DISCUSSION PAPER

August 2005 ■ RFF DP 05-38

Adoption of Clean Leather-Tanning Technologies in Mexico

Allen Blackman

1616 P St. NW
Washington, DC 20036
202-328-5000 www.rff.org

RESOURCES
FOR THE FUTURE

Adoption of Clean Leather-Tanning Technologies in Mexico

Allen Blackman

Abstract

In many developing countries, a host of financial, institutional, and political factors hamstring conventional environmental regulation. Given these constraints, a promising strategy for controlling pollution is to promote the voluntary adoption of clean technologies. Although this strategy has received considerable attention in policy circles, empirical research on the adoption of clean technologies in developing countries is limited. This paper presents historical background and original survey data on the adoption of five clean tanning technologies by a sample of 137 leather tanneries in León, Guanajuato, Mexico, a city where tanneries have serious environmental impacts and conventional environmental regulation has repeatedly failed to mitigate the problem. The analysis suggest that rather than top-down public-sector pressure and technical assistance, the key factor driving the adoption of clean tanning technologies in León is the bottom-up dissemination of information about the cost and quality benefits of the technologies.

Key Words: clean technology, leather tanning, developing country, Mexico

JEL Classification Numbers: Q53, Q55, Q56, 013, 033

Contents

Adoption of Clean Leather-Tanning Technologies in Mexico

Allen Blackman*

1. Introduction

In many developing countries, a host of financial, institutional, and political factors hamstring environmental regulation. Fiscal and technical resources for environmental protection are generally in short supply. Environmental regulatory institutions as well as complementary judicial, legislative, and data-collection institutions are typically weak. Requisite physical infrastructure, such as hazardous and solid waste treatment facilities, is relatively scarce. Public sentiment usually favors economic development over environmental protection, and environmental advocacy—historically a critical stimulus to effective environmental regulation—is generally less prevalent than in industrialized countries (World Bank 2000; Eskeland and Jimenez 1992).

Given these constraints on conventional environmental regulation, a promising strategy for controlling pollution is to promote the adoption of clean technologies that prevent pollution and also have private benefits such as reducing production costs or improving product quality. The hope is that firms will adopt such technologies voluntarily, or at least with minimal prodding by regulatory authorities. This approach has received considerable attention from policymakers worldwide (e.g., United Nations 2002; World Bank 1992 and 1998; World Commission on Environment and Development 1987).

Notwithstanding this attention, empirical research on the adoption of clean technologies in developing countries is limited. Such research can help stakeholders design polices to promote clean technological change. The literature on the adoption of cost-saving innovations in

---

*Thanks to the Tinker Foundation for financial support; Arne Kildegaard, Nicolas Sisto, Cámara de la Industria de Curtiduría del Estado de Guanajuato (CICUR), Procurador de Protección al Ambiente para el Estado de Guanajuato (PPAEG), and Centro de Investigación y Asesoría Tecnológica en Cuero y Calzado (CIATEC) for assistance with field research; and the survey's enumerators at the University of Guanajuato—Federico Arturo, Jorge Barrio, Federico Cantero, Juan Días, Julio Gasca, Claudia Gomez, Erika del Carmen Gonzalez, Jeremy Heald, Edgar Isusquiza, Cid Rodríguez, Arcelia Rodríguez, Fabiola Romero, and Eduardo Vargas—for assistance in administering the survey.

developing countries is broadly relevant but does not have much to say about the regulation, externalities, and peculiar political economy considerations that affect clean technologies. One reason for the lack of research in this area is that hard data are rare.

This paper presents historical background and original survey data on the adoption of five clean tanning technologies by a sample of 137 small- and medium-scale leather tanneries in León, Guanajuato, Mexico. León is an archetype of a city where clean technological change represents the best hope for pollution. The city's leather tanneries have severe environmental impacts, and attempts to mitigate the problem using conventional regulation have repeatedly failed. Recently, however, a significant percentage of León's tanneries have voluntarily adopted clean technologies. This original study is the first to examine this phenomenon.

The remainder of the paper is organized as follows. The next section briefly reviews the literature on the drivers of clean technology adoption. The third section provides background on leather tanning in León. The fourth section describes the five clean technologies. The fifth section discusses the survey methods, and the sixth section presents survey results. The last section offers conclusions.

2. Two Drivers of Clean Technology Adoption

Researchers have identified a wide range of factors that speed or slow the adoption of clean technologies (for a review, see Jaffe, Newell, and Stavins 2003). Among them, two probably have attracted the most attention: regulatory pressure and the availability of requisite technical and economic information. The link between conventional regulatory pressure and clean technological change is well established in the theoretical literature (e.g., Millman and Prince 1989), and a number of researchers have found empirical evidence for it (e.g., Kerr and Newell 2003). As noted above, in developing countries, financial and institutional constraints often preclude effective conventional environmental regulation. However, a growing body of research shows that informal regulation—that is, pressure for improved environmental performance applied by private-sector groups such as neighborhood associations, trade unions, and nongovernmental organizations—can take up some of the slack (World Bank 1999). Some research suggests that this type of private-sector pressure can also spur the adoption of clean technologies. For example, in a study of a city-wide effort to persuade small-scale brickmakers in Ciudad Juárez, Chihuahua, Mexico, to adopt environmentally friendly propane-fired kilns, Blackman and Bannister (1998) found that an important determinant of adoption was the extent to which brickmakers were exposed to pressure from local trade unions and neighborhood organizations.

