5-5-46

PN-AAP-876/62
ISN 34337

Best Available Document

The court threw out EPA's claim, finding that its quest for certainty and perfect information must give way to speed when Congress had expressly directed EPA to act to protect public health within a given deadline. Examples such as the arsenic case demonstrate how essential deadlines and federal court jurisdiction are in the regulation of toxic chemicals.

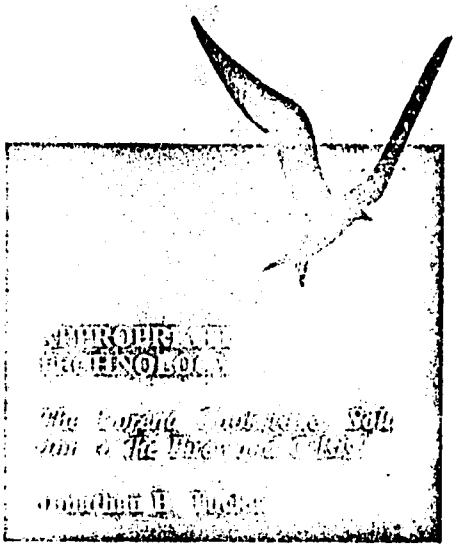
EPA's record since 1970 shows that, regardless of administration, the agency tends to become immobilized; statutory deadlines and federal court jurisdiction are critical to breaking up the bureaucratic logjams. Arguing that court orders often require extensions and amendments misses the point. The likelihood of any regulatory action occurring at all diminishes greatly without the enforced deadlines and court orders.

The relationship between statutory deadlines and court orders on the one hand and the emergence of regulation from EPA on the other is so strong that the three-part statutory scheme has become a measure of Congressional commitment. If Congress wants something to happen, then deadlines and court jurisdiction are included; if Congress wants to take credit for action but not really follow up, then the deadlines and court jurisdiction are left out. Thus, where Congress has intended action, the courts have become the monitors of EPA's processes, as shown in previous rulings on lead, PCBs, toxic chemicals, toxic discharges, and hazardous wastes, and as now seen in the ruling on arsenic.

ROSS SANDLER, a staff attorney with the New York Office of the Natural Resources Defense Council, is the editor of the *Overview-Law* column.

NOTE

1. New York v. Gorsuch, 81 Civ. 6678 (WWC) (S.D.N.Y. January 12, 1983).



The growing demand for energy in the form of wood in many developing countries poses a major threat to the fragile environment on which these nations must depend for their survival. In the arid Sahel region of Africa, just south of the Sahara, firewood currently provides 94 percent of rural energy needs. Because the consumption of firewood consistently exceeds supply, tree depletion is taking place at about twice the natural rate of new growth, causing erosion of the topsoil and progressive desertification.

It is common for women and children there to travel more than 30 miles to collect firewood. Some poor villagers have been forced to do without fuel, eating raw millet flour mixed with water instead of preparing the traditional pancake-like bread. Because the dough is not cooked, fewer nutrients can be absorbed. The villagers are also unable to boil their water and hence have become more vulnerable to debilitating waterborne diseases and parasites.

Unfortunately, there are no readily available substitutes for wood as an energy source for the rural sector. Although some villagers have switched from wood to cowdung cakes as cooking fuel, the use of dung is not economical given its low heat efficiency and the time and labor required to collect it. Burning dung is also ecologically unsound in that it reduces the fertility of the soil.

Other more exotic technologies, such as solar cookers and biogas plants, are currently too expensive for family use and are more likely to be employed in small-scale industrial processing rather than in individual homes.[1] It therefore seems likely that wood and other biomass fuels (such as millet stalks) will remain the primary source of energy for the rural poor in the Sahel for some time to come.

In order to bring wood production and consumption back into balance, there is an urgent need for reforestation programs and the establishment of village woodlots. Such programs will take years to come to fruition, however, so the only short-term hope for an amelioration of the crisis is to reduce the end-usage of wood. In Upper Volta, present fuel consumption is at the exorbitant rate of one kilogram of wood per individual per day, largely because of inefficient cooking methods.[2]

The traditional hearth in the Sahel consists of a triangular arrangement of three stones over an open fire. Due to the unprotected flame, only 5 to 10 percent of the potential energy contained in the firewood is used, with the remainder being lost to the surrounding air. Introducing efficient wood-burning stoves for domestic use might therefore have a significant impact on the rural energy crisis, provided that implementation is rapid and nearly universal in scope. Even a 10 to 20 percent reduction in the consumption of firewood could save millions of trees and slow the pace of deforestation significantly, providing time for natural growth to catch up with the cutting rate.

