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LIFECYCLE ANALYSIS AND POLICY FOR PACKAGING MATERIALS IN MEXICO: SUMMARY REPORT

a final report to

United Nations International Development Organization
Project number SF/MEX/94/001
Lifecycle Analysis and Legislation for Packaging Materials in Mexico
Contract number 94/030

Frank Ackerman
Paul Ligon
Lori Segall
Brian Zuckerman

Tellus Institute
November 1994

11 Arlington Street, Boston, MA 02116-3411 • Tel: 617-266-5400 • Fax: 617-266-8303

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I. Lifecycle Analysis and Policy for Packaging Materials in Mexico

Background

Containers and packaging represent about one-third of Mexico's solid waste, creating a serious environmental and financial problem for municipalities, which bear the burden of management and final disposal of waste. To address this problem, the office of the Secretary of Social Development (Sedesol - *Secretaría de Desarrollo Social*), through its National Institute of Ecology (INE - *Instituto Nacional de Ecologia*), sponsored a study of the management and recycling of containers and packaging, conducted in 1991-92 with the support of the United Nations Industrial Development Organization (UNIDO).[1]

Among a broad range of institutional and technical recommendations, the earlier study called for application of the techniques of life cycle analysis to packaging in Mexico. The goal was to develop standards for regulation of the production, use, and disposal of packaging. The result is the present study, again carried out through UNIDO, this time with the active participation and support of many major industrial enterprises and trade associations. The study was directed by Juan Careaga, of the International Recycling Institute (IIR -*Instituto Internacional del Reciclaje*). Other study participants included a Mexico City engineering firm, MR Servicios de Fomento Industrial (SFI), and two United States organizations with experience in life cycle analysis, Franklin Associates and Tellus Institute.

Project Summary

The project began with the selection of 21 packages to be studied, including at least one made from each of the major packaging materials. SFI interviewed the Mexican industries involved in production of the packages, and collected data on the energy use and emissions from each production stage that occurs in Mexico. Franklin Associates combined the SFI data with comparable information for production stages that occur outside Mexico. The result is Franklin's *Life Cycle Inventory of Packaging Materials in Mexico* (LCI).

Tellus Institute performed three major tasks. First, we reviewed the available methods for evaluation of life cycle inventory results, recommended use of the method introduced in our U.S. Packaging Study, and applied it to Franklin's LCI data. We found process emissions with serious impacts in PVC production (as in the U.S.) and in glass (quite unlike the U.S., and possibly due to a data error). In most other cases, the bulk of the impacts occurring in Mexico were attributable to pollution from power plants.

Second, we analyzed the management of packaging waste and the potential for recycling in the Federal District, using data supplied by IIR. Despite anecdotal accounts of the efficiency

[1] Sedesol Monograph No. 4, *Manejo y Reciclaje de los Residuous de Envases y Embalajes*, by Dr. Juan Antonio Careaga, published December 1993.

of informal recycling by scavengers, we found that large amounts of valuable recyclable material, particularly paper, are being landfilled. The three new recycling plants opening in 1995 are not large enough to capture all the recyclables: the Federal District's waste stream could fill two more plants of the same size at once, and even more additional plants before the end of the decade. The best way to increase recycling would be to promote the separate collection and recycling of paper, before it is mixed with wet wastes.

Finally, we surveyed the approaches to packaging policy in Europe, Canada, and the United States, and developed recommendations for packaging policy in Mexico. We recommend:

- reduction in the worst sources of production emissions, in specific industries and in the electrical system;

- increases in recycling, through construction of additional plants and through separation and collection of paper;

- continued removal of scavengers from landfills, and creation of jobs for former scavengers in recycling facilities;

- consideration of deposit legislation or other measures to control future increases in beverage container litter, and ongoing efforts to combat packaging litter in general; and

- creation of a voluntary industry association to provide support for this agenda and other forms of packaging-related environmental improvement.

