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THE YEARBOOK OF AGRICULTURE 1968

SCIENCE *for* BETTER LIVING

UNITED STATES DEPARTMENT OF AGRICULTURE

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Sensing devices on spacecraft and airplanes are being developed to determine crop condition, detect insect and disease damage, and for other purposes. Here, brown soft scale infestation of citrus trees in Texas is detected at early stage with aerial infrared photo. Infested trees below pond are dark, due to absorption of infrared light by sooty mold from infestation.

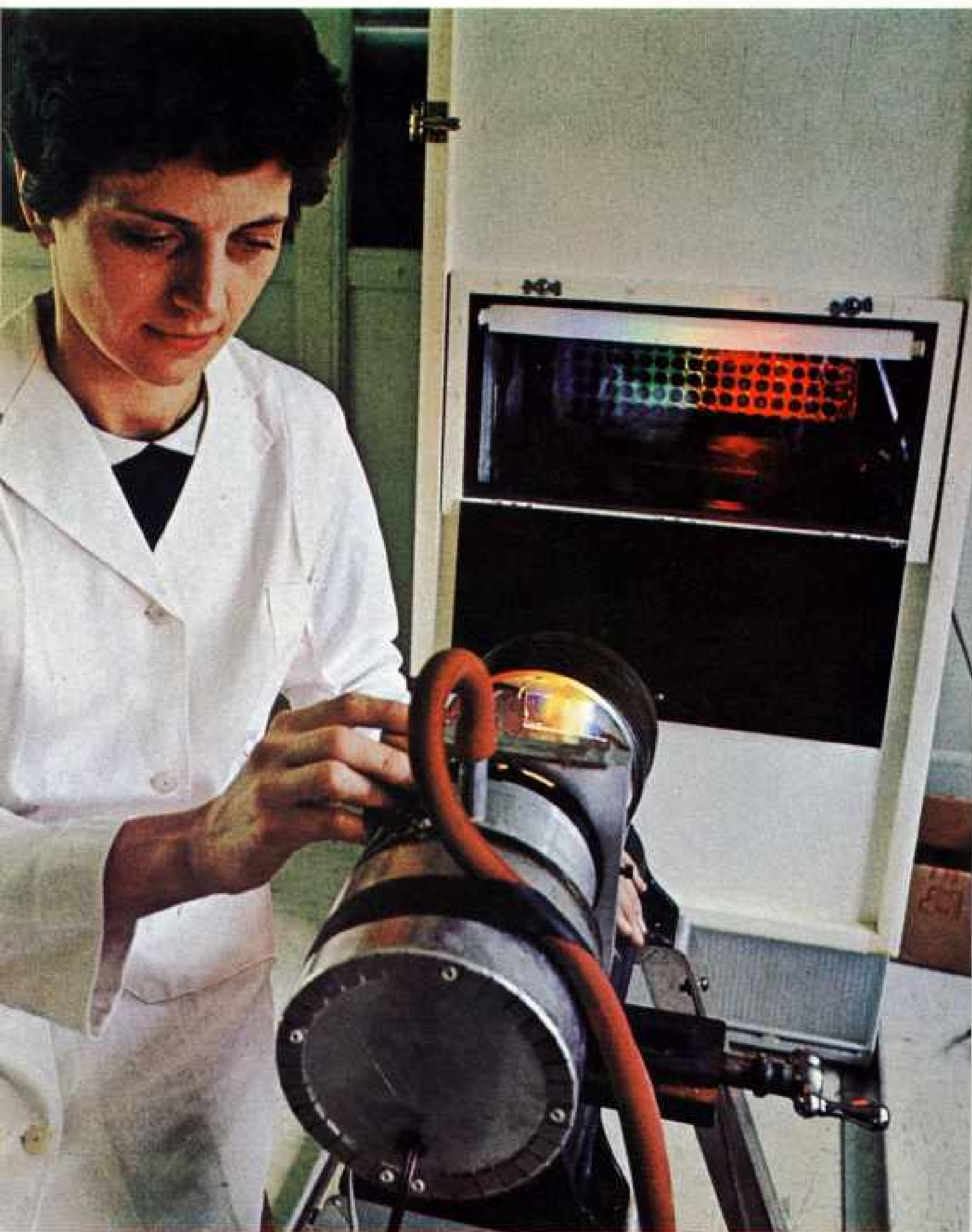
Infrared aerial photo, *right*, confirms or adds to information in regular aerial color photo, *left*. Varying red shades on infrared photo identify types of mixed hardwoods in California—maple, oak, buckeye, madrone, and bay. In aerial color, identification is difficult. Aerial color film indicates brown grassy areas are dead; green coloration on infrared confirms this. Color film picks up marshy vegetation on shoreline, pink border in infrared shows it is alive.

Chicks hatched in poultry research at Beltsville, Md.