The availability of information also drives clean technology adoption. The key idea is that to adopt new technologies, firms must first acquire the requisite technical and economic information—a costly enterprise. Information acquisition may be passive, with firms absorbing information via day-to-day contact with business associates, or it may be active, with firms engaging in training and technical extension programs. The oldest and best-known models of technology diffusion focus on the dissemination of information about new technologies via day-to-day contact among firms, likening this process to the spread of a disease (Mansfield 1968).

3. Efforts to Regulate Leather Tanning in León

The city of León in north central Mexico produces about two-thirds of the country's leather. Almost all of it is used in shoemaking, León's other hallmark industry. Although exact numbers are not known, local regulators estimate that León is home to approximately 1,200 tanneries. At least three-quarters of these tanneries are small-scale, employing fewer than 20 workers, and about one-quarter are unregistered and informal (Villalobos 1999).

Historically, León's tanneries have dumped untreated effluents directly into municipal sewers that then deposit them into the Gómez River, a tributary of the Turbio. The main pollutants from tanneries are salt (used to preserve rawhides); various chemical compounds of sulfur (used to dehair hides); chromium III, commonly known as chrome (used to render hides biologically inert); dissolved and suspended solids; and solid wastes impregnated with tanning chemicals. Tannery pollution has contaminated surface and groundwater and has damaged irrigated agricultural land. A 1987 study found chromium VI—a highly toxic byproduct of chromium III—in three-quarters of the city's drinking-water wells (Hernández 1987). León's water pollution problems attracted international attention in 1994 after a die-off of tens of thousands of migratory aquatic birds wintering in a local reservoir contaminated by the city's wastewater (Commission for Environmental Cooperation 1995).

Regulations governing tannery pollution have been on the books for decades. Among other things, they require tanneries to register with environmental authorities, install sedimentation tanks and water gauges, handle most solid wastes as hazardous materials, and—most important—pretreat wastewater so that daily concentrations of various pollutants do not exceed set standards. For the most part, however, these regulations are simply not enforced. By all accounts, the main reason is that leather tanneries are a mainstay of the local economy and therefore enjoy considerable political power.

Concerted efforts to control tannery pollution in León began in July 1987 when tannery representatives signed a voluntary agreement to comply with written regulations within four years. But when it became apparent in 1991 that the tanners had not taken any action aside from installing crude sedimentation tanks urgently needed to prevent sewers from clogging, the agreement was renegotiated.[1] In October 1991 a new voluntary agreement essentially granted tanners a second three-year grace period. It also committed the city of León to build both a common effluent treatment plant for biological (but not chemical) wastes and a facility for handling solid and hazardous wastes. By the end of this second grace period, these facilities had not been built, and tanneries had made no progress in reducing discharges. A third voluntary agreement was negotiated in June 1995 and a fourth in March 1997. None of these efforts produced any concrete progress in treating tannery industrial wastes.

For the most part, public-sector ineffectiveness in using top-down pressure to force compliance with environmental regulations has been matched by private-sector disinterest in and resistance to such strategies. Interviews and focus groups with a wide variety of stakeholders in León—including environmental advocates, tanners, politicians, and regulators—indicated that environmental advocacy groups and neighborhood organizations have not placed significant overt pressure on tanners to improve their environmental performance.[2]

Surprisingly, the one exception in this regard has been the *Cámara de la Industria de Curtiduría del Estado de Guanajuato* (CICUR), the principal trade organization representing León's tanners. Notwithstanding its continued opposition to promulgating and enforcing pollution control regulations, CICUR has encouraged—and on occasion even pressured—its members to cut pollution. In addition, it has promoted clean technological change in meetings and trade publications (*Dinámica de la Curtiduría* various years).

---

[1] Sedimentation tanks are the only end-of-pipe abatement devices commonly used in León. These inexpensive, low-technology concrete barriers enable suspended solids to settle out of waste streams. To prevent the city's sewers from clogging, the municipal water authority (SAPAL) has strictly enforced regulations requiring sedimentation tanks since the late 1980s.

[2] The following anecdote illustrates the complacency of León's citizens with respect to tanneries. In 2002 the municipality received a nuisance complaint against 22 tanneries operating in a working-class neighborhood, a rare event. In response, the municipality organized a local referendum on a proposal to relocate these tanneries to another location; 188 resident families voted against, and only 8 voted in favor (*Correo de Hoy* 2002).

Given that León's tanneries have yet to install end-of-pipe treatment facilities needed to comply with emissions standards, to date the most significant progress in controlling tannery emissions has resulted from the voluntary adoption of clean tanning technologies. The next section provides background on these technologies, as well as a brief overview of the process of leather tanning.