Tellus Staff and Work Products

At Tellus Institute, Frank Ackerman was the project manager; the project staff included Paul Ligon, Lori Segall, and Brian Zuckerman. Karen Shapiro provided useful insights on life cycle analysis literature and techniques; John Stutz, director of the Solid Waste Group, played a valuable editorial role. Javier Careaga translated this report into Spanish.

Our detailed findings are presented in our three separate reports:

Evaluation of the Environmental Impact of Packaging Production for Mexico
Management of Packaging Waste in Mexico City
Policy Options for Packaging Waste

Short summaries of each of these reports are presented in the following pages.

II. Evaluation of the Environmental Impact of Packaging Production in Mexico

As the Mexican economy has expanded and modernized, the use of packaging materials to transport, safeguard, and sell products has increased as well. The benefits of using packaging materials are significant, and obvious. But their use also imposes hidden costs on society, including the cost of pollution generated during the production and disposal of packages.

As part of this project, Franklin Associates has created a lifecycle inventory (LCI) of the total energy use, solid waste generation, and air and water pollutant emissions during the creation of 21 selected packages used in Mexico. This report provides an impact assessment of the LCI in order to evaluate its results. The impact assessment uses an updated version of the methods introduced in Tellus Institute's *US Packaging Study*, and provides a monetary valuation of pollution impacts. Our principal findings include the following:

- **There is more than a 50-fold range in impacts per tonne of material produced, although most materials' impacts are between 600 and 1200 pesos (N$) per tonne.** The production of one tonne of low density polyethylene in the United States has the lowest impacts, N$ 294 per tonne. Polyvinyl chloride (PVC) produced in Mexico has the highest impacts, N$ 10,382 per tonne. Of the 20 packaging materials studied, 12 had impacts between N$ 600 and N$ 1200 per tonne.

- **There is also a wide range in impacts per package, although most packages have impacts of less than N$ 0.10.** The lowest-impact package studied has impacts of less than N$ 0.01 per package, while the two highest impact packages exceed N$ 1.00 per container. Of the 21 packages, 15 had impacts less than N$ 0.10 per package. Even when packages are standardized on a per weight-of-contents basis, there is wide variability, although 14 had impacts less than N$ 0.10 per liter or kilogram of contents.

- **Mexican packaging industries are not necessarily the direct cause of the impacts.** For five of the packages, more than 75% of the impacts occurred outside Mexico. Of the remaining 16 packages, emissions from the electricity used during production accounted for the bulk of impacts in nine cases and for the bulk of impacts occurring in Mexico in an additional two cases. Only in five cases were emissions from Mexican packaging industry itself the most important source of impacts.

- **Specific emissions reduction measures are the best way to reduce packaging impacts.** Measures to reduce emissions, such as improving emissions controls in Mexican electrical generating facilities and promoting more efficient fuel use in industry, may be the most effective means to reduce the impacts associated with packaging production. Only in PVC and glass production are process emission controls the most important means to consider.

Tellus Impact Assessment Method

The Tellus impact assessment method is applied to many classes of compounds, including US EPA criteria air pollutants, greenhouse gases, carcinogenic compounds, and toxic, noncarcinogenic compounds. The method has two principal components. It employs a **hazard ranking** which ranks compounds according to their toxicity, both carcinogenic and noncarcinogenic. And it includes an **evaluation** method, which assigns costs to the emissions of hazardous compounds based upon the amount of money spent to control them.

Impacts per Tonne of Material

We calculated emissions per tonne of packaging material from the appendices of the LCI. We then applied our impact assessment method to calculate impacts per tonne of packaging material. Low-density polyethylene, polypropylene, and wood are the lowest-impact materials, while aluminum and PVC are the highest-impact. PVC is high-impact because of large emissions of vinyl chloride monomer, a known carcinogen, while aluminum production is highly energy intensive: fuel combustion causes most impacts from aluminum production. A surprising result was the relatively high impact of glass. Glass production uses no toxic solvents or feedstocks, and requires little energy. Very high reported particulate emissions from a single glass mill are responsible for the high impacts. If the reported information is correct, better particulate emission controls would significantly reduce glass impacts.