There are a number of other rationales for the introduction of efficient

cookstoves, particularly the health hazards associated with cooking over an open fire. Because the fire is at ground level, the cook or her young children may be repeatedly burned or scalded, and the smoke can cause chronic eye and lung irritation, leading to blindness, bronchitis, emphysema, and lung cancer. Flying sparks create a constant fire hazard, and the smoke blackens the cooking area and much of the house with soot.

Smokeless cookstoves could therefore have a major beneficial impact on public health. They would also reduce the time and effort devoted to gathering firewood, freeing up resources for investment in development-related activities. For example, women could allocate the time saved in search for wood to cottage industries that would increase the family's income.

The design for an efficient wood-burning cookstove originated in India in the early 1950s and was based on the traditional Indian stove, or *chula*. The Hyderabad chula, developed by the Hyderabad Engineering Research Laboratory, provided the inspiration for the more advanced Lorena stove, which was widely promoted in Guatemala, Honduras, and other Central American countries during the 1970s.

The Lorena stove is sophisticated in concept but easy and cheap to build, requiring only hand tools and locally available materials. It works by containing the heat of the fire and channelling it through a network of internal flues that concentrates the heat at the cooking holes.

Successful extension of an appropriate technology requires a profound understanding of a particular society's economic, political, and cultural characteristics.

The basic construction material is a mixture of sand and clay called *lorena*: a hybrid of the Spanish words for clay (*lodo*) and sand (*arena*). Because the Lorena stove is massive, it must be built on the spot where it will be used. Hence, there can be no central production or distribution of the stoves; each one must be made by hand by the owner or by local craftsmen.

To build the stove, a large block of lorena is first formed and shaped with hand tools while it is still wet. A horizontal tunnel is then carved through the block, and holes to fit cooking vessels are cut through the top. A firebox is constructed at one end of the tunnel, and a chimney installed at the opposite end to carry away the smoke and provide a draft. As the wood burns in the firebox, the hot gases and flames flow through the tunnel and under the pots before being drawn up the chimney.

With a sheet-metal chimney and dampers, the Lorena stove costs between $10 and $15 when owner-built and about $30 when built to order. The only major expense is for the sheet-metal chimney, and this could be reduced by finding cheaper substitutes. The stove itself can be made large or small, high or low, and can be modified to burn a variety of fuels, including woodchips, sawdust, and grain stalks.[3] According to Ken Darrow of Volunteers in Asia, "The Lorena stove is more a concept and a material than a particular stove design. Thus, widely varying cultural adaptations are possible."[4]

Although cookstoves have been developed that work extremely efficiently in the laboratory, the real test of an "appropriate" technology is for it to be transferred successfully to the village context and adopted by the local people as an integral part of their daily lives. In spite of the obvious utility of the Lorena stove, it has suffered numerous failures of acceptance. A recent study by the U.S. National Academy of Sciences came to the disheartening conclusion that in no area where efficient cookstoves have been introduced has there been a significant, long-term improvement in fuel savings. In many cases the stoves have been adopted initially for as long as a year or two, only to fall subsequently into disuse.

Why has this seemingly sensible effort failed so far to achieve its objectives? The biggest obstacle to the dissemination of efficient cookstoves is the financial investment required on the part of villagers. Although peasants are usually willing to invest in new technologies if the perceived payoff is good and the risks are low—for instance, in buying a bicycle—the benefits of efficient cookstoves are not as obvious.

Moreover, women are the primary beneficiaries of the technology (since it is they who must cook and collect firewood), yet it is the men who have the final say in the decision to buy. As women have very low incomes from small businesses and crafts and are therefore unable to pay for the stoves themselves, they require the financial assistance of the husband or a male relative. Women's time is not highly valued, however, and it is only when the search for wood becomes so time-consuming that they are kept from performing other domestic tasks that men perceive wood-conserving cookstoves as an attractive investment.

For families that live in towns and must buy wood, the economic rationale is more compelling. Anthropologist Jacqueline Ki-Zerbo has estimated that a family purchasing 3,000 francs worth of wood each month will recoup their 5,000 franc ($14) investment in an efficient cookstove within four to five months. Still, the amount of wood saved is not immediately obvious and only becomes apparent over a period of time. Thus, there must be motives other than purely economic ones—such as aesthetic, health, or status considerations—to justify adoption of the stove.

