RAFI COMMUNIQUE
RURAL ADVANCEMENT FOUNDATION INTERNATIONAL

March, 1993

Endod: A Case Study of the Use of African Indigenous Knowledge to Address Global Health and Environmental Problems

This issue of *RAFI Communique* takes a look at the transfer of a Third World technology to address a First World problem: the potential use of a traditional African plant, Endod, to control the infestation of zebra mussels in North American waters. The story of Endod offers a fascinating case study in the application (and obstacles) to the use of a Third World technology to address global health and environmental problems.

The U.S.-based University of Toledo has applied for a patent on the use of Endod to control zebra mussels, but royalties will not go to the plant's original "proprietors"--the Ethiopian people who have selected and cultivated Endod for centuries. Nonetheless, if demand is created for Endod in the industrialized world, will Ethiopian people benefit from their botanical treasure?

Endod (*Phytolacca dodecandra*), commonly known as the African soapberry plant, is a perennial that has been selected and cultivated for centuries in many parts of Africa, where its berries are used as a laundry soap and shampoo. Endod is synonymous with "soap" in many African countries. People of the Ethiopian highlands, for instance, use Endod berries to launder their traditional *shamas*, the glistening white shawls characteristic of the region. The fish-killing property of Endod is also well known and, traditionally, people in rural communities use Endod as an intoxicant to collect edible fish.

Endod to Control Schistosomiasis

In 1964, while conducting field work in his native Ethiopia, biologist Aklilu Lemma observed that downstream from where people were washing clothes with the soapberry plant, dead snails were found floating in the water. After several years of intense research, Dr. Lemma discovered that the sun-dried and crushed Endod berries were lethal to all major species of snails--but not harmful to animals or humans, and completely biodegradable.

For Africa, where one of the most serious tropical diseases, schistosomiasis, is transmitted by freshwater snails, the discovery of a low-cost and biodegradable snail-killing agent (molluscicide) represents a major breakthrough. According to the World Health Organization (WHO), schistosomiasis, a debilitating and eventually fatal disease, is endemic in 76 countries in tropical Africa, Asia and Latin America. Only malaria causes more sickness and debility in the developing world. Over 600 million people are at risk of infection and another 200 million infected. Some 200,000 deaths per year are due to schistosomiasis.

Although chemical molluscicides are available to eliminate the parasite-carrying snails that transmit schistosomiasis, the cost is prohibitive. A chemical molluscicide called *Bayluscide*, manufactured by the Bayer Co. of Germany, sells for US $25,000-30,000 per ton. Despite the fact that this expensive

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chemical compound is out-of-reach for many developing nations, it is the only molluscicide currently recommended by the World Health Organization for global use.

Over the past 29 years Dr. Lemma's goal has been to develop Endod as a safe, low-cost alternative to expensive chemical molluscicides. Early field trials in one Ethiopian village showed remarkable success. Using locally-collected Endod to kill target snails, transmission of schistosomiasis was reduced from 63% to 33% in the overall population. Among children, the infection rate fell from 50% to 7%. In addition to effectively controlling disease-carrying snails, Dr. Lemma views Endod as a traditional African plant that can be developed as a capacity-building technology by and for African communities. In the words of Dr. Lemma:

"Through the development and use of simple, appropriate agronomic techniques and extraction and application procedures, people could easily grow, process locally and use Endod products to control schistosomiasis on a community self-help basis."

With suppport from international donors, Endod has been the subject of agrobotanical and extraction studies in Ethiopia, Zambia, Swaziland and Zimbabwe. These countries have undertaken research on large-scale cultivation of Endod, processing and distribution of the plant extract for the dual purposes of producing a locally-available molluscicide, and as a detergent for village-level use. In Ethiopia, with support from the Netherlands government, over 500 varieties of Ethiopian soapberry plants were collected under the direction of Dr. Legesse Wolde-Yohannes of the Addis Ababa University. Sixty-five varieties of Endod were cultivated, and 3 selected for their exceptionally high molluscicidal potency and high berry yields. One variety, E-44, was identified as the most promising candidate for molluscicidal properties, and has since been cultivated on an experimental basis. With support from the International Development Research Centre (IDRC) of Canada, extensive toxicity studies of Endod have also been undertaken.

Unfortunately, Dr. Lemma's 29-year quest to see Endod widely used in Africa has been repeatedly stalled by international regulatory obstacles. Despite rigorous toxicological studies performed by Lemma over the course of two decades, the World Health Organization disregarded Lemma's research (and the traditional wisdom of people who have used Endod for centuries), insisting that the scientific analysis conducted in Ethiopia be repeated under standardized "Good Laboratory Practices" by internationally-recognized institutions. Reflecting on lessons learned from his long struggle to overcome obstacles to widespread acceptance of Endod, Dr Lemma observes:

"We have learned the hard way that the root problems of scientific research in Africa are not only the lack of adequate facilities and funds, but also the biases and reservations of some individuals and organizations in industrialized countries who find it difficult to accept that any good science can come from our part of the world... Also, except for occasional lip service, little credit is given to the wisdom of traditional societies in their ability to select, over long periods of time, such natural products as Endod for their continued and demonstrably safe use."

Much needed and well-deserved support came to Dr. Lemma in 1989 when he and his colleague, Dr. Legesse Wolde-Yohannes, were recipients of the Right Livelihood Award. The "alternative Nobel prize" was awarded them for discovering a natural molluscicide and devising a community-based method of employing it against the snails that carry the schistosomiasis parasite. At long last, WHO plans large-scale field tests of Endod in Africa later in 1993. If successful, Endod may someday become widely available for the dual purposes of

providing a molluscicide to control the spread of schistosomiasis, and as a detergent for village-level use.