Experiments in controlled environments have nearly doubled yields of lettuce, tomatoes, cucumbers, radishes, and other crops. Here, lettuce produced outside growth chamber is compared with much larger plant raised under controlled temperature, light, and carbon dioxide.

Biological controls are fast being developed against plant pests. Cinnabar moth was brought from Europe to control tansy ragwort, rangeweed poisonous to cattle. Above is field infested with ragwort—the gold blossoms. Below is same field with foreground cleared of ragwort by cinnabar moth larvae. At top left of next page, closeup shows moth larvae feeding on ragwort, leaving only bare stalks. Cattle, top right, benefit.

Tiny larva of native ichneumon wasp feeds on far bigger larva of the western spruce budworm, one of the West's most serious forest pests.



Light of certain intensities and color may "awake" insects from resting state (diapause) at time unfavorable to them, as in winter. Here, scientist adjusts color filter through which light is beamed on diapausing insects. New types of pest control are goal.

In insect control study, mosquito feeds on human blood.

Flies released from cage swarm toward experimental flytrap with ultraviolet lamp as attractant.

Biological controls are being tested against weeds that infest waterways, curtailing boating and swimming. Here silver dollar fish graze on pondweed.

Flea beetle feeds on waterweed, in Florida.

Physiologist probes secret of how trees make wood. He is providing radioactive carbon to pine tree, so he can trace carbon into chemicals laid down in wood at different times of year. *Below,* female longleaf pine flower.

Crocuses, *top,* herald spring at National Arboretum, America's beautification center. Rhododendron clusters delight children, *above.*

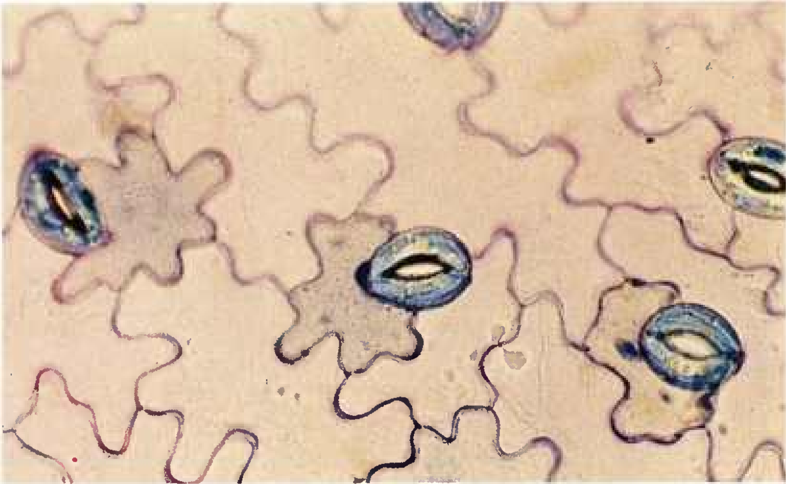
Mississippi and Florida are among Southern States that have long claimed the magnolia. *Magnolia grandiflora* is one of most popular, and is used in breeding program at Arboretum in its search to widen growing range of this tree.

Blackspot disease spores in waterdrops, *left,* are placed on various types of rose leaves to determine resistance to disease. Traveler, *right,* picks bouquet of crownvetch being used for highway beautification and erosion control. USDA plant scientists have developed crownvetch varieties especially suitable for this job.

Checking precise butterfat content of milk sample.

Bee bred to cross-pollinate alfalfa rests on alfalfa blossom. Heavy pollen deposits on legs indicate it has pollinated hundreds of blossoms.

Petunias and marigolds are moved from greenhouse covered with experimental fluorescent plastic material. Test was made to see if energy is increased in red portion of spectrum, resulting in increased plant growth.



Laughing lips of stomata, microscopic porelike cells on plant leaves. These bean stomata are taking up blue dye in tests made with sealants to cut down on water loss from plants through stomata.

Fluorescent dye stains surface of globemallow leaf, in test to show patterns of herbicide entry into plants. Star-shaped trichomes or leaf hairs are important points of entry. Red light in photomicrograph shows veins.

Model of experimental home built at Forest Products Laboratory. Costs are reduced by wood lamination, prefinished components, and modern adhesive compounds. Only a fourth as many nails are needed.

Two sets of twin lambs were born to same ewe 8 months apart. USDA is trying to develop breed of sheep, Morlam, that will stay fairly consistently on 8-month or even 6-month breeding schedule.

State researchers perform ova transplant in sheep. After conception in one sheep, ova have been transferred to host mother who carries embryo and eventually gives birth.

Dramatic contrast results from selective breeding of hogs for high and low meatiness. Top photo shows cuts from high-fat hog, other photo from low-fat hog. Loin eye area is the cut on upper left in both photos, bacon just below. Hams are at right.

Cowboys round up Hereford heifers used in crossbreeding experiments in Montana.