In addition, there may be problems related to construction and maintenance. Cookstove design is fairly critical, so that if the firebox is built too high, the stove may burn more rather than less wood. The users may also fail to clean out the flue, with the result that it gets clogged with soot or pieces of food, reducing the draft and causing smoke to leak out the front of the stove. Finally, the villagers may become disenchanted when the appearance of the stove worsens with continued use, particularly if aesthetics or status considerations were primary motives for adoption. Small cracks often appear in the surface of the stove after several months. Although they have no effect on function, the users may conclude that the stove has broken and stop using it.

Cultural factors have created additional obstacles to the adoption of cookstove technology. As Nicholas Jéquier has pointed out, introducing new cooking methods is a difficult task because it impinges on "spheres of human activity that are inherently very stable and that tend to be greatly influenced by traditions, ethical norms, religion, and taboos. . . ."[5] Western stove designers often overlook the fact that the traditional fireplace, in addition to providing heat for cooking, serves a complex of functions within its setting. If these extended or latent functions are not met by the cookstove or pro-

vided by alternate means, the technology is not likely to be accepted permanently.

What are the benefits of an open hearth that are foregone by the adoption of an efficient cookstove? A few examples are as follows:

- The first drawback of cookstoves is their lack of flexibility. Unlike the open fire, the cookstove has holes of fixed size that limit the number and variety of pots. Although the reduced fuel requirement of cookstoves saves time and effort expended in the search for firewood, the wood must be cut into much smaller pieces in order to fit them into the firebox.

Moreover, the three-stone hearth is portable, whereas the massive Lorena stove is fixed in one place inside the house and cannot be moved. This drawback is particularly acute in areas such as northern India, where cooking outdoors is favored during certain times of year. As a result, although Lorena stoves have been widely adopted in southern India, where women take pride in their kitchens and do all their cooking indoors, the stoves have not been successful in the north.[6]

- Many villagers believe that food cooked over an open fire tastes better than that cooked on a smokeless stove. Whether the difference is real or imagined is not clear, but taste is more important than many outsiders believe. In Upper Volta, for example, villagers attempt to boil water in clay pots—a nearly impossible task—because they do not like the taste of water boiled in more efficient aluminum pots. As a result, they often fail to bring the water to a full boil, and hence are more likely to develop waterborne diseases.

- Although cooking smoke has adverse effects on health, it does serve a number of useful functions. In many countries villagers depend on smoky fires to keep their thatch roofs dry and insect-free, to drive away mosquitos, to protect the beams of the house from termites, or to preserve ears of corn and other stored foods from destruction by pests. If smokeless cookstoves are to be adopted in such areas, it may be necessary to introduce at the same time low-cost methods for the preservation of wood and thatch, mosquito netting, etc.

- Unlike the Lorena stove, which is designed expressly to contain the heat of the fire rather than radiate it, the open hearth emits both heat and light. In temperate zones, the fire may be valued as much for space heating as for cooking, and in villages without electricity or kerosene lamps, it may be the only source of light in the home at night.

The traditional hearth may also serve as a festive center for social interactions, such as gatherings of the extended family. Where Lorena stoves have been adopted, these latent functions of the cooking fire have frequently led to "utilization flaws." In modifying the technology to more closely meet their needs, the villagers may render it less efficient, thereby negating its major intended benefits—namely fuel conservation and smoke elimination.

Peasants in Guatemala cook directly over the flame in the firebox of the stove rather than using the pot holes for the slow, simultaneous cooking of different dishes. Instead, the pot holes are merely employed to keep cooked food warm—a highly inefficient use of the technology.[7] In Botswana, where the traditional hearth serves as a social center, villagers open the front of the firebox to provide heat and light, and therefore do not conserve wood.

In sum, the latent functions of the traditional cooking fire must be taken into account if more efficient cooking technology is to be successfully disseminated. The current design of the Lorena stove should therefore be modified to approximate the same complex of benefits that is offered by the open hearth: heat, light, and community, as well as a cooking flame.

Additionally, the basic cookstove design should have enough inherent flexibility to allow for modifications by local craftsmen without significantly impairing its operational efficiency. Guatemalan Lorena stoves, examined after a year of use, were found to incorporate a number of ingenious modifications, sometimes added by the builder but more often by the user. These improvements included an external damper system, a sloping flue, a concrete bridge to prevent cracking, and a surface coating of clay-cement mix for improved appearance and durability.[8] Such modifications should be tested and publicized so that they can become widely available.

Because of variation in local needs and cooking practices, the design of fuel-efficient cookstoves must be adapted to the specific circumstances prevailing in each region. In this process, user participation in the design and installation of the stoves gives much better results than a more "top-down" approach. For example, the height of the stove can be adjusted to meet local needs and customs. Women in some cultures like to squat while cooking, whereas others prefer to stand.