Impacts per Package

The objective of the study was to evaluate the impacts per package. The LCI calculated emissions per package, and we applied our assessment method to these emissions. The table below shows impacts per package on two scales - emissions per package and emissions per kilogram or liter of contents. The second scale is necessary to eliminate the bias caused by the differences in package size. The expanded polystyrene (EPS) grape crate and the nonrefillable soda bottle have the highest impacts per-package and per-unit, respectively. The PVC water bottle is the second-highest on both scales. The LDPE bread bag and flour sack have among the lowest impacts on both lists.

Analysis of Impacts

The LCI, supplemented by additional information from Franklin Associates, allowed us to analyze the sources of impacts. We separated impacts into four categories - outside Mexico, transportation in Mexico, electricity in Mexico, and on-site Mexican industrial emissions. Of the four categories, Mexican transportation was the least important: in only three cases did transportation account for more than 10% of total impacts.

Five of the 21 packages were produced almost completely outside of Mexico, and impacts in Mexico represented less than one-quarter of the total. For the remaining 16 packages, on-site emissions were most important in only five cases - the two glass soda bottles, the water bottle, the EPS grape crate, and the cereal box. Moreover, the bulk of the impacts for the grape crate and cereal box result from on-site combustion of oil and natural gas rather than emissions from manufacturing processes themselves. For the other 11 packages, emissions from the Mexican electrical grid caused the bulk of the impacts in Mexico. Impacts per kilowatt-hour of Mexican electricity are 50% higher than impacts of electricity produced in the United States.

Priorities for Emissions Reductions

Our results indicate four priorities for emissions reductions. Implementing them would decrease impacts from packaging production in Mexico.

- Reduce emissions from electrical generating facilities
- Reduce fuel use, and thereby emissions from fuel use, by promoting energy efficiency and energy conservation
- Reduce emissions from on-site fuel combustion
- Reduce process emissions from glass and PVC manufacturing

Table 1 - List of Packages and Their Impacts

Package Name	Impacts per package (N$)	Impacts per unit of contents (N$)
Laminated snack pack	0.00	0.13
Bread bag	0.01	0.02
Yogurt container	0.02	0.08
Corn flour sack	0.02	0.02
Pancake syrup container	0.03	0.07
Folding carton cereal box	0.03	0.08
Returnable 500 ml glass soft drink bottle	0.03	0.06
Gable-top milk carton	0.04	0.04
Three-piece can for chilies	0.04	0.21
Returnable 1.5 L plastic soft drink bottle	0.05	0.03
Beer can	0.05	0.15
Edible oil bottle	0.07	0.07
Aseptic brick for milk	0.07	0.07
Sugar bag	0.08	0.00
Shampoo bottle	0.09	0.22
Nonreturnable soft drink bottle. 355 ml	0.11	0.32
Fruit crate	0.21	0.01
Cement sack	0.34	0.01
Box for egg trays	0.55	N/A
Water bottle	1.05	0.28
Crate for grapes	1.13	0.05

III. Management of Packaging Waste in Mexico City

Management of solid waste in the Mexico's Federal District has received increasing attention in recent years. Solid waste generation has been growing due to increasing population and incomes, while packaging materials have become more prevalent in the waste stream. In order to analyze the management of packaging waste and the potential for recycling, Tellus Institute analyzed the Federal District's solid waste system using WastePlan© computer software. WastePlan is a sophisticated planning tool designed for integrated solid waste system planning. The International Recycling Institute (IIR) provided the data on the Federal District.

Using WastePlan, we modeled the waste management system in place in 1994 followed by the planned future system, starting in 1995 and continuing through the year 2000. Despite important recycling initiatives, the planned future system still failed to capture a large fraction of the recyclable paper and other materials. Therefore, we also analyzed the impacts of a major increase in paper separation and recycling.

