Famine Early Warning Closer to Reality

Chronic lag in response to food emergencies in Africa spurs use of remote sensing to improve reaction time

It is the rainy season now in the semi-arid areas south of the Sahara, the make-or-break time for food crops in a region where famine is a perennial threat and periodic reality. This year, the wary watch on agriculture there includes the most systematic effort to date to use remote-sensing data to monitor crop development.

More is at stake than with ordinary attempts at crop forecasting. Time and again, organizations providing food relief in Africa have swung into action too late to forestall food emergencies. This slow reaction costs lives and drastically increases the expense of relief efforts.

The recent disasters in Sudan and Ethiopia have spurred international organizations, including the U.S. Agency for International Development (USAID), to try to improve systems to give early warning of food emergencies. In recent years, these agencies have turned to remote-sensing data to cut reaction time. But while useful (see box, p. 1146), the application of remote sensing has proved to be no technological deus ex machina.

If predicting famine were a straightforward matter of detecting drought, satellite imagery might well solve the early warning problem. But the causes of famine are more complex. People in the dry zone of Africa have learned to prepare for the bad years with a strategy that starts with the storage of food and seed so that a single crop failure or even several poor years will not bring famine. Anticipating famine, therefore, requires a knowledge of economic, political, and social factors in a mix that varies from country to country.

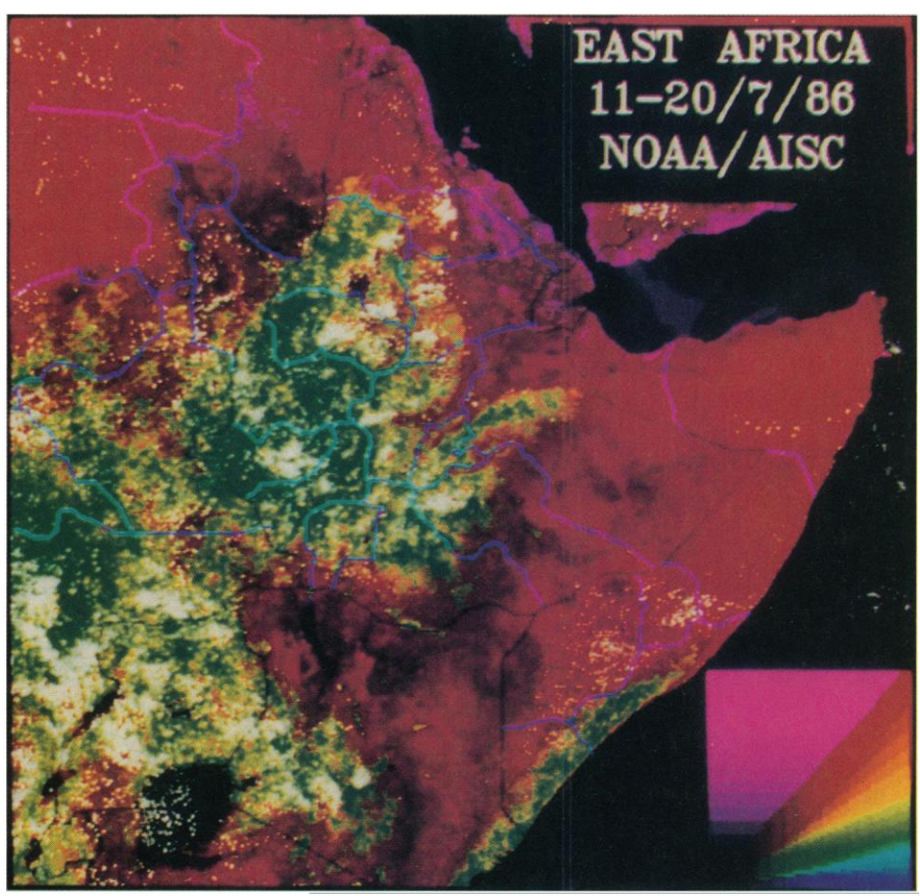
This year, with its new Famine Early Warning System (FEWS), USAID is attempting to create a program that takes these complexities into account. The aim is to provide timely information that can be used by agency planners and African government officials responsible for meeting food emergencies.