A key factor in the success or failure of a new technology is the way it is promoted. Because the population of the Sahel is diverse, a range of stove models and promotion techniques will be required to achieve maximum possible diffusion. The promoters will also have to take political factors into account, such as the need to secure the approval of local elites and the possible existence of interest groups that oppose the innovation. One source of opposition to the fuel-efficient stoves may come from local entrepreneurs who sell wood at high prices and who may profit from the fuel shortage.[9]

It will also be necessary to train large numbers of extension agents to bring the technology to the people. According to Ki-Zerbo, villagers may entertain unrealistic fears about cookstoves, such as the belief that the stoves will erupt in flames if incorrectly used. Extension agents should therefore be available to demonstrate the stoves, educate the villagers about their workings, and provide clear instructions concerning installation, use, and maintenance.

Because there is a shortage of skilled manpower in Africa, additional extension agents will have to be trained if cookstove extension is to become self-sustaining after the handful of foreign consultants leave. A major failing of current training programs is that, for cultural reasons, women are rarely involved in extension work and almost never participate in the actual construction of Lorena stoves in the home. Since acceptance of the technology may depend on the extent to which the users (all of them women) feel involved in the decision-making process, it is essential to train more female extension agents.

A second problem is that cookstoves are an "invisible" technology, hidden away in the privacy of a family's kitchen, making it difficult to promote the stoves through demonstration. One solution would be to provide model cookstoves for the preparation of fancy foods in the village markets. Finally, a near-complete diffusion of cookstoves throughout the rural population will be required if the technology is to have a significant impact on the fuelwood crisis.

In Upper Volta alone, the German Forestry Mission has estimated that to achieve a sustainable rate of firewood consumption, the country would have to build 250,000 cookstoves per year, or a total of one million new stoves over four years. This daunting figure suggests that it is unwise to rely on efficient cookstoves alone as a solution to the fuelwood crisis. Instead, cookstove extension should be integrated with other intensive programs designed to increase wood supply, reduce consumption, and meet basic human needs.

One way to reduce fuelwood consumption would be to establish food-processing

(continued on page 44)

in fiscal year 1982 was $78 million. The budget for fiscal year 1983, which began in October 1982, is not definite, but will likely be between $45 million and $50 million, according to Dick Munson of the Solar Lobby, private communication, November 8, 1982.

29. These points are made in private by both industry and government researchers, though many will not openly criticize the Reagan approach for fear of losing government contracts or their jobs. An additional problem plaguing the U.S. R&D program today is uncertainty. Recent budget appropriations by Congress have been made after a fiscal year begins, so researchers do not know how much their programs will have to be cut, even as those programs proceed. This has caused chaos for some program managers and has led to a general decline in morale among researchers. For further industry views on the effects of budget reductions, see U.S. Congress, General Accounting Office, **Industry Views on the Ability of the U.S. Photovoltaics Industry to Compete in Foreign Markets** (Washington, D.C.: September 1981).

30. The differences between the various national R&D programs are described in Robert R. Ferber, note 8 above.

31. Science Applications, Inc., note 6 above; U.S. Congress, General Accounting Office, note 29 above.

OVERVIEW/Appropriate Technology

(continued from page 5)

industries at the village level that would render food grains softer and easier to cook. Solar stoves might be used to steam newly harvested rice or millet, removing the oils so that the grains last longer and are easier to hull. It might even be possible to process rice and millet into a form of "minute rice" or "instant hot cereal" that does not require much fuel to prepare.[10]

Experience with the Lorena stove has shown that there are major constraints on the dissemination of "appropriate" technology in developing countries. Proponents of small-scale technology, having experienced numerous failures of acceptance, are now moving from a total preoccupation with technical hardware to a new concern with the "software" necessary for the diffusion of technical innovation. In addition to managerial skills and promotion techniques, successful extension requires a profound understanding of a particular society's economic, political, and cultural characteristics, to which the technology in question must be adapted. Unfortunately, what is technically possible will be limited by what is culturally acceptable.

JONATHAN B. TUCKER has recently returned from working in Somalia with CARE, Inc. He is a freelance writer currently living in Boston and specializes in science, technology, and Third World development issues. Prior to his work with CARE, he served on the *Scientific American* board of editors.

ACKNOWLEDGMENT

The author would like to thank the Science and Technology Division of the World Bank and AT International for the use of their research libraries.