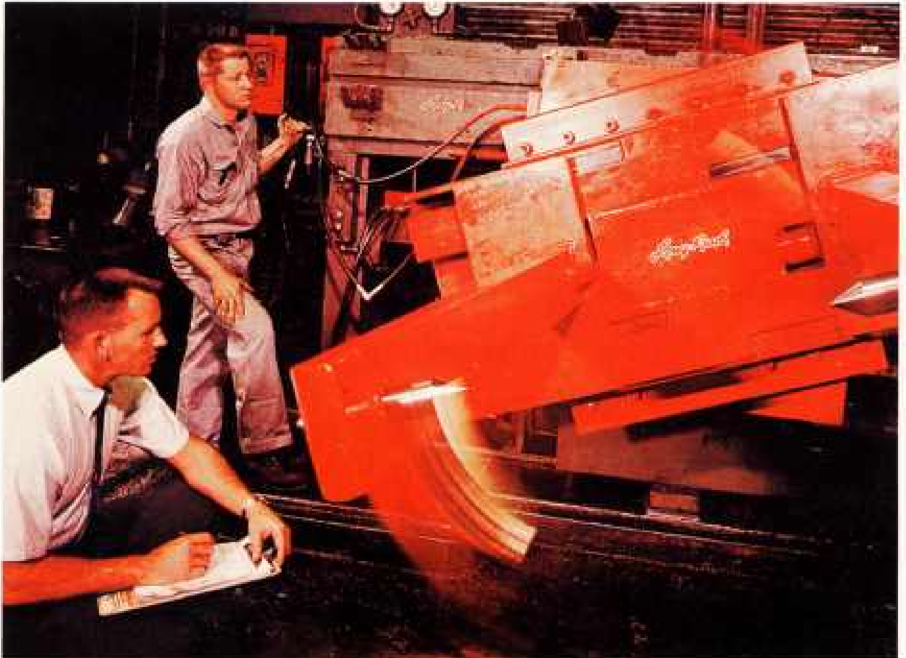
Brilliant red laser beam, *right,* is used to automatically guide new types of farm drainage machines.

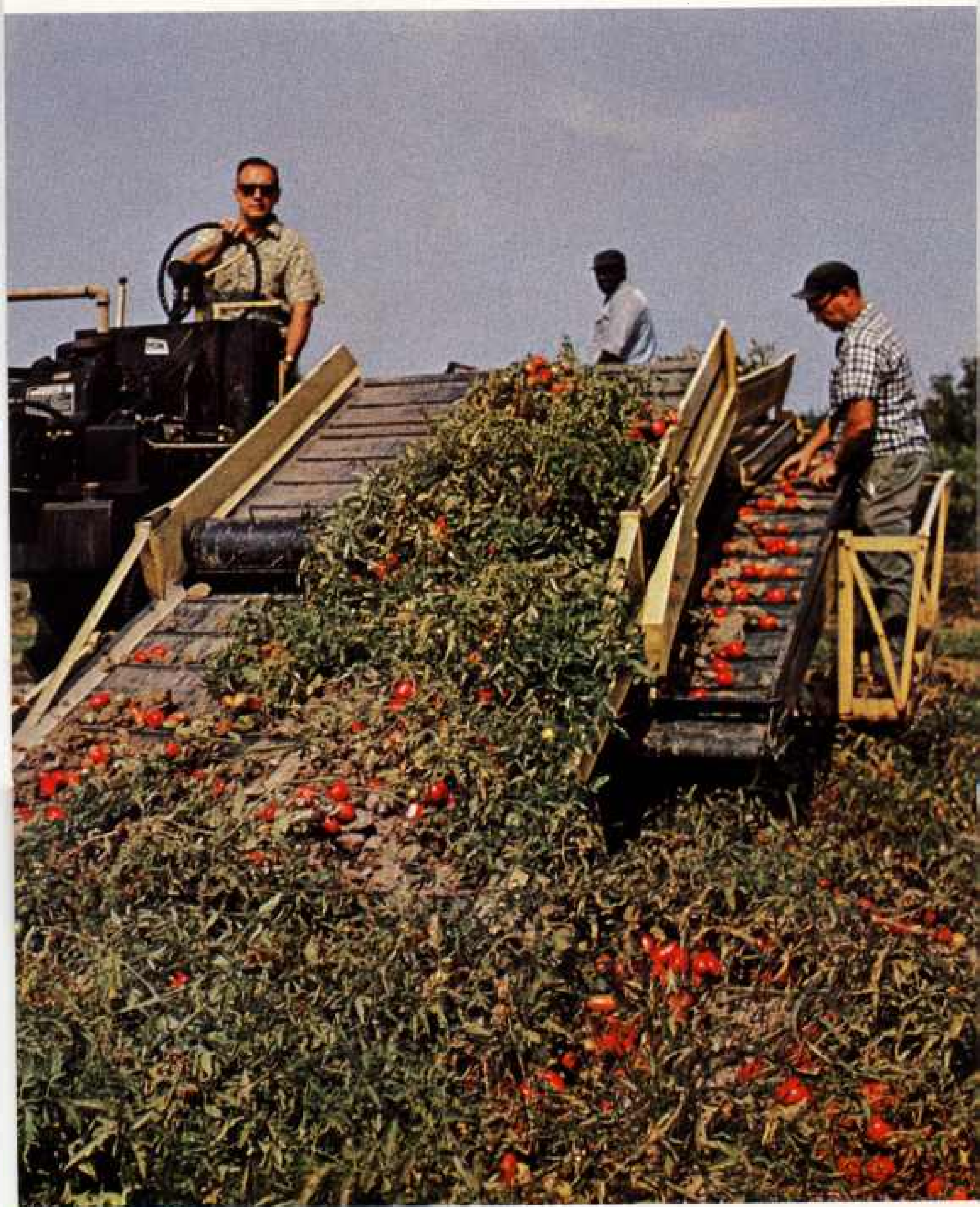
USDA chemist hydrogenates a fatty acid in studies at Peoria, Ill., to improve soybean oil for salads and cooking.