4. Clean Tanning Technologies

Leather tanning consists of two meta-processes: wet blue production and finishing. The former involves removing unwanted substances (salt, flesh, hair, and grease) from a rawhide, trimming it, treating it to impart the desired grain and stretch, and finally soaking it in a chrome bath to prevent decomposition.[3] Finishing involves splitting, shaving, re-tanning, and dying the wet blue. The wet blue and finishing processes are technologically and economically separable, and many tanneries in León specialize in one or the other. The wet blue process is far more polluting than finishing, generating 90% of the water pollution associated with leather tanning. Two substages of this process are particularly dirty: dehairing, in which rawhides are soaked in a bath of lime and sodium sulfide to dissolve hair and flesh, and chrome tanning, in which hides are soaked in a chrome bath to render them biologically inert.[4]

Five clean technologies are considered here: two associated with dehairing and two associated with chrome tanning (for technical details, see UNEP 1991).

- High exhaustion—using special inputs and procedures to ensure that more of the chrome in the tanning bath actually affixes to the hide, and less ends up in waste streams. Although this technique requires a more expensive type of chrome (self-basifying) and a longer soaking period, it offers significant cost savings due to reduced overall chrome use (UNEP 1991).
- Enzymes in the dehairing bath—substituting biodegradable enzymes for lime and sodium sulfide.

[3] The resulting semifinished hide is called a wet blue because the chrome bath imparts a bluish tint.

[4] A small percentage of tanneries in León use an alternative to chrome tanning called vegetable tanning, which involves soaking hides in tree bark extracts. This process produces low-grade leather used primarily as shoe soles. The survey sample does not include any tanneries that use this process.

- Precipitation of chrome—using alkalis to precipitate out the chrome in the tanning bath, then collecting the resultant sludge and processing it with sulfuric acid to recover the chrome.
- Recycling the dehairing bath—saving and reusing the contents of the dehairing bath instead of discharging it all into the sewer after a single use. This simple technology requires only fixed investments in a holding tank, a pump, and a filtering system to remove suspended solids (usually a simple wire mesh screen). Because the chemical inputs into the dehairing bath are relatively inexpensive, only minor cost savings accompany the environmental benefits. According to UNEP (1991), a tannery that produces 1,000 wet blues per day could expect to save only US$8,000 per year.
- Recycling the chrome tanning bath—reusing contents of the tanning bath instead of discharging them into the sewer after a single use. Like recycling the dehairing bath, this simple technology requires only fixed investments in a holding tank, a pump, and a simple filter. It can reduce chrome use by up to 20% (UNEP 1991).

5. Survey

In January 2000, a team of trained enumerators administered a (face-to-face) questionnaire to the owners or managers of 164 tanneries in León. Respondents were asked to provide information on whether they had adopted each of the five clean technologies described above, whether they had received technical training in the use of the technologies, and their views on costs and benefits of adopting each. Twenty-seven records were ultimately eliminated from the sample due to missing or inconsistent responses, leaving a total of 137 records.

Unfortunately, the conventional approach for randomizing survey samples—randomly selecting firms from a complete list—proved impractical because so many of León's tanneries are informal and are not included on any public or private registries. Just as important, in preliminary surveys, randomly selected tanneries often declined to participate. As a result, the survey relied on so-called convenience sampling, a technique commonly used in industrial sectors with large numbers of informal firms. Participants were identified by setting up interviews with firms on a list of 766 formal tanneries maintained by Centro de Investigación y Asesoría Tecnológica en Cuero y Calzado (CIATEC) and by going door to door in León neighborhoods where tanneries are plentiful. Given the reliance on these second-best methods, there is no guarantee that the survey sample is representative of the León tannery population.

6. Survey Results

This section presents summary statistics from the survey data. Most of the respondent firms were small-scale, reflecting the population of tanneries in León. The average tannery in the sample had 16 employees and produced 499 wet blues per week

6.1. Familiarity with Clean Technologies

More than 70% of respondents had heard of each of the five clean tanning technologies (Table 1). They were least familiar with the enzymes and chrome precipitation and were most familiar with chrome bath recycling and high exhaustion. Those respondents who had heard of the five technologies claimed a relatively high level of familiarity with technical details. In each case, the average respondent rated his or her familiarity higher than 3 on a scale of 1 to 5 (where 1 = not familiar and 5 = very familiar).

Although most tanners were familiar with the five technologies, this knowledge appears to have been relatively new. In each case, fewer than half the respondents had known about the technology for more than five years. With the exception of enzymes, the plurality of respondents first learned about each technology from CICUR, the tannery trade association. In the case of enzymes, the key source of initial information was input suppliers. Input suppliers were also an important source of information about high exhaustion.

6.2. Adoption of Clean Technologies: Rates, Timing, and Reasons

Table 2 presents survey data on rate and timing of adoption for the five clean technologies, and the reasons the respondents gave for either adopting or not adopting. With regard to rates of adoption, the two technologies that have diffused most widely are high exhaustion and enzymes: 59% of the respondents have adopted the former and 35% have adopted the latter. About one-fifth of the respondents had adopted the remaining three clean technologies.

These technologies are fairly new to the adopters in the survey sample, a finding that is not surprising considering that, as discussed above, most adopters learned about them only recently. Most adopters acquired the technologies in the mid-1990s. Recycling the dehairing bath was adopted earliest (on average 1994), and enzymes were adopted most recently (on average 1997). Figures 1 through 5 show precisely when the survey participants adopted each technology.