Base Scenario - 1994 Solid Waste System

The waste management system in place in 1994 delivers waste collected from the 16 delegations in the Federal District to 14 transfer stations, which, in turn, transfer waste to three landfills. This system includes two levels of informal sector scavenging: urban sanitation workers, accompanied by "volunteers," who remove high-value recyclable materials before waste arrives at the transfer stations, and "*pepenadores*" who remove and sell whatever remaining materials they find at the landfills. Urban scavenging (before the landfill) was estimated to remove 126,000 tonnes of material in 1994, while landfill scavenging removed 157,000 tonnes, approximately 3% and 4% of the solid waste generated in the Federal District, respectively. Health hazards and terrible working conditions at the landfill are major reasons for banning the practice of landfill scavenging in 1995, when three "selection plants," facilities for removal of recyclable items, will be operational. The former *pepenadores* will be employed in these plants.

Future Scenario: 1995 - 2000

As of 1995, two of the three landfills will close and three selection plants will each receive 1,500 tonnes per day of waste to be sorted. These three plants together are expected to divert 252,000 tonnes per year of recyclables, an increase of approximately 60% over the total diverted by *pepenadores*. Using the estimated percentages of each recyclable waste type that will be recovered in these facilities, we compared the diversion rates of the selection plants to that of the *pepenadores* (see Figure 1). Even though workers at selection plants can capture materials more efficiently than do the landfill scavengers, they will have access to only a fraction of the Federal District's waste. The *pepenadores* had access to more of the city's garbage, and could therefore divert a higher quantity of some materials.

Despite the anecdotal evidence suggesting that scavenging in the District diverts huge proportions of the recyclable materials, the WastePlan analysis shows that significant proportions of many valuable materials are being landfilled. Moreover, the switch from landfill scavenging to selection plants still will not prevent the loss of many tonnes of recyclables. Both in 1994 and in the future, large percentages of the Federal District's paper, plastics, organic materials and other wastes are landfilled; recovery rates are reasonably high only for metals and glass.

The selection plants do not have the capacity to process all of the waste from higher-income delegations at present, let alone in the future. Figure 2 displays the projected yearly capacity of the selection plants compared with the amount of waste available to be sent to them. In 1995 the selection plants are projected to have only 60 percent of the capacity required, even assuming that wastes from four of the lowest-income delegations are sent directly to the Bordo Poniente landfill. By the end of the century, rapid population and waste generation growth imply that the three selection plants will be able to process only 40 percent of the waste sent to them.

Paper Recycling Program Scenario

Another scenario was developed to assess the impact on selection plant capacity of diverting paper through a separate recycling program. Paper waste could be separated by households and businesses, and then could be collected and diverted by sanitation workers, or, alternatively, by formal or informal private recycling enterprises. We assumed that a future program would remove 50% of paper, cardboard and cardboard containers from the waste stream, in addition to that removed through illegal dumping and urban scavenging. The percent of paper products recovered at the selection plants was not changed: the workers would therefore divert the same percentage of a much smaller incoming quantity of paper products. Figure 3 shows the impact on selection plant capacity. Although the quantity of incoming material is greatly reduced, such a paper collection program would still not change the need for more selection plant capacity.

Policy Conclusions

Our analysis leads to three principal recommendations for waste management policy:

- **Promote formal and informal systems for maximizing front-end recycling, especially of paper.** Paper forms the largest category of recyclable materials, and by far the largest quantity of valuable material being landfilled. It is also a material which must be kept separate from general waste collection to produce high-value feedstocks.

Promoting collection of used paper from residences and businesses could significantly increase the quality and quantity of Mexican recycled paper.

- **Expand the capacity of the waste selection plants, or build additional plants.** The capacity of the three existing plants is already inadequate to recover all of the valuable recyclable materials in the waste stream. As the population and waste stream grows, the need for new capacity will become even greater.

- **Compost organic wastes.** Approximately half of the District's waste is food scraps and yard trimmings, which are readily compostable. After separation of recyclables, most of the remaining waste is compostable. Composting these wastes will convert organic materials destined for the landfill into a useful soil amendment.