Automation in food packaging:
A radish bagging machine.

Pineapple is watered in low-rainfall area in Hawaii. Engineering research has led to mechanization of many agricultural operations.

Hydraulically operated lift truck attachment gets final check on test stand. This plant makes cotton handling equipment.





USDA plant breeders are developing new tomato varieties adapted to machine harvesting for use in processed products. The tomatoes all ripen near same time, come from vine easily, and are firm fruited. Two of lines are oblong shaped, which reduces rolling on harvester and lessens bruising.

USDA scientists pluck feather from sandhill crane for chromosome count. Their studies may save whooping crane and other wild birds from extinction. By careful breeding, scientists seek to overcome genes that make a species unable to adapt to changing world. Another potential result: Major improvements in domestic fowl.

Riffle sifter in Alaska stream blows silt from gravel bottom, providing better spawning beds for salmon—a fish crop worth some $116 million annually. Machine was developed by Forest Service and industry research. *Below*, pink salmon egg at 36 days.

Spacecraft oceanography is new phase of fishery science. This photo by astronauts of southern tip of Florida and the Keys aids studies of pink shrimp nursery grounds. To right of Keys is main flow of Florida current. From this, eddies flow through Keys distributing shrimp larvae into shallow nursery waters.

At 90 feet below surface, fishery technician collects lobsters for use in behavior studies.

New technique for producing oysters. After free-swimming oyster larvae attach to shells or other hard objects, they are put in tank, *above,* and fed artificially. When young oysters have grown so they adhere firmly to hard object, they are taken to natural oysterbeds to grow to adult size.

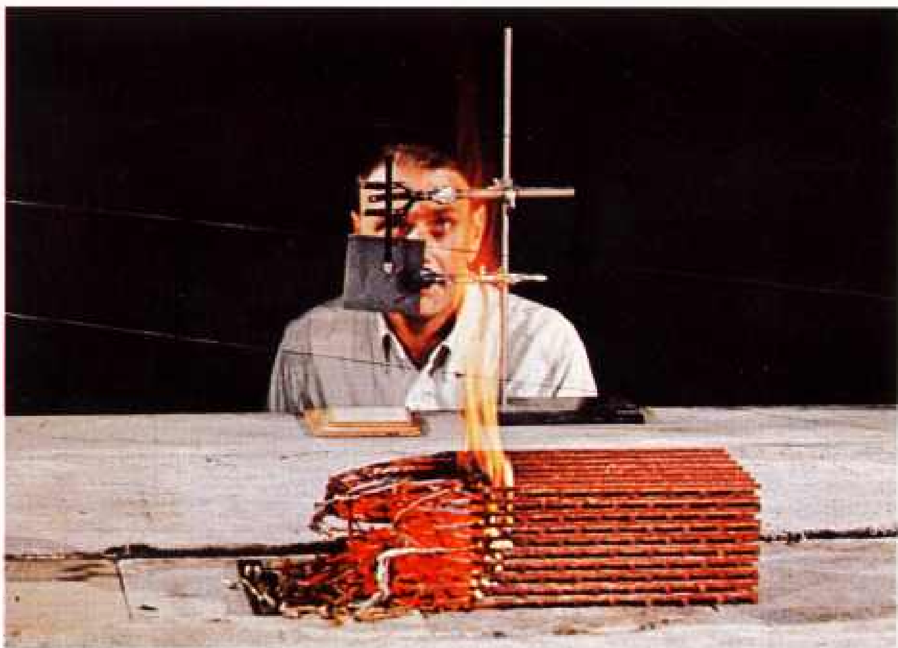
Machine-washable wool garments above were developed through USDA research.

Commercial wash-wear, stretch cottons resulted from government-industry cooperation in research and development.

Wool research starts with sheep. At right, woolly lamb makes new friend.

