The Canadian Forestry Service is studying the acid rain phenomenon at three main field locations, chosen to reflect the areas of greatest concern in our most productive tracts of forest. One is north of Sault Ste. Marie, Ontario, the second in Laurentide Park, Quebec, and the third in Kejimkujik National Park in Nova Scotia. At these sites, meteorological stations of the Atmospheric Environment Service measure the characteristics of every rain or snow fall. Scientists follow changes in the precipitation from the time it hits the canopy of the trees, to its path through the branches and down the trunk to the soil. Then they study it through the various organic and inorganic soil horizons until it reaches a lake, at which point the aquatic people take over. Explains Rennie: "We want a good average picture of what sulphates and nitrates are being deposited, where they go in the system, how they leave, and what effects they have on other dynamic processes."

These field surveys of chemical element budgets are supplemented by indoor laboratory studies, which indicate that a pH of 3.5 to 4 can distort the growth of seedlings. The natural processes can be speeded up in these indoor experiments to allow a more rapid analysis of what is happening in the soils. In turn, predictions can be made of what changes can be expected under natural conditions.

"Acid rain's potential destructive impact on the forest is largely confined to Eastern Canada," says Peter Rennie. "One of our concerns in the toxic effects of heavy metal uptake, but we're looking at all aspects of acid deposition. In Canada we raise between 300 and 400 million seedlings every year, and we wouldn't want anything to affect the viability of that production."

Effects on Croplands

"Forests growing on essentially unmanaged lands are more sensitive to problems associated with acidic precipitation than crops grown on managed land," explains Dr. Sam Linzon of the Phytotoxicology Section of Ontario's Ministry of the Environment. "We are not aware that anyone has documented conclusively any visible effects on crops grown in fields exposed to ambient acid rain. Part of the reason is that, in addition to cultivating, watering, and fertilizing soil, farmers also add lime to it where necessary to bring it to the appropriate pH. They are already managing soil acidity."

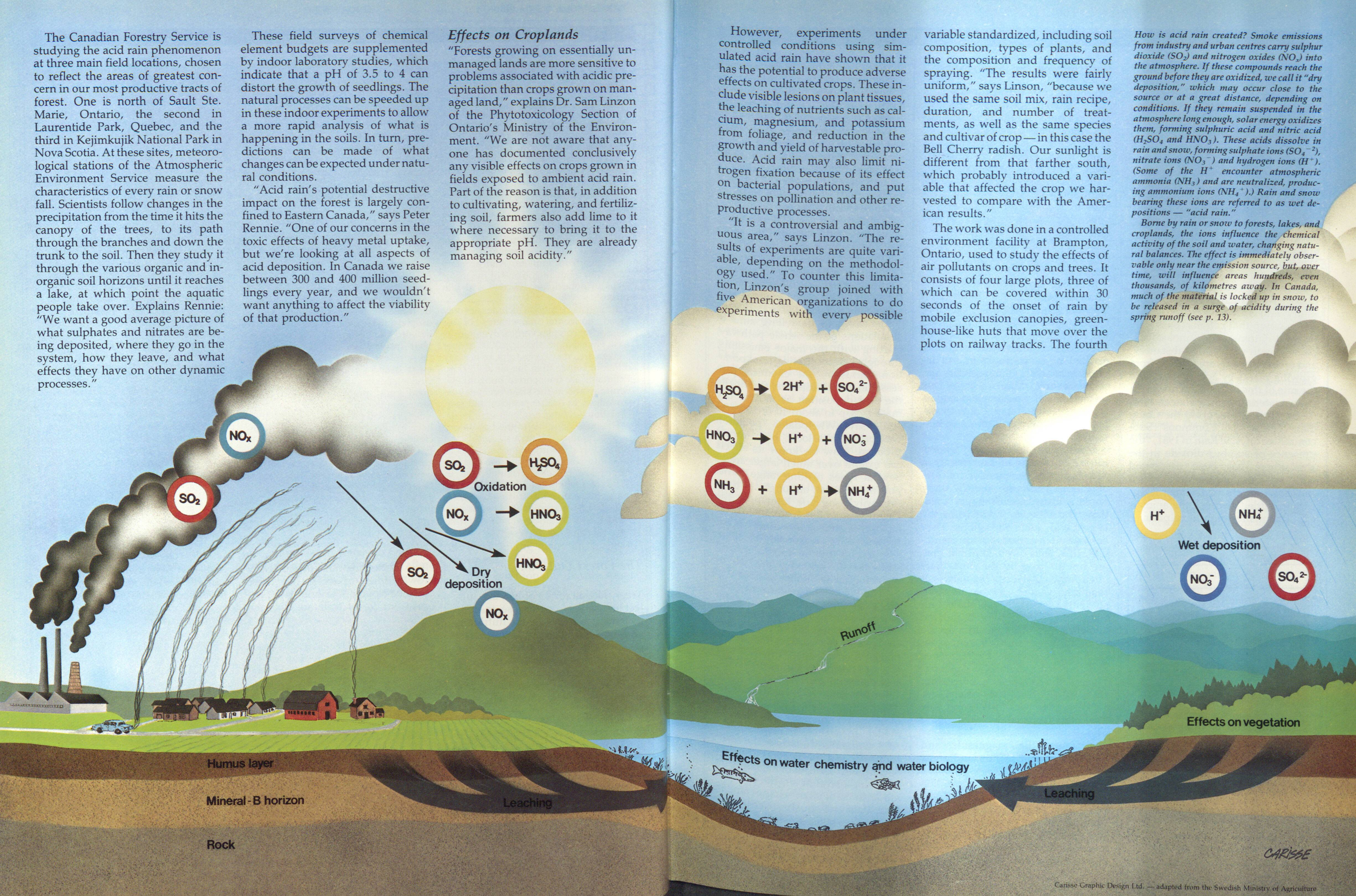
However, experiments under controlled conditions using simulated acid rain have shown that it has the potential to produce adverse effects on cultivated crops. These include visible lesions on plant tissues, the leaching of nutrients such as calcium, magnesium, and potassium from foliage, and reduction in the growth and yield of harvestable produce. Acid rain may also limit nitrogen fixation because of its effect on bacterial populations, and put stresses on pollination and other reproductive processes.