Figure 1 - Comparison of diversion rates from landfill scavenging and selection plants

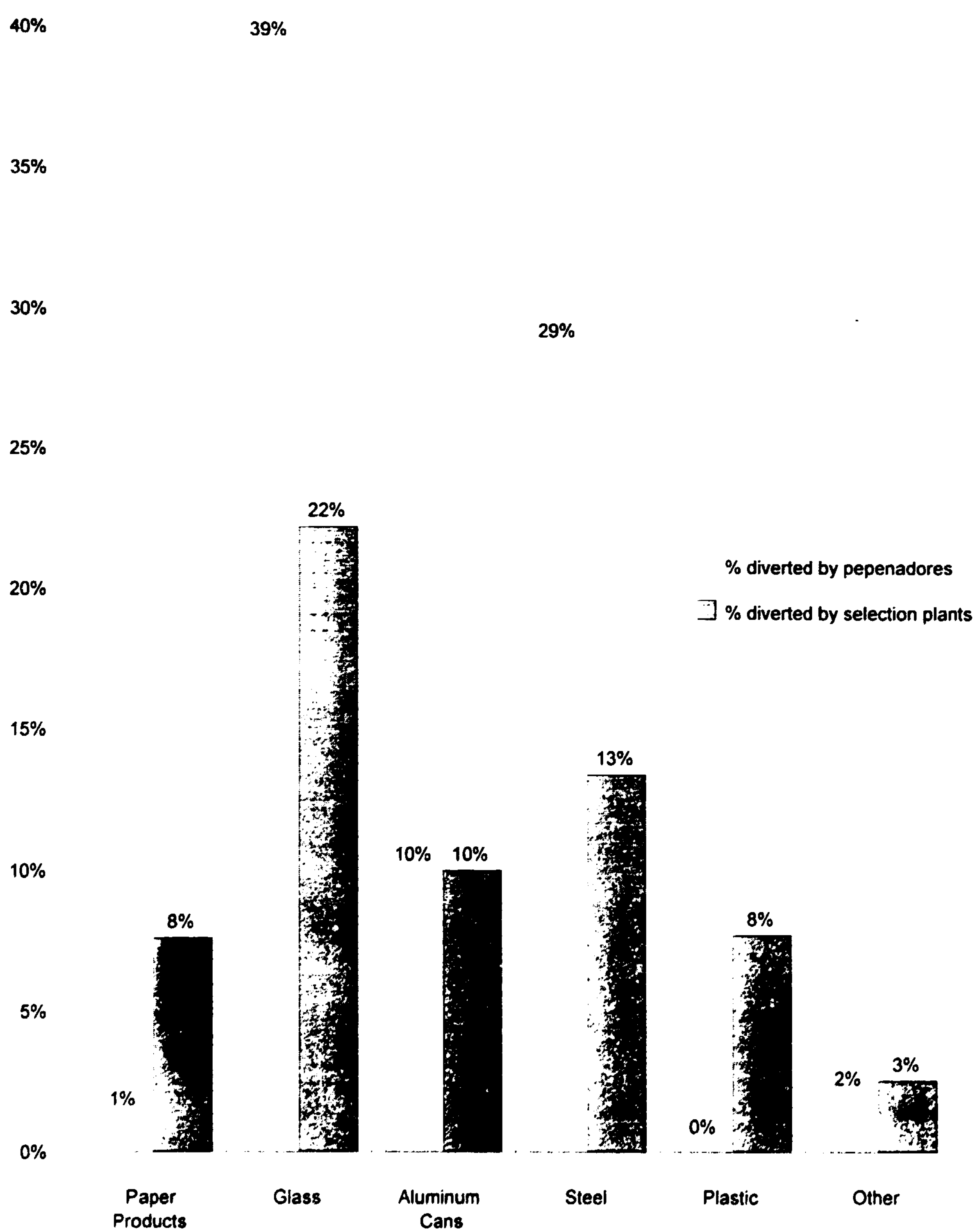