What reasons did the surveyed adopters give for their choices? The reasons were similar for the three technologies that do not involve recycling (high exhaustion, enzymes, and precipitation of chrome) and for the two that do (recycling of the chrome bath and recycling of the dehairing bath).[5] For the three nonrecycling technologies, the majority of adopters cited private nonenvironmental benefits—improving product quality and reducing variable costs—as the most important reason for adopting (Table 2). Improving product quality was clearly viewed as the most important reason in the cases of enzymes; more than two-thirds of adopters cited it as most important. This factor also appears to have played a key role in the adoption of chrome precipitation and high exhaustion; more than one-third of respondents in each case said it was the most important reason for adopting. Although the environmental benefits of adopting the nonrecycling technologies were cited as most important by a significant percentage of respondents, very few cited current or expected future regulatory pressure as a factor. As for the two recycling technologies, the plurality of respondents who adopted recycling the dehairing bath—and a near plurality of those who adopted chrome bath recycling—cited environmental benefits as the most important reason for adopting. Even so, very few of these adopters cited current or expected future regulatory pressure as a factor.

What reasons did nonadopters give for their choices? Here, reasons were strikingly consistent across the five technologies. The plurality of respondents in every case cited a lack of technical information as the most important reason for not adopting. Fixed costs were also often cited as a barrier to adoption.

6.3. Technical Assistance in Use of Clean Technologies

The majority of tanners in the survey sample had received some instruction in the use of each of the five clean technologies (Table 3). Almost three-quarters of the tanners had received instruction in the use of high exhaustion and enzymes. More than half had received instruction in the remaining technologies. In each case, more than 60% of the respondents received some type of formal instruction; whether the instruction coincided with adoption or preceded it is not known. Clearly, however, more tanners received instruction than actually adopted. Presumably, then, for many respondents, instruction preceded adoption.

[5] Adopters in the survey sample were asked to choose the one most important reason from a list of reasons, one of which was a catchall "Other." Like all of the multiple-choice questions in the survey, this one was constructed from feedback that tanners provided in focus groups and open-ended preliminary surveys.

Surprisingly, the most important sources of instruction were not public regulatory agencies but private-sector entities, namely, input providers, CICUR, and CIATEC. Input providers were the most important sources of instruction in the use of high exhaustion and enzymes, and CICUR was the most important source of instruction for the precipitation of chrome, recycling the dehairing bath, and recycling the chrome bath.

The principal findings from the survey are as follows:

- The vast majority of tanners in the sample were aware of the five clean tanning technologies but had learned about them only in the previous five years.
- Most of tanners in the sample learned about the technologies from private-sector sources, such as the tannery trade association, input suppliers, and other tanners.
- Rates of clean technology adoption by survey participants were significant (18–59%, depending on the technology) and highest for high exhaustion and enzymes.
- The majority of respondents in the sample who had adopted the nonrecycling technologies cited private nonenvironmental benefits—improving product quality or reducing variable costs—as the most important reasons. For the recycling technologies, environmental benefits were more important. However, neither current regulatory pressure nor expected future regulatory pressure appeared to be an important reason for adopting any of the technologies.
- The plurality of respondents in the sample who had not adopted cited lack of sufficient technical information as the key reason.

7. Conclusion

Although a rigorous statistical analysis of the determinants of the adoption of clean technologies by León’s tanneries is beyond the scope of this study, the summary statistics and historical information presented in Sections 3 and 6 paint a fairly compelling and coherent picture of the important factors at play. Clearly, formal regulatory pressure is not a key factor. As the historical overview in Section 3 makes clear, notwithstanding continuing official hullabaloo, real regulatory pressure has been quite weak, if not completely superficial. The survey results support this hypothesis. Very few of the respondents in the sample cited regulatory pressure—either current or expected—as the most important reason for adopting. Also, very few pointed to the public sector as having provided technical information.

The data presented here suggest that, rather than top-down public-sector pressure and technical assistance, the key factor driving the adoption of clean tanning technologies in León is the somewhat haphazard, bottom-up dissemination of information about the cost and quality benefits of the technologies. For three of the five technologies, including the two technologies with the highest adoption rates, the majority of adopters cited quality and cost advantages as the most important reasons for their decisions; for all five technologies, the plurality of nonadopters cited lack of technical information as the most important reason for their decisions. Furthermore, the survey results suggest that the technologies have been introduced in León only recently and have yet to be discovered by many tanners. Finally, the survey results clearly demonstrate that trade associations, input suppliers, and tanners—not public-sector institutions—have been primarily responsible for disseminating information about the technologies.

Hence, in many respects, clean technological change in León resembles productivity enhancing technological change worldwide: many firms adopt to improve quality or cut costs, and they do so after having been exposed to requisite technical and economic information by various private-sector contacts. From a policy perspective, this is welcome news. It implies that clean technological change can occur absent strong regulatory pressure or even significant public-sector assistance. As a result, it may be—as proponents argue—an effective means of ratcheting up environmental performance in developing countries with weak environmental regulatory institutions. Furthermore, the survey findings imply that an effective means of promoting clean technologies in developing countries is to disseminate technical information about clean technologies through the trade associations, input suppliers, and other private-sector institutions that are already helping to perform this function.