With the rainy season more than halfway along in most countries in the dry zone, FEWS analyses indicate that general conditions so far are similar to those of 1985, when rainfall was at about the average for the past 30 years. That means a good year compared with 1984, which ranked among the driest in the dry cycle that began in the Sahel region in 1968. A main concern at this point is an attack of grasshoppers and locusts affecting areas from Senegal, The Gambia, and Mauritania in West Africa to Sudan and Ethiopia in the east. (Efforts to assess and combat the insect threat will be the subject of a future article.) In Sudan, the civil war in the south of the country is causing serious disruption of farming and food distribution. The fact that man not nature is causing the problem poses special difficulties for relief organizers.

FEWS provides information in the form of monthly reports throughout the agricultural season that runs roughly from June to October. What is unique about FEWS, says William H. Trayfors, who oversees the program for USAID in Washington, is the effort to collect and integrate physical and human data. The reports are put together from three elements: satellite data analyzed in Washington, along with crop assessments and social data collected in Africa.

Where FEWS differs from most early warning programs is in having a representative on the ground in each country. Their main responsibility is to collect and evaluate population, health, and nutrition data, but they serve as conduits for a wide range of information and provide technical assistance to host country officials. The FEWS program started by covering five countries with persistent food supply problems—Sudan, Mauritania, Mali, Niger, and Chad. Now Burkina Faso and Mozambique have been added.

The program's major mission is to try to shorten response time in serious food emer-



This satellite photo of East Africa showing part of Sudan, Ethiopia, and Somalia, was produced for a USAID/NOAA climate impact assessment program. Using NOAA satellite data and rainfall readings, the program is in its second year of producing monthly reports on the impact of weather on agriculture for 11 sub-Saharan countries. The reports include maps based on satellite imagery and using a color coordinate system developed for the program. The maps are intended to be readily assimilable by government decision-makers without training in remote sensing. Bright red, for example, denotes sand, light green healthy food crops.

gencies. Adequate lead time is essential because mounting a big relief operation normally requires time-consuming preliminaries of persuading donor governments to earmark money and marshal food supplies. The food is then shipped to ports that often are crowded and inefficient.

Distribution of relief supplies to remote areas in Africa is difficult. Railroads are often not equal to the task. As for reliance on truck transport, roads in remote areas tend to be poor or nonexistent, and in many countries, trucks are too few to handle the quantities of supplies required or are immobilized by lack of fuel or spare parts. The time of greatest need comes at the beginning of the agricultural cycle when local food stocks are exhausted and the rains can make movement in the countryside impossible.

In Sudan the late-reaction scenario was replayed in classic fashion last year. The country had endured 3 years of drought from 1982 through 1984, and in rural areas resources were exhausted. Private voluntary organizations, a prime source of information from the field, reported impending difficulties but the information was fragmentary. In the event, it was necessary to mount a major airlift of food last summer and the face of famine was seen again on the evening news. Last September, a FEWS pilot report called attention to an area in western Sudan where poor weather and the presence of refugees from Chad portended food shortages. This caused the prepositioning of relief food to avert a possible crisis.

The ideal is an accurate warning of trouble in the autumn rather than 4 or 5 months later when a crash program is required. The budget of FEWS is $3 million a year, a sum AID officials say might easily be surpassed in paying for one emergency airlift.

The signs are there if they can be recognized. As stress occurs, behavior changes, says Trayfors. In bad times, there are shifts in food-consumption patterns. In southern Burkina Faso, for example, red sorghum is grown as a cash crop and not highly esteemed by rural people as food, but when food is short it is eaten by the family. The migration of males from rural areas picks up as they seek work in order to send money back home to buy food. People begin to sell personal possessions and jewelry. Sale of animals is another sign. In the case of nomads, it is one of real distress. As matters worsen, people begin to consume famine foods—roots, berries, and grasses. In the later stages mass movement occurs to urban areas and refugee camps.

The FEWS staff is working to develop a methodology that will include indicators denoting stages in the process leading to famine. While FEWS now employs what one USAID official called the "vacuum cleaner" approach to make use of whatever information is available, the aim, increasingly, is to handle data quantitatively. One promising avenue is the analysis of market

Satellite of Choice

The advent of the National Aeronautics and Space Administration (NASA) Landsat earth resources satellite series in the early 1970's and advances in computer processing of satellite data opened the way to broad applications of remote-sensing technology to benefit developing countries.