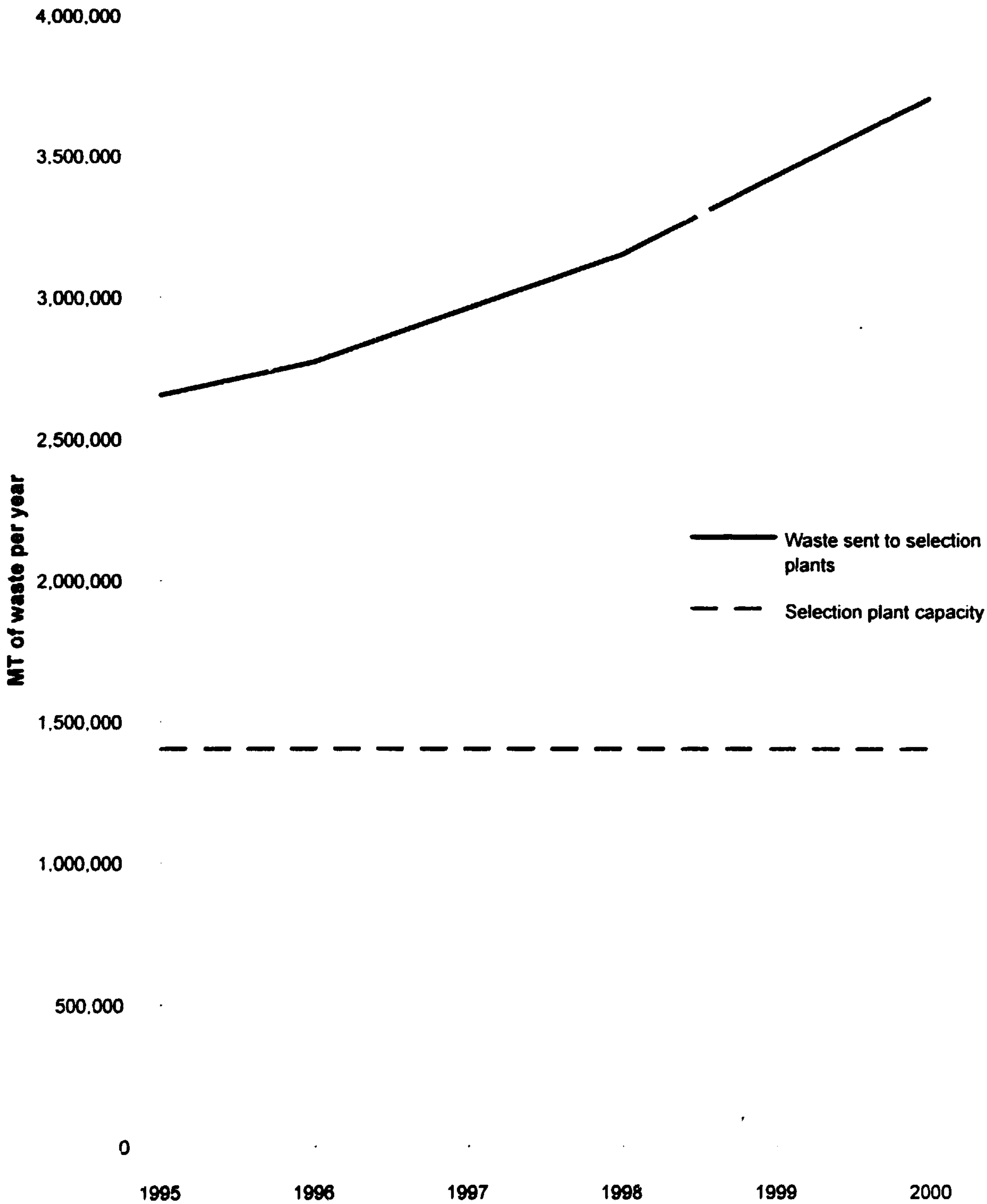
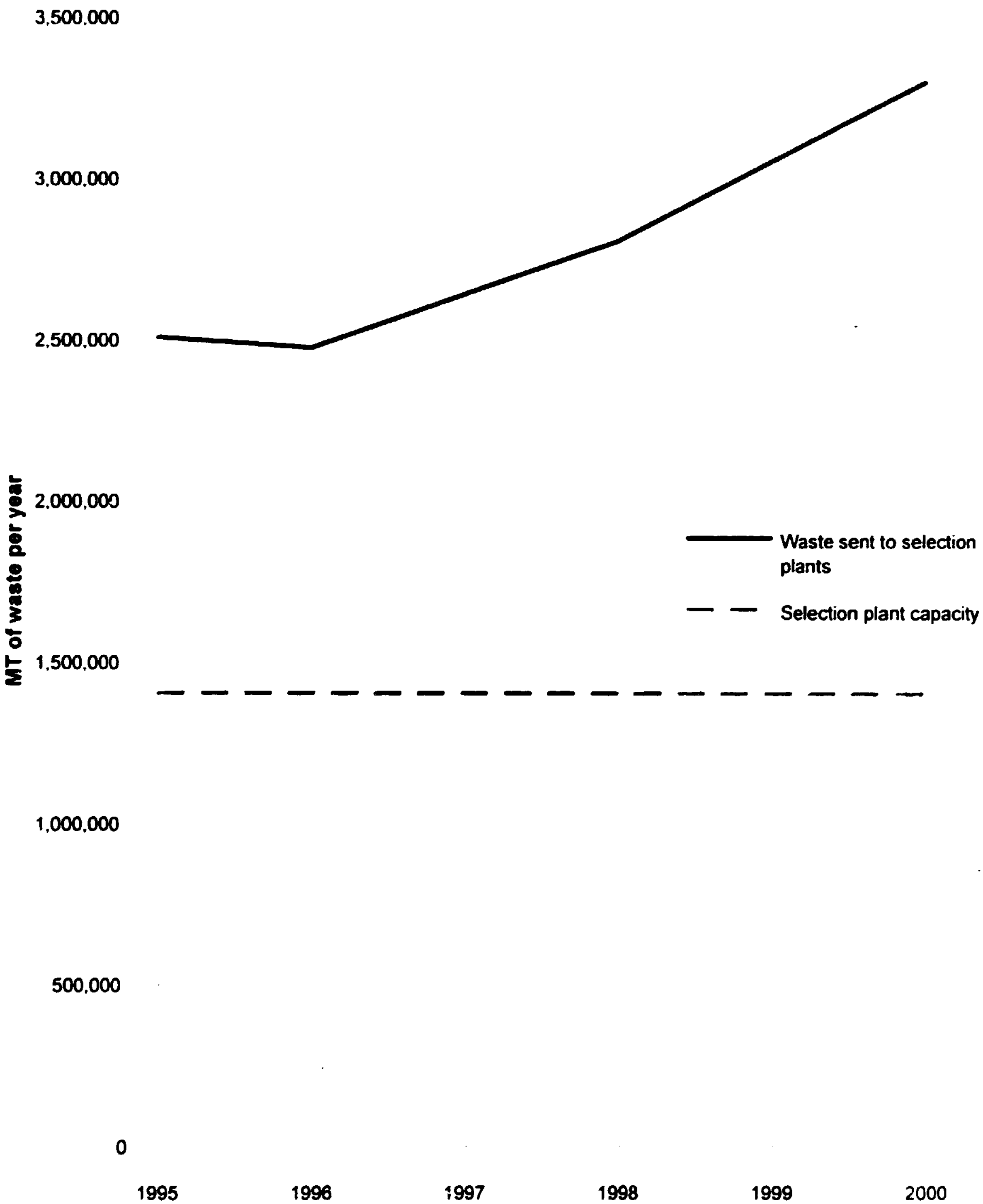