"It is a controversial and ambiguous area," says Linzon. "The results of experiments are quite variable, depending on the methodology used." To counter this limitation, Linzon's group joined with five American organizations to do experiments with every possible variable standardized, including soil composition, types of plants, and the composition and frequency of spraying. "The results were fairly uniform," says Linson, "because we used the same soil mix, rain recipe, duration, and number of treatments, as well as the same species and cultivar of crop — in this case the Bell Cherry radish. Our sunlight is different from that farther south, which probably introduced a variable that affected the crop we harvested to compare with the American results."

The work was done in a controlled environment facility at Brampton, Ontario, used to study the effects of air pollutants on crops and trees. It consists of four large plots, three of which can be covered within 30 seconds of the onset of rain by mobile exclusion canopies, greenhouse-like huts that move over the plots on railway tracks. The fourth

How is acid rain created? Smoke emissions from industry and urban centres carry sulphur dioxide (SO_2) and nitrogen oxides (NO_x) into the atmosphere. If these compounds reach the ground before they are oxidized, we call it "dry deposition," which may occur close to the source or at a great distance, depending on conditions. If they remain suspended in the atmosphere long enough, solar energy oxidizes them, forming sulphuric acid and nitric acid (H_2SO_4 and HNO_3). These acids dissolve in rain and snow, forming sulphate ions (SO_4^{-2}), nitrate ions (NO_3^-) and hydrogen ions (H^+). (Some of the H^+ encounter atmospheric ammonia (NH_3) and are neutralized, producing ammonium ions (NH_4^+).) Rain and snow bearing these ions are referred to as wet depositions — "acid rain."

Borne by rain or snow to forests, lakes, and croplands, the ions influence the chemical activity of the soil and water, changing natural balances. The effect is immediately observable only near the emission source, but, over time, will influence areas hundreds, even thousands, of kilometres away. In Canada, much of the material is locked up in snow, to be released in a surge of acidity during the spring runoff *(see p. 13).*



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