved in promoting use of agricultural chemicals.

Transnational corporations increasingly control both what is produced and how it is produced. Contracts often specify what brands of seeds and chemicals are to be used and with what strength and frequency chemicals are to be applied.

Pesticide use in the export sector of Mexican agriculture is strongly linked with international dynamics, in particular to the consumer tastes, scientific perspectives, and government regulation of the U.S. When the U.S. banned imports of fruits and vegetables sprayed with DDT, agriculturalists in Mexico began using other pesticides which have shorter half-lives (and thus allow the produce to pass border inspections), but are more acutely toxic for agricultural workers and their families who come into immediate contact with them.  

Wright documents numerous deaths in Mexico attributed to the new pesticides, most notably of young, pregnant Indian women.  

Not all of Mexico’s rain-fed agricultural lands are best suited for agricultural purposes. Many marginal lands were brought under cultivation through land reform. This process was frequently implemented by opening up “unused” lands, including those deforested to accommodate agriculture, rather than redistributing existing agricultural lands. In semi-arid, temperate, and tropical zones, rain-fed agricultural land has been hit hard by problems of overuse and abandonment, desertification, and deforestation.  

The fertility and ecology of smallholdings in Mexico’s rain-fed agricultural sector are further squeezed through overuse. Peasants intensified production on their smallholdings due to their increasing integration into the cash economy, growing numbers, and increasing poverty. Crops were grown for sale and subsistence. Landholdings were subdivided as families grew, further intensifying land use. This led to new problems:

Traditional farming technologies such as crop rotation and fallow periods gave way to intensive and repetitive use of the land for single crops, a process that leached and depleted the soil, adding up to increasingly poor harvests and low quality crops. This in turn necessitated greater inputs of fertilizers and improved seeds, the purchase of which led to even greater indebtedness...  

Chemicals may be applied in inappropriate conditions or quantities, even lowering crop yields. Government and industry advisors recommend intense applications of fertilizer even where not environmentally prudent. Non-chemical and traditional methods of
maintaining or restoring soil fertility (intercropping, crop rotation, letting the land lie fallow) may not be used and may be forgotten.35

Some or all family members may be forced to migrate as smallholdings fail to sustain families.36 The environment suffers from neglect as this rural out-migration occurs.37 By 1960, 15 million hectares of ejido land had been abandoned.38 While it is true that some marginal lands should never have been cultivated in the first place, abandonment of any land after cultivation has resulted in severe erosion of remaining topsoils (see below). "Traditional" land managers are no longer there to take care of the land, to sustain and protect its fertility.

The Garcia-Barrioses observed endemic soil erosion and desertification in their study in the San Andrés Lagunillas, Oaxaca, area: "most unfertile or distant lands have not been productively occupied, not even by goat herders, and are now completely eroded."39 The effects of this soil erosion spilled over, seriously affecting fertile land in the valleys below.40

Forty-six percent of the most humid lands with the longest growth periods of the valleys are now silted with sands of scarce fertility coming from intense erosion in hillsides. This has meant a great reduction in land productivity. In 1985, plots in not silted humid environments yielded in average 873 kg/ha... while silted humid lands yielded around 480 kg/ha. Also, a large proportion of flooded lands are suffering from salinization.41

Redcliff links desertification in the highlands with deforestation: "desertification" is becoming a reality as forests are destroyed in Durango and Chihuahua, soils are eroded and even greater pressure put on the carrying capacity of semi-arid regions... In Mexico as a whole, it has been calculated that 225,000 hectares of land are lost each year as desertification spreads.42

In Mexico "15 percent of the agricultural land has been totally lost to erosion, 26 percent is highly advanced in this process of destruction, and another 24 percent is in the initial stages of deterioration."43 "Three million square kilometers" of dry-lands in Mexico are "under severe threat of desertification."44

Not only tropical moist forests, but also other forests in Mexico have been hit hard by deforestation. Forests play an important role maintaining water supply and quality, controlling runoff, and preserving soils.45 Mexico lost 530,000 acres of forest in 1980 alone.46

First "colonization" and then cattle-raising have contributed to the widespread deforestation of Mexico's humid tropics. As Mexico's rural population increased, there were continuing demands for "opening up" new lands. The last great areas for land reform in Mexico were the tropical moist forests. Tropical-humid areas did not prove to be productive to settled agriculture. As a result, despite considerable expenditures, land reform was not successful there.47

Land reform in tropical-humid areas was an effective forerunner for the cattle-industry. With the growth of livestock raising, Mexico's tropical moist forests have become a resource to exploit for short-term gain. Livestock have taken a heavy toll on the forest.48

"The number of head of cattle and acreage for grazing in Chiapas...doubled between 1967 and 1976, leading to eighty-six major peasant protests by communal Indians deprived of their lands."49 "In Chiapas the forests are literally being 'mined'... The tropical 'Lacandona' forest, once one of the richest ecosystems in the New World, will not exist by the year 2010, if present trends continue."50 Four-fifths of the Mexican forest has been destroyed in the last twenty years "for the meat religion," according to Esieva.51

Agricultural development in Mexico has had important indirect social and environmental effects as well as direct impacts. These include catastrophic environmental conditions in Mexico's rapidly growing cities and changes in social relations.

