Small-scale agricultural changes may help eradicate widespread disease

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Small changes in agricultural and sanitation practices may eliminate the spread of a disease that affects some 200 million people living in developing nations around the world.

Researchers working in remote farming villages in western China report that providing medicine to infected people and animals, along with modifying irrigation and waste treatment practices could reduce, or even eliminate, the long-term transmission of schistosomiasis.

Schistosomiasis is a disease that can affect the liver, the gastrointestinal tract or the bladder. The researchers report their findings in a recent issue of the Proceedings of the National Academy of Sciences.

Right now, governments in many countries where the disease is prevalent provide medicine to afflicted people, as well as a pesticide that kills the snails that carry a larval stage of the parasitic worm, Schistosoma – the cause of schistosomiasis. Farmers either spray the pesticide, or apply it as a paste-like mixture, on the soil where snails dwell.

“But this dual approach only temporarily reduces infection rates in many areas,” said Song Liang, the study's lead author and an assistant professor of environmental health sciences at Ohio State University.

“We know agricultural and irrigation practices play a large role in the transmission of schistosomiasis,” he said. “Altering these practices, in addition to providing the medicine and pesticide, may be the best way to

drastically reduce, or even eliminate, the spread of the disease."

The practices Liang refers to include building concrete walls to line irrigation ditches, which would radically change snail habitat, as well as using a device that kills most of the Schistosoma eggs in human and animal waste – the primary fertilizer in these areas.

Schistosomiasis is caused primarily by three major species of Schistosoma, parasitic worms that lay eggs in the bowels of humans and animals. The disease kills about 20,000 people each year, mainly from cirrhosis of the liver or from bladder cancer. In tropical and subtropical regions, the number of people infected with schistosomiasis is second only to malaria, the most common infectious disease in the developing world.

Liang conducted the work with a number of public health experts, including senior author Robert Spear, a professor of public health at the University of California, Berkeley. Liang, Spear and their colleagues used mathematical models to forecast disease transmission through 2010 in three Chinese farming villages in Sichuan, a province in western China.

Data collected several years ago by another team of researchers shows that schistosomiasis returned in each of these villages despite nine years of intense use of praziquantel, an anti-schistosomiasis drug for animals and humans, along with the toxic agent niclosamide, a pesticide that kills snails that harbor the disease-causing parasite.

From 1987 through 1995, the Chinese government sponsored an intensive praziquantel and niclosamide campaign aimed at drastically reducing disease transmission. The average infection rate for the three villages dropped from 63 percent in 1987 to 8 percent in 1995. But funding for the campaign ended in 1995. And despite continued,

although less intensive, control efforts by village governments, infection rates in the three villages ranged from 44 and 69 percent by 2000.

Liang and his colleagues used data gathered from these villages between 2000 and 2004. They surveyed each village for infection intensity at the end of 2002 and 2004 (each village had undergone intensive, government-sponsored medicine and pesticide efforts again in 2002 and 2003.) They used this information to run a number of different scenarios involving different levels of drug and pesticide interventions and environmental interventions.

Irrigation ditches are prime snail habitat in this region. Pouring concrete along the mud walls of the ditches is one strategy for eliminating snails. But doing so is expensive – about $28,000 for the average irrigation ditch, Liang estimates – so instead of lining irrigation ditches with concrete, researchers used intensive niclosamide treatments as a way to simulate the effectiveness of concrete walls.

The pesticide ultimately reduced snail populations in irrigation ditches by 85 to 95 percent, numbers Liang would expect to see if concrete walls were in place in the ditches.

Aside from intensive niclosamide treatments, some of the homes in each village were equipped with household biogas digesters, a specially constructed container that holds human and animal waste while bacteria digest it. The bacteria give off methane, which villagers use as a fuel for cooking. The digestion process also destroys eggs of Schistosoma, leaving a family with a more sanitary fertilizer to use on their crops (the farmers in these villages typically use raw animal and human waste to fertilize their crops.) In this study, the use of biogas digesters resulted in a 99 percent decrease in the concentration of Schistosoma eggs.

Liang said that it costs about $200 to install a biogas digester in a home.

There are about 40 homes in each village, so it would roughly cost $8,000 to install digesters in every home.

“It is reasonable to think that each home should have a digester and that irrigation ditches can be lined with concrete,” Liang said. “But the cost for comprehensive intervention efforts is apparently too much for villagers to afford, and the Chinese government also thinks it is too much to invest in a short period of time for all affected villages.

“But in 10 or 15 years, the use of niclosamide in a village would cost nearly as much as lining a ditch with concrete,” Liang continued, adding that a year's worth of niclosamide treatments cost around $1,900.

Both medicine and pesticide treatments and sustained environmental controls are needed in order to eradicate, or at least significantly decrease, schistosomiasis transmission in the near future, Liang said.

Under scenarios that don't include environmental changes, schistosomiasis transmission either remained the same or increased by 2010.

“Environmental change is absolutely necessary to stop transmission in some areas where schistosomiasis is common,” Liang said. “Our findings underscore the importance of comprehensive controls to fight this disease.”

Source: Ohio State University

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