NOTES

1. Jacqueline Ki-Zerbo and Guido de Lepeleire, "L'Amelioration des Foyers pour l'Utilization Domestique du Bois de Feu: Ses Possibilités et son Impact au Sahel," CILSS et Club du Sahel, May 1979, p. 8.

2. Volunteers in Technical Assistance, **Wood Conserving Cook Stoves: A Design Guide** (Mt. Ranier, Md.: VITA, Inc., 1980), p. 2.

3. Jayanti Banerjee, **Cooking With Firewood—The Burning Issue** (New Delhi: Institute of Social Studies Trust, February 1981), p. 5.

4. Ken Darrow, "Foreward," in Ianto Evans, **Lorena Owner-Built Stoves** (Stanford, Calif.: Volunteers in Asia, January 1979), p. 5.

5. Nicolas Jéquier, "Appropriate technology needs political 'push'," **World Health Forum**, Vol. 2, No. 4, 1981, p. 542.

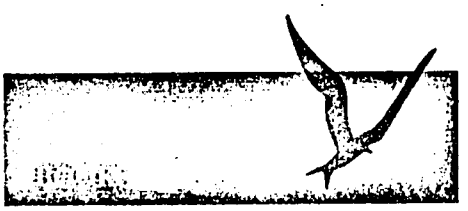
6. Banerjee, note 3 above, p. 8.

7. Dale V. Shaller, "A Sociocultural Assessment of the Lorena Stove and its Diffusion in Highland Guatemala," in Ianto Evans, **Lorena Owner-Built Stoves**, note 4 above, p. 84.

8. Aprovecho Institute, **Cookstove News**, Vol. 1, No. 3, November 1981, pp. 4-5.

9. Helen Gould and Stephen Joseph, "Designing Stoves for Third World Countries," Intermediate Technology Development Group, London (mimeograph), p. 11.

10. Interview with Marilyn Hoskins, Department of Anthropology, Virginia Polytechnic Institute, Blacksburg, Va.



WATER: THE NATURE, USES, AND FUTURE OF OUR MOST PRECIOUS AND ABUSED RESOURSE

Fred Powledge

Farrar Straus Giroux, New York, 1982; 423 pp.; $14.95

Fred Powledge's *Water* rolls and tumbles, rages and swirls, rampages and toils like a prairie river during spring thaw. A reader who wades through the book's turbulent style is rewarded with one of the most comprehensive pictures now available of this nation's water situation.

It is common now to compare the coming water crisis to the calamity of the energy crisis in the early 1970s. We have heard often that the future water shortages will make the past energy shortages seem like a vacation. Powledge says that, too. He also goes past the rhetoric to present overwhelming evidence of those coming water problems. Much of the evidence is the reality of present-day water problems—shortages, pollution, and flooding—and the indications that government and industry are not effectively dealing with the problems. Americans are consuming and polluting their water supplies with reckless disregard.

Powledge writes: "A lot of the cliches by which the nation grew, and which were used to excuse some really relentless and destructive exploitation, must now be abandoned: the idea of TVA [Tennessee Valley Authority] as the savior of a region; of the Corps of Engineers as the objective instrument of progress; of the inherent *goodness* involved in making the desert bloom; of the essential *rightness* in the damming up of a river; of the unquestionable *purity* of water that falls from the sky or that comes out of a well" [emphasis in original].

The benefits of Powledge's book are twofold. First, it pulls together comprehensive information about water in America. It describes the overdraft of aquifers on the nation's High Plains between the Missouri River and the Rocky Mountains and in western Oklahoma and Texas. There, the irrigators are pumping the water from the ground faster than nature can replace it.

And the book also explains the tragic pollution of ground water in New Jersey, New York, and other heavily industrialized areas of the country. "It would be foolhardy to think that all the problems are being caused by a handful of irresponsible corporations," writes Powledge. "One of the more unfortunate truths of our recent history is that the president of Hooker Chemical [the company that dumped most of the toxic chemicals found in Love Canal] was correct when he said that his firm's procedures in dealing with toxic wastes were in keeping with the 'state of the art.' "

Moreover, Powledge's book details the strain on the West's water from the booming population growth of recent years in the Southwest. It deals with acid rain. And it examines the institutional failures within our government and industry in dealing with the problem of water supply and quality.

The second reason Powledge's book is important is because it takes the message of our nation's water problems to the people. It is written for a general audience. It is dramatic; it is alarming. Perhaps it will become a handbook for those who resolve to demand that their government and industries protect this nation's water.

"The failure of government is at the bottom of the crisis in water," counsels Powledge, "but it cannot continue in its careless, irresponsible role much longer, for the simple reason that we can't play