Inexpensive cotton lace, *left,* made by processes devised by USDA.

Scientists test effectiveness of fire-retardant chemical for forest fire use. Flames blaze high through untreated wood crib fuel bed, *top,* then die down, *below,* on reaching portion treated with chemical.



Preface

JACK HAYES
Yearbook Editor

"Science for Better Living" for you and your family is what you will find in this book, since the theme is agricultural research. We all benefit in our daily lives from that research because it improves the meals we eat, the clothes we wear, our water and air, the wood we build much of our homes with, and the plants and trees that make our surroundings more livable.

The color section gives you an idea of the sweep of that research. Geographically, too, this book covers vast areas. It roams from the United States to Japan, the Philippines, Finland, and points between. Subjects range from the alfalfa bee to the weed-eating sea cow, from balloon logging to WURLAN wool fabric, from a low-calorie cheese to farming by space satellite.

Scientists come to life in these pages. Keith E. Gregory pioneers crossbreeding in beef production. William C. Crow plans markets big enough to feed city areas of 15 million people. B. Jean Apgar, mother of three, determines the structure of a nucleic acid for the first time. Norman E. Borlaug, a foundation man in Mexico, brings short wheats to amazing yield levels.

Mostly we report on research in the last five years or so, although some older landmark achievements are included. Since agricultural research more often than not is cooperative, we describe Federal, State, and industry work.

You may notice that agricultural scientists often are endowed with serendipity, the "gift of finding valuable . . . things not sought for." All it takes is long years developing expertise in a specialty, and a strong streak of sagacity. Then something totally unexpected happens in the lab, and the next thing you know the scientist has figured out a hard-nosed practical use for it. Perhaps a water repellant for paper products, or a flame-resistant finish for fabrics.

George W. Irving, Jr., Administrator of the Agricultural Research Service, served as chairman of the Yearbook Committee. Others on the Committee that planned this book are:

Ned D. Bayley, Director of Science and Education.

Agricultural Research Service—Walter M. Carleton, Earl R. Glover, Edwin R. Goode, Jr., Willis A. Gortner, Sam R. Hoover, Robert B. Rathbone, Eugene P. Reagan, Martin G. Weiss.

Cooperative State Research Service—Bruce F. Beacher, Nelson B. King, Thomas S. Ronningen.

Economic Research Service—Wesley B. Sundquist.

Forest Service—Stephen G. Boyce, William R. Moore, Leon R. Thomas.

National Science Foundation—M. Frank Hersman.

Office of Management Services—Ward W. Konkle.

University of Maryland—Clyne S. Shaffner.

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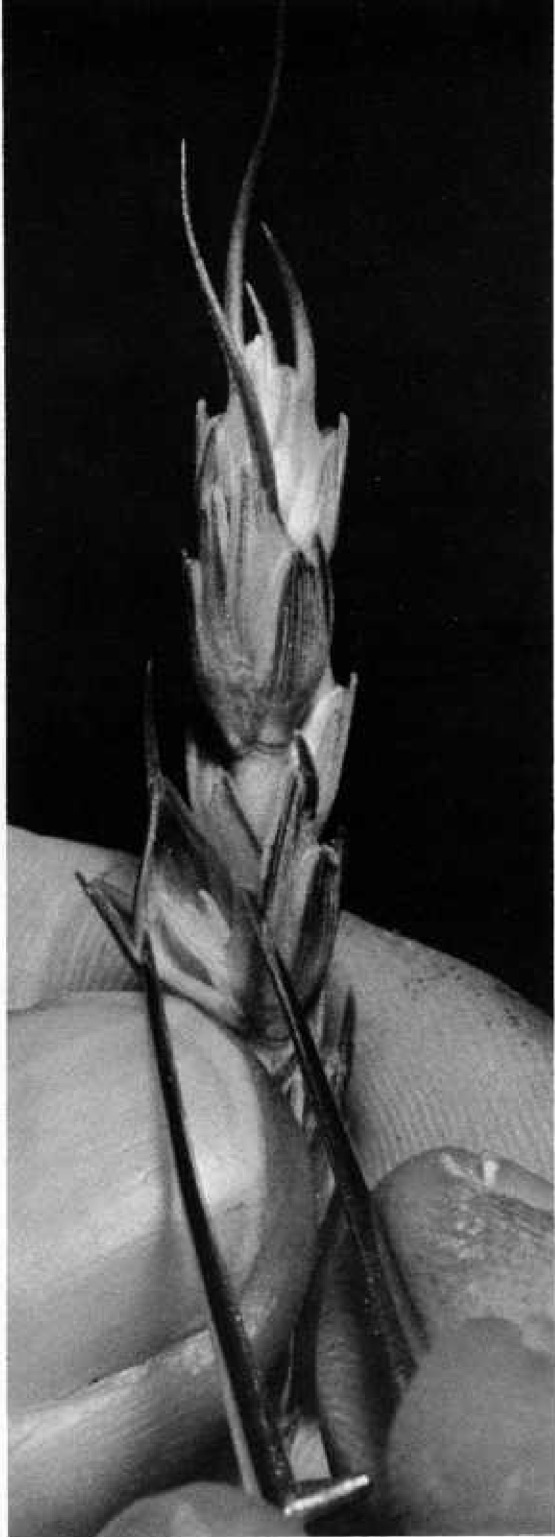