In Africa, Landsat data have been used with substantial success, for example, in mapping and resource and land-use surveys. For famine early warning systems, however, the U.S. National Oceanic and Atmospheric Administration (NOAA) polar orbiting weather satellite with its Advanced Very High Resolution Radiometer (AVHRR) aboard has become the satellite of choice.

The NOAA satellites offer much lower resolution than Landsat—a 1-kilometer or 4-kilometer square compared to 30 meters or 80 meters for Landsat—but they provide flyovers twice a day in comparison with a pass every 16 days for Landsat. Since dust or cloud cover may obscure the ground at any time, the odds are obviously better for the weather satellite.

Not only is NOAA data acquired twice daily but it is relatively inexpensive. Landsat's higher resolution permits much finer discrimination of features on the ground. The U.S. Agency for International Development's Famine Early Warning System (FEWS) program, for example, used Landsat's terrestrial mapping capacity to identify small clusters of huts in Sudan to check on population movements. But the volume of data produced by Landsat imposes a much heavier burden of interpretation than the NOAA satellites and costs much more for coverage of a given area.

Both systems enable analysts to track vegetation development satisfactorily. Unfortunately, both are less impressive at providing information for crop forecasting, particularly for accurate predictions of crop yields.

C. J. Tucker, a researcher at NASA's Goddard Space Flight Center, who has used NOAA imagery to study vegetation trends in the Sahel transition zone, says, "If you're interested in getting an estimate of plant growth and development, you can do fairly well to very well. But all systems are oriented toward total herbage. They don't pretend to know how it's subdivided. The crop yield portion is very speculative."

Basic characteristics of African agriculture contribute to the problem. Food production depends mainly on subsistence farming. The dominant rain-fed agriculture is typically carried on in small scattered fields. Intercropping—growing two or more crops on the same plot—is common, as is planting crops under trees. Such practices make crop estimates by remote sensing difficult. Interpreters of remote-sensing data, therefore, find it even more necessary in African conditions than elsewhere to verify their analyses with physical observations on terra firma—ground truth, as it is known in the trade.

For remote sensing in agriculture, the main issue is whether the correlation between the development of natural vegetation and of cultivated vegetation is close enough to provide a basis for reliable estimates of crop production. Tests conducted in the Sudan and elsewhere in Africa have produced mixed results.

Prospects for improving this performance are also mixed. Decisions about which remote-sensing sources to rely on for famine early warning systems have been determined by the cost and capacities of the technology available. The remote-sensing technology used by military and intelligence agencies is known to be superior to that now available in the civil sector. And computer hardware and software coming into use should permit rapid advances in analysis in early warning programs. But trends in the global economics of remote sensing have taken an unfavorable turn for those with limited funds. Use of remote sensing in African projects has been subsidized in one way or another.

Now Landsat is the property of EOSAT, a private company which expects to sell Landsat data at an economic price. And France's new high-resolution resources satellite, SPOT, and a Japanese satellite, scheduled to be put up this year, will provide competition to the American satellites. But with the rise of a market economy in remote-sensing data, those working with remote-sensing data in Africa fear that in the future they could be priced out of that market. ■ **J.W.**

prices for cereals and animals. The FEWS advisers have microcomputers, permitting them to store and analyze data and transmit it electronically to Washington. An objective of the program is to combine historical information with current data to create a database that will provide a firm foundation for agricultural reporting in general.

FEWS is trying to find its way to being an operational program at a time when the use of remote sensing faces a number of major policy and funding questions at USAID. FEWS has been financed by AID's office of foreign disaster assistance. But that funding runs out at the end of the year. The program has earned support in the agency's Africa bureau and won backers on Capitol Hill. However, the activity faces the universal jeopardy imposed by the Gramm-Rudman deficit reduction drive and survival is by no means assured.

In surveying the options, the agency is negotiating a contract with the National Academy of Sciences to evaluate National Oceanic and Atmospheric Administration satellite technology in comparison with other available technologies. Underlying the initiative is said to be a growing interest in the upper echelons of USAID management in the broad question of what the role of remote sensing in development should be.