Mexico's environment has also been destroyed by rapid, unmanaged urbanization, the flip side of rural out-migration. People were intentionally driven out of the countryside and into the cities as part of Mexico's agricultural modernization strategy.52 Initially, this was functional for Mexican industrialization, providing an ample supply of labor and a growing cash-based domestic market. However, Mexico's industry has not grown fast enough to absorb a rapidly growing population.

In rapidly growing urban areas, residences and industry have taken over prime agricultural land. In the Valley of Mexico, for example, "Government seizure of ejidal land for urban construction...over the last two decades has claimed 8,926 hectares...in the Federal District and 16,500 hectares...in the State of Mexico."53

Rapid urban growth has also critically affected people and the environment through pollution. Mexico City and cities on the U.S.-Mexico border have grown so quickly that tens of millions of people live in areas without sewage systems. A confidential study conducted by a United Nations task force in the late 1980s calculated
that "600 tons of solid human waste are dumped into [Mexico City's] air daily... the number of colonies of micro-organisms per cubic meter [are] uncountable." The source of this waste material is "the deposited wastes of about six million people and two million dogs" on the outskirts of Mexico City. The waste comes into Mexico City in the form of dust which is blown into the city, especially in the months of February, March, and April, at a rate of 20 tons per square kilometer per month.

Nezahualcóyotl, an incorporated suburb of three million people on the outskirts of Mexico City, sometimes called the third or fourth largest 'city' in Mexico, has never had "drainage, nor sewers, nor running water, nor electricity... Ninety percent of the population suffered from chronic hunger, malnutrition, and parasitic infections." Of 220 existing sewage treatment plants, half are inoperative and another quarter operate at suboptimal levels for lack of maintenance. Mexico has grown "1300% in the last thirty-five years," from 40,000 in 1950 to 780,000 in 1984. Tijuana, with a population of over one million, "has nearly tripled" in population since 1970, after having "doubled or tripled every decade between 1930 and 1970." Other Mexican border cities with sewage treatment problems include Nuevo Laredo and Naco, Sonora.

The disposal of solid, chemical, and toxic wastes is a problem throughout Mexico. "At least twenty percent of Mexico's chemical and radioactive waste is dumped illegally." "Parastatal industries... (TEMEX, AZUCAR, S.A., FERTIMEX, and the Comision Federal de Electricidad) are the largest sources of industrial pollution in Mexico." Mexico's water supply today is severely polluted; 95 percent of Mexican cities discharge untreated industrial and organic wastes, causing four-fifths of all watersheds to be highly contaminated.

In Mexico City, "at least 12,000 tons of garbage are produced daily, most of it left open to the skies. Solid and liquid toxic wastes of industrial and biomedical origin amount to an estimated 2,500 tons a day." The industrial development area in Mexico City, once well outside the city, is now in the middle of the urban zone. According to Leonard, "Today, thousands of poor urban residents live very close to industrial facilities. Many people's yards or temporary dwellings even share back walls with heavy chemical plants." Leonard continues:

In all of Mexico, there are apparently only two facilities adequate for incinerating toxic wastes...many of Mexico City's...
Conclusion

The above compendium of evidence of environmental destruction related to agricultural development in contemporary Mexico can only be the roughest of beginnings towards an environmental history of Mexico’s Green Revolution. Clearly much more research, drawing on Spanish-language sources, on the new 1990 Mexican agricultural census, and on direct field observation, is required to validate the nature of generalizations formed from anecdotal information in the English-language literature and to correct its analytical bias towards U.S.-Mexico borderlands and the export-sector of Mexican agriculture.

Nevertheless, the evidence is ample enough to raise serious concerns, particularly in the context of continuing deliberations on the increasing economic integration of North America, and North American agriculture, through the vehicle of the NAFTA. There are no easy answers, no clear separation between “right” and “wrong.” But the livelihood of millions of rural Mexicans, and the integrity of Mexico’s rural environment are at stake.

In the irrigated sector of Mexican agriculture, accumulation has been sustained (directly) by heavy chemical inputs, and (indirectly) by overuse of agricultural smallholdings for extra-wage cash cropping and subsistence farming. Corporate and private farmers have raised grain for animal feed on highly-subsidized, prime agricultural land, rather than food for domestic human consumption, which then had to be imported. Workers in the irrigated sector and their families have not been sustained; they have been paid less than a living wage, forced to put young children to work, exposed to chemicals, pushed off their own smallholdings. The irrigated environment has not been sustained; it has been damaged by salinization, heavy metals, overuse of agrochemicals, and erosion.

In the rain-fed sector, cattle-raising has been a primary focus of capital accumulation. This form of accumulation has been sustained through the underutilization of extensive lands and livestock. Sheep have damaged trees and fragile soils. This in turn has led to deforestation and desertification. The new agricultural technologies have not been developed for rain-fed agriculture in Mexico.