Scientific Agriculture: Keystone of Abundance

ORVILLE L. FREEMAN
Secretary of Agriculture

Tomorrow morning at 3 o'clock in New York City's Hunt's Point market—or in Boston, Chicago, San Francisco, and other large cities—a quiet, friendly, businesslike man will begin moving in and out of the fruit and vegetable stands, checking with food buyers and sellers on the quantity, quality, and prices of commodities offered and sold. He's a USDA market news reporter. Farmers and dealers in farm products use his information daily in operating today's scientific agriculture and keeping a steady supply of food flowing to consumers.

Some hours later in a research lab at Beltsville, Md.—or Philadelphia, New Orleans, Peoria, or one of many other agricultural laboratories around the country—a chemist studies ways to develop new or improved uses for farm products. He's a USDA research scientist. He and his colleagues have already developed commercial penicillin, wash-and-wear cottons, shrink-resistant woolens, concentrated orange and other fruit juices, and hundreds of other products for better living.

In Lewisburg, Ky.—or Shell Pile, N.J., Lovelock, Nev., Centerville, Iowa, or any of thousands of other small rural communities—a local resident conducts a meeting of community leaders working on the problem of expanding job and living opportunities in rural America. He's a USDA field representative of the Farmers Home Administration or the Extension Service.

In an agricultural area of far-off India—or Thailand, Nigeria, Kenya, Brazil, and other foreign lands—a team of scientists and other specialists is helping farmers and government officials to irrigate and drain land, establish market news systems, conserve soil, water, and timber resources, set up credit-cooperative programs, and improve farm productivity and management. They are selected from many USDA agencies to help win the war on hunger.

These are some of *your* public servants in the U.S. Department of Agriculture. They and their colleagues, working with American farmers and American agriculture, keep your market basket filled with food, develop new products for your convenience, play a leading role in revitalizing rural communities, and build better agricultures in poor nations.

But this is not all. They have also helped beyond measure to project this Nation into the first economy of abundance known to man—an economy in which disposable per capita income in 1967 rose to $2,735.

Most of the world's people, unlike most of us, live amid scarcity. Three persons out of four have per capita incomes averaging about $110 per year. In India, the average is only $80—about 22 cents a day.

In these economies of scarcity, most of the people are bound to the soil. Living in villages, in clustered dwellings from which they go to cultivate

the fields, they use human muscle supplemented by animal power to do their work. Their agriculture is primitive. The ancient hand sickle, the threshing board, the short-handle hoe, the wooden plow—implements used for thousands of years—are still in common use.

To produce enough food for sustenance is the primary goal, and for many hunger is as constant as their shadow.

Transportation is primarily by foot, animals, or bicycle. The women carry babies on their backs, market baskets on their heads. Most roads are country lanes, sometimes little more than trails.

A high proportion of the people, especially in rural regions, are illiterate. Communication is mainly by word of mouth, neighbor to neighbor.

In an economy of scarcity, life goes on pretty much as it has for 30 centuries.

In an economy of abundance such as ours, *all is change.*

Abundance has enabled us to collapse time and space. It has put us on wheels and given us wings. It makes possible mass education and communication, an increased leisure, extended vacations, hundreds of laborsaving devices, and thousands of gadgets for easier living.

Abundance provides machines to replace, supplement, and extend muscles. Man can literally move mountains, travel at incredible speeds, hear and see events as they occur an ocean span away.

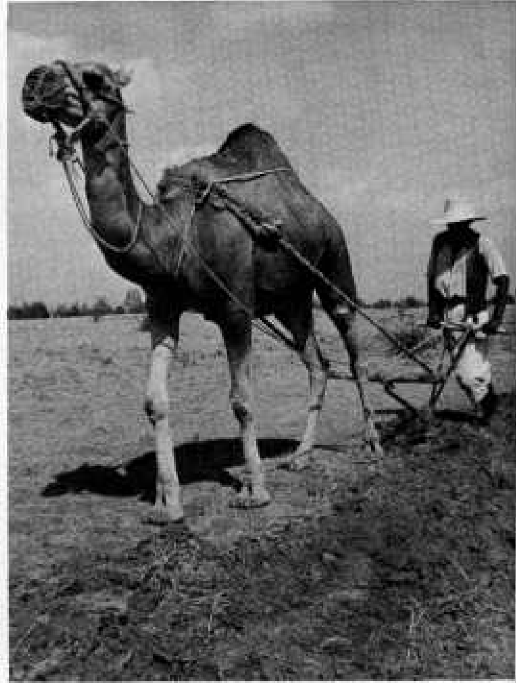
But why us? Why is America, above all nations, far and away the leader in entering the age of abundance?