Figure 2 - Comparison of waste sent to selection plants with selection plant capacity



1995, 1997 and 1999 values are interpolations.

Figure 3 - Comparison of waste sent to selection plants with paper recycling program and selection plant capacity



1995, 1997 and 1999 values are interpolations.

IV. Policy Options for Packaging Waste

The ultimate objective of this project is to develop proposals for policy and regulation of Mexico's packaging waste. Existing laws and regulations provide a sound general framework for addressing environmental issues, but for the most part have not yet incorporated specific packaging measures and standards. Our discussion of policy options includes a review of international experience, and a set of five recommendations for Mexico.

International experience in packaging policy

A review of international experience and proposals suggests numerous directions in which packaging policy could be developed. The most widely discussed, and most controversial, packaging policy is Germany's "Green Dot" system. German industry, required by law to meet ambitious recycling targets for packaging, has established the Duales System Deutschland (DSD). The DSD charges license fees to member companies for use of its green dot symbol on their packages, and finances widespread collection and recycling of packaging that bears the green dot. With DSD and the green dot system, Germany has achieved very high recovery of packaging, but at very high cost.

Other European countries, such as France and Spain, are pursuing more moderate variants on the German system. The French approach maintains the idea of industry responsibility for packaging waste, and employs an industry consortium, Eco-Emballages, comparable to DSD. However, there are important differences from the German model: in France industry rather than government has set the recycling targets; incineration as well as recycling of recovered packaging materials is allowed; and greater use is being made of existing local waste management systems. The result is a much lower-cost, less controversial system. Spain is moving toward adoption of a system patterned on the French model.

A proposal that resembles the French approach is also under active consideration in Ontario, Canada's largest province. Canada's "packaging stewardship" initiative would require packaging industries to either establish their own recycling systems, or pay roughly two-thirds of the net cost of municipal recycling of their packages. The proposal relies heavily on Ontario's extensive network of curbside recycling programs.

In the United States, packaging policy is set by states, and "packaging stewardship" proposals have received little attention. State policies include beverage container deposit legislation in 10 states (similar laws are in force in most of Canada and Europe); establishment of reduction and recycling targets, and support for municipal recycling efforts; and a few incentives for increased secondary content or higher recycling rates in packaging. Florida's advance disposal fee for packaging is one of the most-discussed innovations of 1994.

Five recommendations for Mexico

Drawing on our review of international experience, and our separate reports on impacts of packaging production, and management of packaging waste in Mexico City, we have five principal recommendations for packaging policy.

1. Reduce the worst sources of production impacts. These include process emissions from glass (if the data is correct) and PVC production, and fuel-related emissions, particularly in the power plants that serve Mexican industry. If emissions cannot be reduced to acceptable levels, reduction in the use of high-impact products should be considered.

2. Increase the level of recycling. Informal scavenging does not recover most of the recyclable materials in the waste stream, nor do the existing recycling programs. Even the three new recycling facilities will not have enough capacity to recover half of the Federal District's recyclable materials by the year 2000. Other urban areas will likely need additional capacity as well. Large quantities of paper, in particular, are being landfilled; improved separation and collection of paper waste can allow recovery of this potentially valuable material.

? Replace landfill scavenging with recycling plants and sanitary landfills. The greatest environmental damage due to waste management is the impact on the health and safety of the *pepenadores* who work and live on landfills. The humane alternative is the policy adopted in Ciudad Juarez, and now being implemented in the Federal District: opening new, sanitary landfills, and employing the former *pepenadores* in recycling facilities.

4. Develop policies for litter control, both for existing litter and for the potential increase due to nonrefillable beverage containers. Litter, much of it packaging material, is already a problem in Mexico. Based on U.S. experience, the rapid increase in nonrefillable beverage containers, now just starting in Mexico, may lead to a much larger litter problem in the near future. Deposit legislation has been used in some U.S. states, and in Canada and Europe, to address this problem; this or other approaches will be needed to address litter in Mexico.

5. Create a voluntary industry organization to provide support for this agenda. Industry has a crucial role to play in addressing the environmental problems associated with packaging. The concept of product stewardship, of producer responsibility for packaging even after disposal, is becoming accepted in many parts of the world. It does not seem appropriate to establish a formal tax or fee mechanism to support recycling and environmental improvement. However, it is the responsibility of industry to show that it can voluntarily raise funds and provide support for an ambitious agenda of packaging-related environmental improvement