Smallholders in the rain-fed sector have not been sustained. They have had to migrate to survive. As rural poverty increased, the land was overused: crops rotated too quickly; too much fertilizer and other chemicals were applied. Soils have declined in fertility and productivity and then have been abandoned. With rural out-migration and the abandonment of remote and marginal lands, traditional rural land managers have migrated away, taking their knowledge of local micro-ecosystems and collections of diverse, locally-adapted seed stock. With the abandonment of rain-fed rural lands have come down-stream soil erosion problems.

In the tropical-humid sector, accumulation has been sustained by short-term “mining” of rainforest nutrients, obtained through burning while clearing the forest for intensive agriculture or cattle-raising. Workers have not been sustained as colonization efforts fail. The tropical environment has not been sustained, as tropical moist forests have been destroyed faster than they can regenerate or are replanted. Cattle have destroyed vegetation and soils. Rain has washed away soils.

For all of its success, Mexican agricultural development seems to have been achieved at the expense of millions of rural and urban poor and of Mexico’s physical environment. This social and environmental degradation has been not circumstantial, not just an “unintended consequence” of agricultural development, but rather an intentional and integral part of the structure of accumulation in Mexican agriculture. As a result, social and environmental conditions of production today may constrain further development or even the maintenance of agricultural productivity in Mexico.

Continuing research, debate, and practice are necessary to validate these theses and to answer such important questions as: What is the possibility of the Mexican environment recovering from destruction? Of conversion to non-destructive practices? Of rebuilding sustainability? Perhaps the fundamental question is whether Mexico’s agricultural development strategy is reformable or if agriculture there must be reestablished on an entirely new basis.

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The "Green Revolution" was based on large-scale, irrigated, mechanized, chemical-dependent techniques, using hybrid seed stock specially developed for responsiveness to petrochemical fertilizers. Based on monocropping, Green Revolution technologies were heavily dependent upon chemical pesticides as well. See Angus Wright, The Clash of Ramon Gonzalez: The Modern Agricultural Dilemma (Austin: The University of Texas Press, 1990), 371ff.


3 Davidarkin, "The End of Food Self-Sufficiency in Mexico," Latin American Perspectives, 54 (Summer).

4 Yates, op. cit.


6 The English-language literature on Mexican agriculture, though vast, is not definitive with regard to environmental problems; it relies too heavily on anecdotal and partially sourced information, and draws insufficiency from the Mexican literature. It does, nevertheless, indicate the existence of severe environmental problems. An important next step, beyond the scope of this paper, is a review of the related Spanish-language literature.


9 Sanderson, op. cit.

10 Grindle, op. cit., 58.


12 Gustavo Esteva, ed., The Struggle for Rural Mexico (South Hadley, Mass.: Bergin & Garvey Publisher, Washington, D.C., 1986). Much of the land was expropriated and now belongs to large land trusts and marginal rural areas. According to Esteva (ibid., 61), land controlled by U.S. interests was minimally impacted by land reform.

13 Yates, op. cit., 46.


15 De Janvry, op. cit., 217.


20 De Janvry, op. cit.

21 Hewitt de Alcántara, op. cit., 310.

22 The U.S.-Mexico border industrialization program, born in the mid-1960s, heralded the beginning of export-oriented industrialization in Mexico. See de Janvry, op. cit., 39; and Wallerstein, op. cit., 77-79.


24 Ramos, op. cit.; Johnson, et al., op. cit.

25 Cf. Grimbl, op. cit.; Wright, op. cit.; Grindle, op. cit.; de Janvry, op. cit.

26 C. M. A. Sonnenfeld, "The End of Food Self-Sufficiency in Mexico," Latin American Perspectives, 3 (Summer).

27 Grindle, op. cit., 44; see also Esteva op. cit., 81-82; de Janvry, op. cit., 44; and Cartas Contreras, op. cit.

28 Esteva, op. cit., 64. See also Barkin, op. cit., 279. Cooperation between Mexican farmers in the 1920s and 30s, attempted to participate in the agrarian modernization program. However, according to Gerardo...
Constructing the Environmental Spectacle: Green Advertisements and the Greening of the Corporate Image, 1910-1990

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Within the advertising community and within parts of the environmental movement, the "greening" of corporate consciousness has been touted as evidence that environmental concerns are general in nature and affect all social actors equally. Moreover, this same phenomena has been cited as evidence that market-based solutions to environmental problems are possible. A proliferation of "green advertisements" is cited as evidence that businesses will respond to any increase in consumer demand for more "natural" or "environmentally friendly" products. The increase in the number of such ads is construed to reflect a healthy process of de-centralized market-based adjustments to new environmental imperatives. This paper challenges these allegations. Using a survey of over 500 newspaper and magazine advertisements from the periods 1910, 1930, 1950, 1970 and 1990, the paper argues that the use of natural imagery by business to sell products is nothing new, and that corporations and advertisers have always attempted to associate their products with...