That issue is the subject of a conference in West Berlin this month. The meeting grew out of the Vienna economic summit meeting of Western countries and includes representatives of developing nations as well. Enthusiasm for remote sensing on the part of African countries remains high, but the use of remote-sensing data in Africa has gone haltingly, particularly attempts to help African countries to take over responsibility for applications of remote sensing.

The reasons are multiple. Stiff costs, competition between proponents of rival technologies, a scarcity of technical manpower trained in remote sensing in the less-developed countries, and suspicions by African nations that information will be appropriated by hostile neighbors or by rich nations for economic or other purposes, all figure in.

Except in South Africa, there is still no ground-receiving station for satellite data in sub-Saharan Africa. African countries continue to depend on European and American sources for the products of remote-sensing technology. And the famine early warning systems established by the United States, international agencies, and European countries are operated essentially by and for the aid agencies. A major challenge for the donors is to find ways to make the transfer of technology that will break this pattern of dependence. ■ JOHN WALSH

Briefing:

Test of Tobacco Containing Bacterial Gene Approved

Rohm and Haas Co., a Philadelphia-based conglomerate, has obtained federal approval to conduct the first open-air field test of a genetically engineered plant containing a pesticide. The experiment involves a tobacco plant that has had a gene from an organism, *Bacillus thuringiensis*, added to its genetic structure. The gene triggers production of a protein that is toxic to a broad spectrum of caterpillars that feed on plant leaves.

The U.S. Department of Agriculture Animal and Plant Health Inspection Service, which notified the company on 26 August, okayed the experiment barely 2 months after the proposal was submitted to the agency for review. Ronald Meeusen, manager of Rohm and Haas' agriculture research program, observes that there are three decades of toxicology data on *Bacillus thuringiensis*. The bacterium has been used as an insecticide since the early 1900's and is not toxic to mammals, birds, and most insects, he adds.

Lunchtime. *A moth larva feasts on tobacco.*

In recent years, however, its use has been abandoned by commercial farmers because synthetic pesticides were more effective and less costly to use. It has remained the insecticide of choice for combating gypsy moth infestations in urban areas because of its low toxicity.

The incorporation of the *Bacillus* gene into the tobacco plant, in this case the Petite Havana strain, is expected to dramatically improve the efficacy of the toxin, says Meeusen. With traditional applications, the bacterium is only effective as long as it coats plant leaves. The bacteria are subject to being washed off and they degrade quickly in sunlight, Meeusen notes.

If the field trials prove successful, the company aims to market major crop seed varieties including the gene addition by the mid-1990's. The company sees the gene addition being applied to a number of crop plants ranging from citrus to rice. It also hopes to develop softwood and hardwood tree hybrids that are resistant to pine borer and gypsy moth larvae. Rohm and Haas plans to conduct the test this fall on one-eighth acre plots in Homestead, Florida, and Cleveland, Mississippi.

Two other field tests of genetically altered tobacco are already under way. Agracetus, a joint venture of W. R. Grace & Co. and Cetus Corporation, is conducting research on a tobacco plant containing a marker gene that has no enhancing properties. Meanwhile, in North Carolina, Ciba-Geigy is growing a strain of herbicide-resistant tobacco. ■ MARK CRAWFORD

AID Withholds U.N. Population Funds

The Agency for International Development (AID), in the wake of vigorous lobbying by right-to-life advocates, has decided to withhold this year's $25 million contribution to the United Nations Fund for Population Activities (UNFPA). The grounds for the action are the alleged widespread use of coerced abortions in China's population program. China uses its UNFPA money for demographic analyses and training for program managers, not for the provision of services. However, the agency cited a congressional amendment last year barring federal aid to groups that "support or participate in the management of" coerced abortion or sterilization.

The U.S. in the past has supplied about 27% of the UNFPA budget. Last year, $10 million was withheld from the $46 million earmarked by Congress. Because this year's cut-off was expected, UNFPA director Raphael M. Salas says an additional $20 million has been pledged by other donors. AID officials say the $25 million will be spent on other family planning programs.

The Population Crisis Committee says UNFPA is the only source of population assistance in some countries and calls the withdrawal an "unmitigated disaster. It says to the world that we are willing to dismantle our family planning programs abroad to keep happy a small, but noisy, anti–family planning constituency at home." ■

CONSTANCE HOLDEN