References

Blackman, A., and G. J. Bannister. 1998. Community Pressure and Clean Technology in the Informal Sector: An Econometric Analysis of the Adoption of Propane by Traditional Mexican Brickmakers. *Journal of Environmental Economics and Management* 35: 1–21.

Commission for Environmental Cooperation (CEC). 1995. *CEC Secretariat Report on the Death of Migratory Birds at the Silva Reservoir (1994–95).* Montreal, Quebec, Canada: CEC Secretariat. Available from www.cec.org.

Correo de Hoy. 2002. Permite Cabildo Uso de Suelo a Tenerías Instaladas en Colonia La Piscina, Guanajuato. December 5, 19.

Dinámica de la Curtiduría. Various years. León, Guanajuato, Mexico: Cámara de la Industria de Curtiduría del Estado de Guanajuato.

Eskeland, G., and E. Jimenez. 1992. Policy Instruments for Pollution Control in Developing Countries. *World Bank Research Observer* 7(2): 145–69.

Hernández, J. 1987. *Situación Actual del Problema de Contaminación en la Región Calzatecnia 9.* León, Guanajuato, Mexico: CIATEC.

Jaffe, A., R. Newell, and R. Stavins. 2003. Technological Change and the Environment. *Handbook of Environmental Economics,* edited by K.-G. Mäler and J.R. Vincent. Amsterdam: North-Holland/Elsevier Science.

Kerr, S., and R. Newell. 2003. Policy-Induced Technology Adoption: Evidence from the U.S. Lead Phasedown. *Journal of Industrial Economics* 51(3): 317–43.

Mansfield, E. 1968. *Industrial Research and Technological Innovation*. New York: W.W. Norton.

Millman, S., and R. Prince. 1989. Firm Incentives to Promote Technological Change in Pollution Control. *Journal of Environmental Economics and Management* 17: 247–65.

Thorstensen, T. 1997. Pollution Prevention and Control for Small Tanneries. *Journal of the American Leather Chemists Association* 92(10): 245–55.

UNEP (United Nations Environmental Programme). 1991. *Tanneries and the Environment: A Technical Guide*. Paris: UNEP.

———. 2002. Sustainable Consumption and Cleaner Production: Global Status 2002. Paris: UNEP.

Villalobos, J. L. 1999. Personal communication from J. L. Villalobos, subprocurador de verificación normativa, PROFEPA, Guanajuato, Mexico. January 27.

World Bank. 1992. *World Development Report: Development and the Environment*. New York: Oxford University Press.

———. 1998. *Pollution Prevention and Abatement Handbook.* Washington, DC: World Bank Group.

———. 1999. *Greening Industry: New Roles for Communities, Markets and Governments*. New York: Oxford University Press.

World Commission on Environment and Development. 1987. *Our Common Future*. New York: Oxford University Press.

Figures

Figure 1. Adoption of High Exhaustion by Year (*n* = 48)

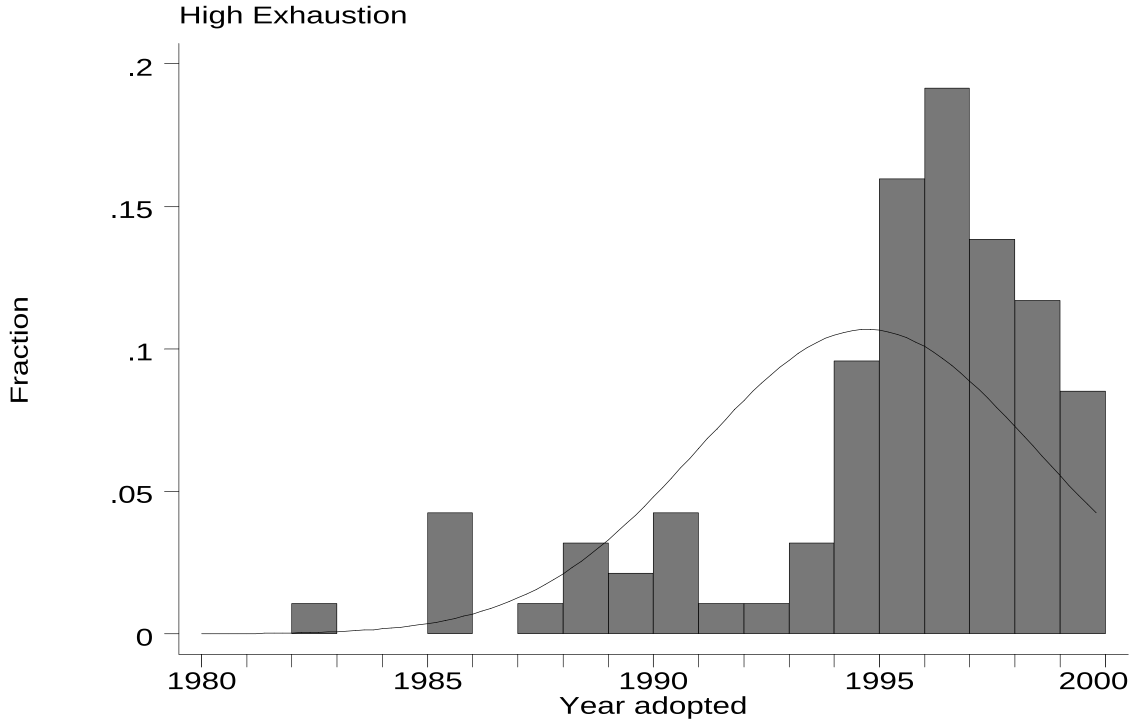


Figure 2. Adoption of Enzymes by Year (*n* = 48)