One reason—undoubtedly the most basic, almost certainly the least recognized—is scientific agriculture.

History clearly shows that the application of research to increase agricultural productivity is the solid base upon which all subsequent economic development rests.

Scientific agriculture in the United States has made and continues to make at least six specific contributions of major importance to this country's economy of abundance.

- It has, in effect, multiplied the Nation's manpower. Scientific agriculture's rapidly rising productivity released millions from farming, thus providing much of the labor force for the continuing industrial revolution. Not only did the rise in productivity make it unnecessary for more people to enter agriculture to supply the food and fiber needs of a growing population; it enabled the actual number of farmers to be steadily reduced.



In a primitive agriculture, camel helps till the soil.

Almost one-fourth of our people lived on farms in 1937, and 15 percent lived there in 1950. But in 1967, less than 6 percent of the Nation's population was on farms—yet we ate better than ever before.

In 1937, one person employed in agriculture produced enough food and fiber for 10 persons—and in 1950 for 15. But in 1967, he produced abundantly for more than 40 persons.

Agriculture's rising productivity, as a consequence, has made possible the application of a continually rising

proportion of the Nation's labor force, including its inventive genius and management, to mill our steel and to generate our electricity; to build homes, schools, office buildings, and factories; to produce cars, television, air conditioners, and computers; to build and sail ships; to make and fly planes; and to man our professions and service occupations.

The scientific and technological progress of our agriculture has been so rapid, however, that the economy has found some difficulty in adjusting to it. Commodity surpluses and rural underemployment have been among the results.

Nevertheless, agriculture's laborsaving contribution has been, and continues to be, a cornerstone of U.S. abundance.

• Scientific agriculture's progress has resulted in sharply lowered food costs relative to income.

This both reduced inflationary tendencies and provided a larger market for industry.

American consumers in 1967 paid out only 17.7 percent of their spendable income for food. In 1960, it was 20 percent—in 1950, it was 22.2 percent—in 1900, about 40 percent.

If U.S. consumers in 1967 had paid for food the same proportion of income as in 1960, they'd have had some $12 billion less to spend on cars, TV's, air conditioning, and vacations. Compared with 1950, the difference becomes $24 billion—compared with 1900, it is at least $120 billion.

• Scientific agriculture sustains our abundance by its steadily growing purchases of goods and services—despite the rapid drop in farm population.

Farm gross income in 1967 was almost $49 billion. Of this, farmers spent about $34 billion for goods and services to produce crops and livestock. Most of the remainder went for the same things that city people buy—food, clothing, drugs, furniture, appliances, and other consumer products and services.

In the mid-1960's, farmers were spending annually about $3.4 billion for new farm tractors and other motor vehicles, machinery, and equipment—providing jobs for 120,000 employees.

They annually purchase products containing about 5 million tons of steel and 320 million pounds of rubber—enough to put tires on nearly 6 million automobiles.

They use more petroleum than any other single industry—and more electricity than all the people and industries in Chicago, Detroit, Boston, Baltimore, Houston, and Washington, D.C., combined.

• Growing exports of U.S. farm products produced by scientific agriculture bulwark the Nation's economy of abundance. In fiscal 1967, foreign markets took $6.8 billion of agriculture's products, absorbing the production equivalent of some 71 million acres. These exports pay wages and interest, buy machinery and fertilizer, storage and transportation, packaging and processing.

Commercial exports or "sales for dollars" in fiscal 1967 totaled $5.2 billion, bringing back to the United States many of the dollars that move out because of defense and aid, tourism, and U.S. investment abroad, thus aiding the overall balance of payments situation.

• Scientific agriculture, the world's number one weapon in the war on hunger, is the basis upon which future world economic development rests.

After World War II, Europe was devastated and the Japanese economy was shattered. Food and fiber from U.S. farms helped them back on their feet. And in the 1960's, Japan became our top dollar customer for U.S. farm products.

Many of the world's people live in underdeveloped areas where agriculture does not produce enough food for them to feed themselves. U.S. exports of grain and other commodities help these nations to meet their immediate needs.

But American agriculture is also the world's biggest "storehouse" and research "factory" for agricultural knowledge. Exporting this knowledge

to improve farm production in food-short countries can contribute immensely to world stability and peace—and to the eventual entry of the entire free world into the age of abundance.

- Scientific agriculture is the keystone of prosperity in rural America. Rural America faces a grave challenge. Following World War II, a mass migration of rural people into the cities drained too many human and economic resources from the countryside. At the same time, it added to the housing, unemployment, congestion, and relief burdens of metropolitan America.

