company has just established a subsidiary, TDK Akita Research Institute, which will eventually be spun off from the parent company as an independent all-female research center, hiring women chemists, physicists, and engineers. Nissan motor company is also proving fast off the blocks: Half of this year's scientific recruits were women, a staggering fraction in Japan.

Sea change. *Nagami Kishi says companies are busy restructuring.*

The STA cannot afford big pay raises but is trying to lure more women into its research institutes by providing new types of fringe benefits. Says Hirano, "We must offer such things as flexi-time and the opportunity to join management based on productivity, not on being a male and having seniority, as in the present system."

Target number two is older people. Sony is taking a similar approach to TDK's all-female research institute with a subsidiary that is hiring only people between 55 and 65. So far, 71 engineers who would normally have retired have been recruited from other companies. According to Kishi, they earn around 5 million yen ($40,000) a year, but "they are very happy to be working...even though they were making much more money before." One key attraction: Sony guarantees that everyone can work to 65 or 70 instead of the usual retirement age of 55.

It's no surprise that companies like Sony, renowned for their innovative capacity, are trying new ways to attract scientific expertise. More unexpected, however, is that—after decades of complaints—major changes now seem on the way in the government-run universities and research institutes.

Last week, in the latest of a series of government reports, the influential Science and Technology Council—which is chaired by the prime minister and sets overall science policy—called for the government to double its investment in R&D as early as possible, raise pay for scientists, increase the numbers of research students, and give more jobs in research institutes to women.

The report comes on top of an announcement last month that the STA has hammered out a new law that it believes will soon end criticism of Japan's research system as closed and inflexible. "It is designed to facilitate full-scale communication among universities, private organizations, and other countries," says Youchi Itoh of STA. One key change would allow foreign companies participating in government-funded research to own patents jointly with the government, which is currently impossible.

In spite of all these changes, however, it's clear that foreign researchers—mostly from Asia—will continue to be Japan's hidden resource. Foreign graduate students are pouring into Japan and the government wants more: The target is to (almost) triple the numbers enrolled in graduate courses to 100,000 by the year 2000. There will then be far more foreigners than Japanese in engineering courses.

The prestigious University of Tokyo has even begun offering graduate civil engineering courses in English to boost applications from top-class foreigners who don't have time to learn Japanese. Hajime Okamura, a senior member of the civil engineering faculty, says that many other universities are now imitating the course. And, he says, about half the foreign students decide to stay and work in Japanese industry.

That's no surprise, given that there are plenty of jobs and good promotion prospects. Geng Yang, an electrical engineer from mainland China, will finish his doctorate at Sophia University this April. "Extremely easy," is how he evaluates the prospects of getting a job in Japan. B. Deveraj, a biophysicist from India, left Tohoku University 2 years ago and already has a responsible post on a large MITI-sponsored research project. "I'm doing fine," Deveraj says. "If I was in the United States or India I could not be in such a position at 31."

For many Japanese companies, there is no time to wait for foreigners to come to them. Instead, they are following the boom in setting up—or buying—overseas research R&D facilities. That is getting the Japanese government a little worried. A recent Ministry of Education report cautions that hiring scientists abroad could be seen as an attempt to corner the worldwide market in research. The result, it says, could be further political problems between Japan and the United States. But if the next century's trade war is over brain power, not microchip power, everyone will know exactly who to blame: the bright young scientists who went into the stock market and by then will be running Japan. ■ FREDERICK S. MYERS

Frederick S. Myers is a science writer based in Tokyo.

Sequencing Venture Sparks Alarm

The latest tussle in the international genome project went public last week when word got out in the British press that U.S. businessman Frederick Bourke is attempting to hire two of the leading lights of the project—John Sulston of the Medical Research Council (MRC) in Cambridge, England, and Robert Waterston of Washington University in St. Louis—to start a private DNA sequencing company. Sulston and Waterston head what is in many ways the flagship project of the Genome Project: an ambitious effort, funded jointly by the National Institutes of Health (NIH) and the MRC, to sequence the genome of the nematode *Caenorhabditis elegans*.

Officials at the MRC are crying foul, accusing Bourke and Leroy Hood of the University of Washington, his close adviser, of trying to "poach" Sulston and skim the cream off a project that has been funded with public money for 20 years. Nobel laureate Aaron Klug, who directs the MRC's Laboratory for Molecular Biology in Cambridge, likens it to a hostile takeover. Dai Rees, secretary of the MRC in London, denounces it as a "flagrant bid to create an IBM of human genetics."

James Watson, who directs the genome effort at NIH, is said to be equally incensed but could not be reached for comment. He was in England over the weekend meeting with Rees, Klug, and Sulston in an effort to halt the defection. He and others worry not just about the loss of Sulston and Waterston but about the effect if such a major component of the public Genome Project goes private. They raise the specter of Bourke buying up the rewards of the Genome Project and secreting away data that should be in the public domain.

Bourke, who met with Watson for several hours recently, dismisses the complaints as "ridiculous" and casts himself as a "revolutionary" battling a "reactionary response." To him, the real reason for the backlash is that "people's egos are dented. They are concerned about credit." His goal is simple, he says: "I want to move the science forward just as Jim Watson does. Here is a vehicle to make the Genome Project move faster. It is good for everyone."

Several leading genome scientists agree, at least in principle. "It has been understood from the beginning of the [Genome] Project that a lot of the analysis of genomes would be done in private companies," which could do the job both faster and cheaper, says Maynard Olson of Washington University, who serves on the committee that advises Watson.