Endod to Control Zebra Mussels--A New Use for a Traditional African Plant

In addition to the use of Endod to control the spread of a tropical disease afflicting millions of people in the Third World, the traditional African soapberry plant promises to become one of the most effective means of preventing zebra mussels from clogging water intake pipes in North American waters. In other words, a Third World technology comes to the rescue of industrialized nations. Ironically, the need to de-clog mussel-infested water pipes may seem petty in comparison to the value of controlling schistosomiasis, but the economic incentives for controlling zebra mussels are enormous.

The black and white striped zebra mussel (*Dreissena polymorpha*) is native to western Russia near the Caspian Sea. Zebra mussels were accidentally introduced into the Great Lakes in 1985, and have rapidly spread throughout the region. The zebra mussels are disrupting municipal water facilities because they restrict water flow by attaching themselves to pipes and other hard surfaces. In addition, they are a serious threat to fisheries because the mussels cover rocks in spawning areas, and remove algae (a source of nutrients) from the water. Municipal water plants and ship owners already spend millions to rid their pipes of zebra mussels. The U.S. Fish and Wildlife Service estimated in 1990 that the zebra mussel would create a $2 billion loss to fisheries by the end of the decade. Nobody knows for sure how much damage the zebra mussels will cause, but the potential damage is far greater now that the mussels have spread into inland waterways.

The discovery that Endod is lethal to the zebra mussel came about when Dr. Aklilu Lemma visited the United States in June, 1990 to receive an honorary degree from the University of Toledo. Lemma and his U.S. colleague, biologist Harold Lee, raised the question in casual conversation, and then tested it in the laboratory. The result: Endod is lethal to adult zebra mussels after 4-8 hours of exposure, and is biodegradable within 24 hours. Safety of Endod has been evaluated by a consortium of laboratories in Canada, the Netherlands, Denmark, Ethiopia and in the USA.

Patent Pending

In October, 1990, just a few months after Lee and Lemma first exposed zebra mussels to the Endod powder in the laboratory, the University of Toledo applied for a U.S. patent on the use of Endod to control zebra mussels. If a commercial product is developed in the future, the University of Toledo will share 50% of the royalties with the "inventors", Drs. Harold Lee and Peter Fraleigh of the University of Toledo, and Dr. Aklilu Lemma, who is presently working with the United Nations Children's Fund (UNICEF) in Uganda. According to Dr. Lee, several companies have expressed interest in developing a commercial Endod product to control zebra mussels, but he would not reveal their identities because negotiations are still in early stages.

The application for a U.S. patent on Endod raises many questions about the true "ownership" of Endod and the "discovery" of this traditional African plant as a control for zebra mussels. This legal claim ignores centuries of indigenous knowledge of Ethiopian people who have cultivated and selected Endod for centuries, using it not only as a detergent and shampoo, but as a fish intoxicant. If an Endod-based molluscicide is commercialized, the University of Toledo and three scientists stand to benefit from royalties, but there is no guarantee that the plant's true proprietors, the Ethiopian people, will be justly rewarded.

What Benefit for Ethiopia?

If Endod is commercially developed as a molluscicide to control zebra mussels, there would be immediate demand for large quantities of Endod berries. For example, scientists at the University of Toledo estimate that treating a 100 million-gallon water treatment system at 5 parts per million for 8 hours would require about 170,000 gallons of crude Endod extract. Rather than using Endod in open waters, specialized reactor systems containing the Endod extract would be placed at the entrance to water intake pipes.

According to Dr. Harold Lee of the University of Toledo, it is possible, but not economically feasible to produce small quantities of the mussel-killing Endod toxin in the laboratory using a technique known as "biosynthesis." However, laboratory biosynthesis of Endod is far too expensive, and tremendous quantities of the product will be needed for commercial use. Lee says that researchers in the U.S. have made an "informal agreement" to buy raw materials of Endod directly from Ethiopian sources.

Ideally, a new and substantial export market could be created in Ethiopia for Endod as a raw material or processed product. The most potent variety of Endod, the Ethiopian variety E-44, has already been cultivated on a large-scale by Ethiopian researchers, yielding approximately 1.5 metric tons per hectare of the berries. Under optimum conditions there can be two harvests of berries annually. The outcome remains to be seen. Hopefully, Endod will become a positive example of a sustainable technology for both First World problems and Third World development.

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New and Controversial Developments in Intellectual Property

Agracetus Inc. (Middleton, Wisconsin, USA), a subsidiary of W.R. Grace and Co., has received a broad-based patent covering all genetically-engineered cotton products. The unusually broad scope of coverage is unprecedented in plant biotechnology and "may be an indication of how major corporations can use biotech patents to get proprietary control of huge segments of agriculture" (*AgBiotechnology News, December 1992).* Because it was first to develop transgenic cotton, Agracetus claims rights to any and all transgenic cotton, regardless of which engineering technique is used. All transgenic cotton products will have to be licensed through Agracetus before they can enter the marketplace.

Another broad-based patent was recently granted to Plant Genetic Systems (PGS) of Belgium. The U.S. Patent covers many plants and seeds genetically engineered with *Bacillus thuringiensis* (Bt) genes. According to PGS, it was the first to demonstrate that Bt genes could be engineered into plants and, accordingly, any company that genetically engineers Bt into most plant crops will need to negotiate a licensing agreement with PGS (*AgBiotechnology News, February 1993*).