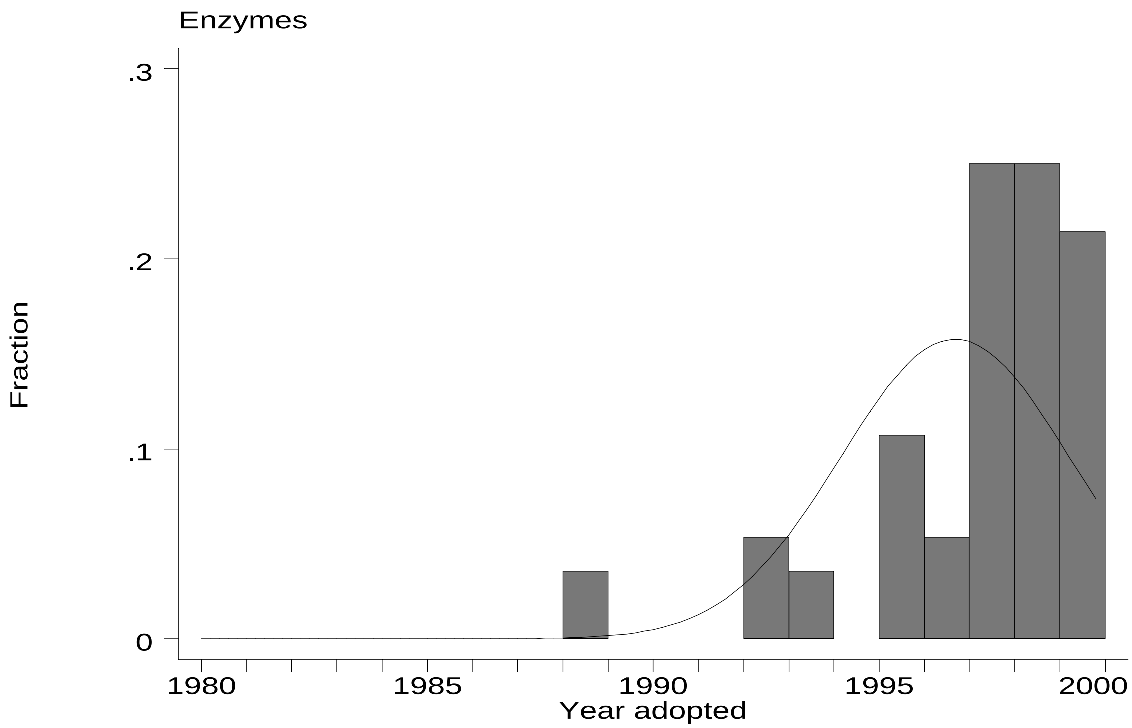


Figure 3. Adoption of Chrome Precipitation by Year (*n* = 28)