"This is what we all hoped would happen," agrees Francis Collins, who directs an

NIH-funded genome center at the University of Michigan. But, he adds, "the timing took everyone by surprise. We all thought it was 3 or 4 years away." Without question, Collins adds, Bourke's scheme would not have caused such outrage if he hadn't gone after Sulston and Waterston and their worm project. At a time when the Genome Project is under closer scrutiny, "theirs is the project everyone brings up when we are asked if we are making progress."

Sulston and Waterston seem bemused by all the fuss, though they do understand British sensitivities about a brain drain. They point out that they haven't agreed to anything; indeed, they have yet to receive a written offer from Bourke. But they are tempted by the possibility of a substantial infusion of up front capital that would enable them to finish the nematode sequence several years earlier, perhaps by 1997 instead of 2000. Their non-negotiable demand—which Bourke has already agreed to—is that all of their work remain in the public domain.

What's in it for Bourke? A role in what he thinks is the next industrial revolution, one spawned of the information that will be derived from the DNA sequences of humans and other organisms. If he can snare Sulston and Waterston and several others as well, he intends to invest $50 million in building what is being billed as the "largest DNA sequencing engine in the world" in Seattle, close to the new department of Hood, Bourke's adviser.

In the short term, at least, Bourke envisions a contract service company that would sequence large chunks of DNA for the government, universities, and pharmaceutical companies, serving, in a sense, as the Martin Marietta of the Genome Project. Where Sulston and Waterston come in is in building the capability to sequence 100 million bases or more a year, which is their goal for the nematode project. If they can pull it off, that sequencing ability can then be turned loose on more lucrative projects, such as developing new diagnostics and therapeutics.

As for the proprietary concerns the critics raise, Bourke insists he has no interest in patenting the sequence data or in keeping them secret, though the company will get a first look at anything interesting its scientists turn up. All sequencing done for the government would be publicly available, though projects undertaken with pharmaceutical companies would remain confidential.

Bourke says he will decide within the next 2 or 3 months whether or not to launch the company. "I won't do it unless I can hire the best people in the world," he says. As he continues his quest for the best and the brightest sequencers, he seems certain to ruffle yet more feathers. ■ LESLIE ROBERTS

Third World: S(ave) O(ur) S(heep)!

To city slickers, a moo is a moo is a moo: We recognize little diversity among breeds of livestock like cows and sheep. But a new initiative by the United Nations Food and Agriculture Organization (FAO) highlights the varied nature of these species, especially in developing countries, and warns that we may be courting trouble by allowing valuable indigenous livestock breeds to go extinct. "Breeds in developing countries are coming under fire. They're at risk," says David Notter, an animal geneticist at Virginia Polytechnic Institute.

Indigenous breeds are being pushed toward extinction because native farmers, in the interests of greater productivity, have in many cases adopted specially bred Western animals like the American Holstein or European Friesian cow. And, as a result, some of the valuable genetic characteristics of the native breeds are vanishing as the newcomers replace them.

The attraction for Third World farmers is that Western breeds have been improved through selection methods to be better producers of milk, eggs, and meat. But, because they are accustomed to constant grain, antibiotics, and temperate climate, modern breeds like the Holstein sometimes cannot handle the more rigorous life in poorer developing countries. "Many of these high-tech animals are not very successful, but it takes a few seasons to learn this," explains Don Bixby, executive director of the American Minor Breeds Conservancy. By then, however, the stock of native breeds can degrade considerably.


UNFAO

Eye-openers. *These African N'Dama cattle will be targeted by FAO conservation efforts—because they are resistant to sleeping sickness.*

To combat this trend, the FAO now proposes a $15 million, 5-year plan to preserve the genetic diversity of breeds in Africa, Asia, and South America. Included in the proposal are a world inventory of native livestock breeds, conservation banks of frozen semen and embryos from selected threatened animals, and assistance in the breeding of native animals to improve productivity—so farmers won't be so tempted to replace them with imports.

Advocates of the program say the point isn't merely to conserve indigenous species but to make their genetic heritage available for improving livestock. "Livestock improvement and livestock conservation are part of the same package. And livestock improvement is a must for us," says Notter. For example, a better pig may develop from the Taihu breed in China, a strain that has drawn attention because of its remarkable fecundity—it can produce twice as many piglets per litter as Western breeds. The short, fat pig has little else going for it, but the genes that control fecundity could be invaluable in cross-breeds.

FAO's first action has been to start compiling an inventory of all native livestock breeds and strains. An expert consultation scheduled for Rome this April will evaluate the rest of FAO's proposal and discuss how to fund the effort. In addition to committing $3 million from its own budget, the FAO will receive $1 million from Japan and hopes other developed countries will contribute money.

A topic that may prove controversial in Rome is what breeds should be added to the semen and embryo banks. The choices are limited by funding constraints, and one group of scientists believes the banks should focus only on strains that contain known valuable genetic material like that for disease-resistance or high fertility. A second faction suggests that since researchers have little idea what characteristics may be important in the future, anything unique should be saved.

In addition to storing genes, the FAO will try to conserve and improve existing populations of endangered breeds like the N'Dama cattle of Africa and the Murrah buffalo of Asia. With the help of modern breeding practices, the native livestock may one day match the production of Western breeds. Lastly, the FAO hopes to establish a legal framework that addresses issues like global trade in animals and their germ plasm. All these measures, advocates of the program hope, will help save the indigenous heritage of livestock—keeping the right moo in the pasture. ■ JOHN TRAVIS