The exodus from rural America was due in part to the agricultural technological revolution. But it was stimulated also by many other factors: Highways that bypassed small towns and brought city stores, doctors, dentists, and entertainment facilities close to rural residents; railroads that stopped serving rural communities; the lure of the city itself.

The exodus is still going on, and this is a problem we must solve. We must restore rural-urban balance.

Fortunately, the tide of outmigration is slowing—and may soon be stemmed as concerted efforts of local people in thousands of rural communities are opening up new economic, social, and cultural opportunities throughout rural America.

Even though only about one in five of our rural people lives on the farm, agriculture remains the core around which the rural economy revolves. It is the biggest single industry, the biggest single source of employment, the biggest single producer of income in Countryside USA.

Working closely with farmers and other rural people, the U.S. Department of Agriculture is helping to stimulate a rural renaissance.

Private enterprise is being attracted to the countryside. Rural people, both farm and nonfarm, are taking advantage of government supported opportunities to establish part-time businesses or trades.

Contour strips sweep across the land in a panorama of scientific agriculture, the keystone to our American economy of abundance.

Rural communities are acquiring better housing, modern water and sewer systems, and other facilities.

On thousands of farms, picnic and camp sites, riding stables, game and fishing preserves, winter and water sports facilities have become supplementary and even primary sources of income.

The revitalization of rural America now underway is of primary importance to the Nation's continued economic progress.

The age of abundance is obviously the end product of many converging forces. At the base and providing the foundation for all, however, is our productive and efficient scientific agriculture.

For more than a century, the U.S. Department of Agriculture has carried out a large and increasing variety of services which have been largely instrumental in making U.S. agriculture the most productive in the world. These services are well known. They include production and utilization research; conservation of soil, water, and timber; supervised credit to improve farming and family living; programs to extend electric power to almost all farms; measures to support farm prices and income and bring about needed adjustments in supply and demand.

But the Department provides another battery of services directly to all citizens of the United States and in a sense, particularly to urban dwellers. These services, too—though not so well known—have hastened our entry into the age of abundance and steadily contribute to the "better life."

For example, through various food distribution programs, the Department improves diets for the elderly, the unemployed, the disabled, mothers left to rear children alone, and children in schools and institutions.

To assure clean, wholesome meat supplies, USDA inspects all the meat

and poultry products which are shipped across State lines.

USDA grademarks on food help consumers get full value for their food dollars.

New or improved foods, cotton, wool, leather, and other agricultural products emerge every year from USDA research laboratories.

New USDA-developed marketing methods—including plans for complete big city wholesale markets—result in a higher food quality, less waste, and consumer savings totaling millions of dollars annually.

USDA educational programs, of special value to the poor and underprivileged, teach people to manage their incomes, buy wisely, prepare more nutritious meals, and to make proper use of credit.

Although the Department is not customarily thought of as a health-protecting agency, it regularly makes immense contributions in this area. Penicillin, dextran, streptomycin, and other wonder drugs all have an agricultural background. Control of cancer, for example, may be aided by a world search now being carried out by USDA to find plants containing substances that inhibit the disease.

USDA plant quarantine inspectors and cooperating customs officials maintain a constant guard at U.S. ports and borders to keep foreign crop and animal pests and diseases from becoming established in the United States.

USDA soil surveys and land use plans help public and private developers and engineers build on sound sites, thus saving taxpayers and individuals many millions of dollars every year.

In the future, such services as these will be increasingly needed not only to meet the demands of a larger population, but also to continue the advance into better living which is the ultimate goal of the age of abundance.

We in USDA have been giving much concentrated thought to our goals in the years ahead. We have expressed these goals in terms of a common theme: AGRICULTURE/2000.

The American of Tomorrow—of the year 2000—will achieve a considerable measure of control over weather and climate. He will employ new sources of energy. He will wipe out most of the presently known diseases. He will increasingly use science in the service of man.

He will substitute additional elements of a manmade environment for that provided by nature. In so doing, he will face a new set of consequences, some favorable, some menacing. Some shadows of the future are already discernible. A few short years ago, we considered air and water to be essentially "free" goods. Because of manmade pollution, pure air and water are now fast becoming scarce goods.

We must anticipate the problems and seize the opportunities of the future.

We must give primary concern to the further conservation and development of natural resources—and this involves devising new methods to prevent pollution.

We must give careful thought and planning to the modification of weather and to biological and chemical control of the environment.

We must build communities for good living—both rural and urban.

We must develop new concepts and technology in transportation and communication.

We must provide new teaching methods and new facilities to provide quality education for all.

Recognizing that leisuretime is a major product of the age of abundance, we must provide new recreational and cultural facilities to take advantage of it.

And finally, we must continue to make new discoveries and applications of science in the production and use of food, fiber, and forest products.

This is the nature of the challenge held out to us by the age of abundance. Agriculture and agricultural science have done much to project us into this age. I am confident that they will continue to convoy us safely in the exciting adventure that lies ahead.

Photographers

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