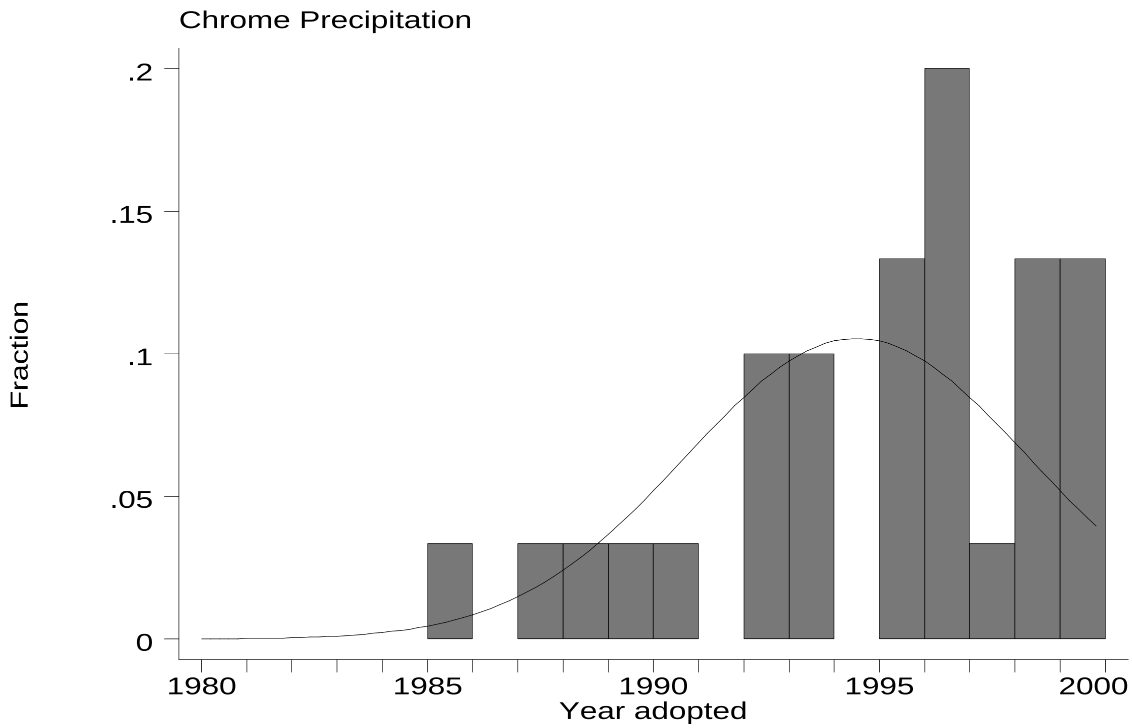


Figure 4. Adoption of Recycling of Dehairing Bath (*n* = 18)

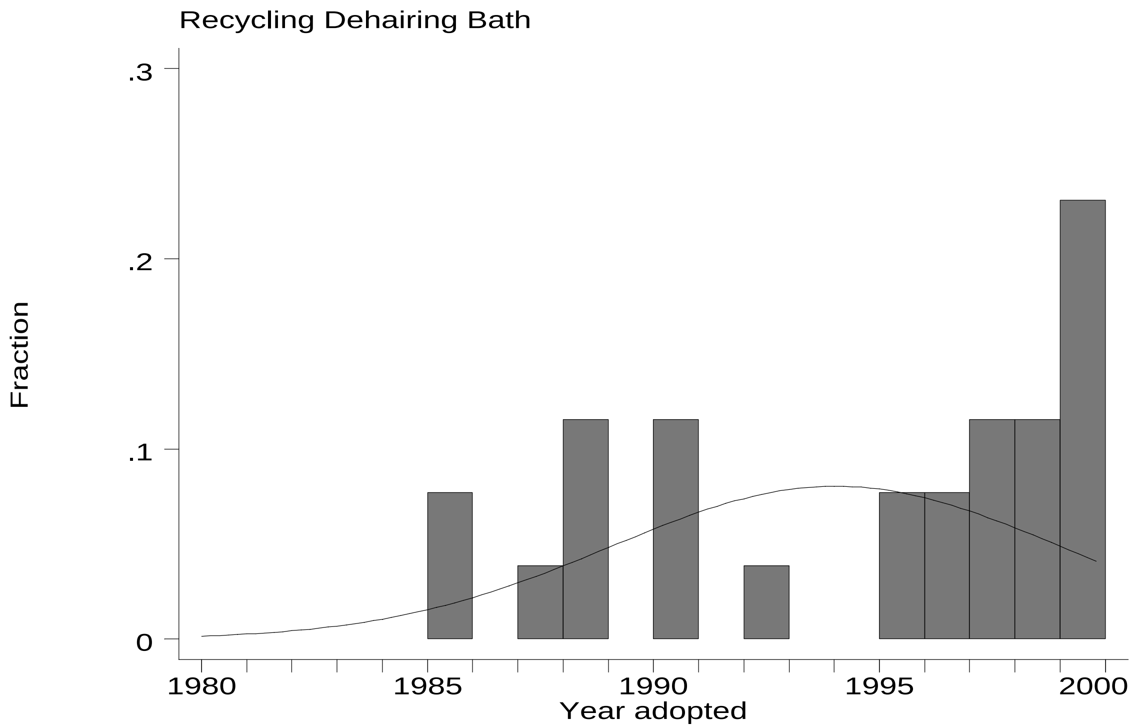
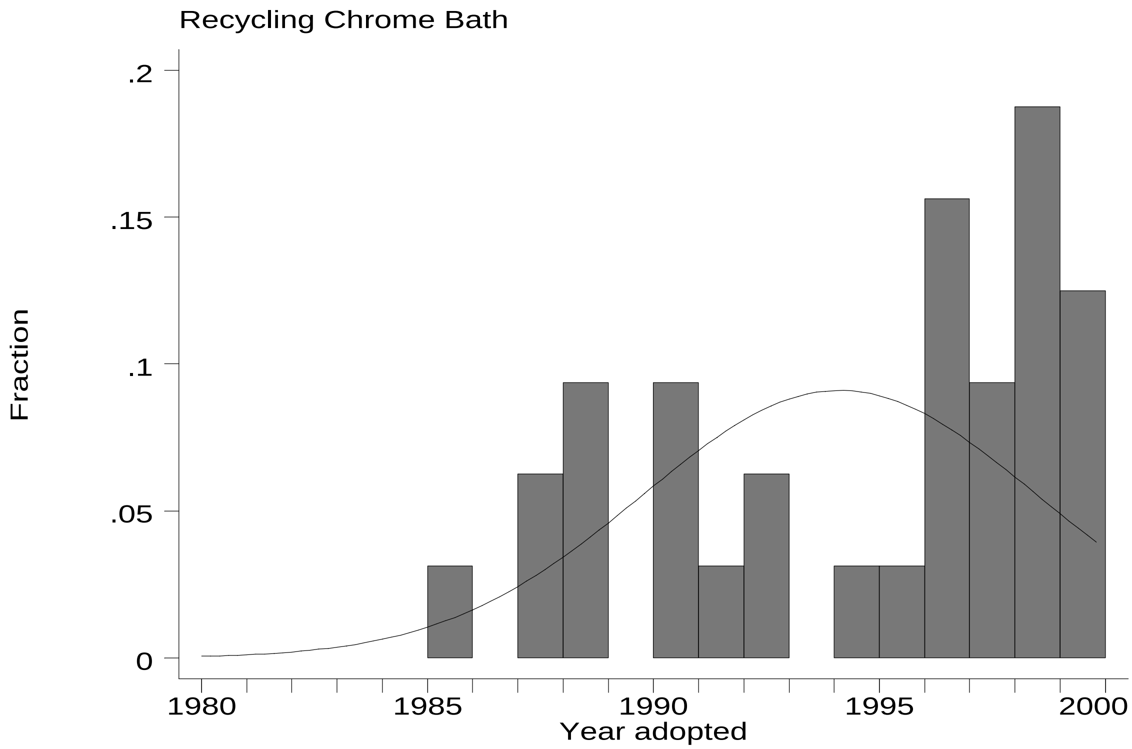


Figure 5. Adoption of Recycling of Chrome Bath (*n* = 20)



Tables

Table 1. Familiarity with Clean Technologies (*n*)

	High Exhaustion	Enzymes	Precip. Chrome	Recycle Dehairing	Recycle Chrome	Avg.
Heard of technology?	95	72	77	81	91	83
[% yes]	(137)	(137)	(137)	(137)	(137)	
Familiar tech. details?	3.73	3.54	3.32	3.43	3.37	3.48
[scale 1 = none to 5 = very]	(128)	(98)	(104)	(111)	(125)	
No. yrs. since first heard of tech.						
[% each category]						
This year/never	5	28	23	19	9	17
Less than five years	47	46	45	51	56	49
5–9 years	29	20	16	20	21	21
10–14 years	14	3	9	8	12	9
15–20 years	4	2	4	1	1	2
More than 20 years	1	0	1	1	1	1
	(137)	(137)	(137)	(137)	(137)	
Source of initial info. about						
[% each category]						
Tanner	15	9	16	19	23	16
Input supplier	21	46	14	8	9	20
CICUR	30	19	27	32	35	29
CIATEC	9	12	16	13	12	12
Other	23	13	24	27	22	22
Do not recall	2	0	2	2	0	1
	(130)	(98)	(104)	(111)	(124)	

Table 2. Adoption of Clean Technologies (*n*)

	High Exhaustion	Enzymes	Precip. Chrome	Recycle Dehairing	Recycle Chrome	Avg.
Adopted? [% yes]	59	35	20	18	20	30
	(137)	(137)	(137)	(137)	(137)	
Year adopted [average]	1995	1997	1995	1994	1995	1995
	(81)	(48)	(28)	(24)	(27)	
Reason adopted?						
[adopters only; % each category]						
Reduces variable costs	20	6	25	32	41	25
Improves product quality	31	71	36	4	7	30
Law requires it now	11	4	4	8	7	7
Law will require	0	2	0	0	7	2
Reduces pollution	36	15	32	44	37	33
Other	2	2	4	12	0	4
	(81)	(48)	(28)	(25)	(27)	
Reason have NOT adopted?						
[non-adopters only; % each category]						
Lack of technical information	49	44	46	41	37	43
Uncertainty	6	14	5	12	10	9
Fixed costs too high	23	12	21	25	24	21
Variable costs too high	4	2	5	1	4	3
Ruins quality	0	4	8	2	9	5
Other	17	24	14	19	15	18
	(47)	(50)	(76)	(85)	(97)	

Table 3. Technical Assistance in Using Clean Technologies (*n*)

	High Exhaustion	Enzymes	Precip. Chrome	Recycle Dehairing	Recycle Chrome	Avg.
Received instruction? [% yes]	72	74	59	54	56	63
	(130)	(98)	(105)	(111)	(125)	
Received instruction from:						
Another tanner? [% yes]	5	6	6	3	6	5
	(93)	(72)	(62)	(59)	(70)	
An input provider? [% yes]	30	51	18	17	13	26
	(93)	(72)	(62)	(59)	(70)	
SAPAL? [% yes]	3	0	2	3	1	2
	(93)	(72)	(62)	(59)	(70)	
Ecologia Municipal? [% yes]	2	0	0	0	0	0
	(93)	(72)	(62)	(59)	(70)	
CICUR? [% yes]	27	19	32	37	39	31
	(93)	(72)	(62)	(59)	(70)	
CIATEC? [% yes]	17	13	24	22	27	21
	(93)	(72)	(62)	(59)	(70)	
Other? [% yes]	24	18	24	31	23	24
	(93)	(72)	(62)	(59)	(70)	
Formal instruction? [% yes]	65	60	66	73	71	67
	(93)	(72)	(62)	(60)	(70)	