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More food for our multiplying millions

THE REVOLUTION IN AMERICAN AGRICULTURE

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THE GEORGIA FARMER glanced at my city-shod feet with benevolent eyes framed by gold-rimmed spectacles. Then he handed me a pair of plastic boots—pulled from a roll that reminded me of the tear-off bags housewives use for leftovers.

"You cain't go into thet chicken house less'n you put these on," he drawled. "You see, you jest might not be clean."

Plastic boots, indeed! Not to preserve my polished shoes from the litter of the chicken house floor, but to protect the chickens from me! What a far cry, I thought, from the days when one of my childhood chores was scattering feed for the handful of hens Mother kept in our backyard. But that's modern agriculture for you.

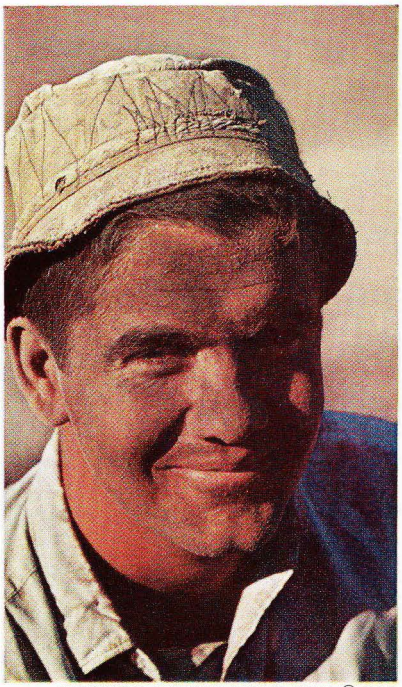
Some 13,000 pullets crowded that shed I was visiting. And a sign on the door told a potent story: PPLO CLEAN BIRDS. NO TRESPASSING ALLOWED. The initials stood for pleuropneumonia-like organisms, a hazard for which the birds had been tested. It or other diseases that might be brought in on a stranger's soles could spread like wildfire. And with an expected return of only five cents a bird, my Georgia friend could ill afford to take chances. For the agricultural revolution ablaze in the United States today demands the utmost in careful management.

Bounty Flows From Fewer Farms

Secretary of Agriculture Clifford M. Hardin summarized that revolution for me. "Through the decades before the Civil War, the American farmer produced food and fiber enough to feed and clothe himself and three other persons," he said. "A century later, when we entered World War II, new machines and techniques had helped inch the figure to

The sweeping pattern of abundance

A broad flag unfurled to the horizon, wheat grows in golden stripes across Glacier County, Montana (preceding pages). Small in the vastness, two lumbering combines ply mile-long strips, harvesting grain that has already been cut and windrowed to avoid whipping winds that would thresh it on the stalk. Near a tiny pickup used for refueling the machines, a larger truck hauls away the grain. Dark strips lie fallow for spring planting in a rotation that conserves moisture and



KODACHROMES (INCLUDING PREVIOUS PAGES) © N.G.S.

guards against wind erosion. Arrow-straight roads ripple the pattern in a lonely region where neighbors often live ten miles apart.

Asprawl in the shadow of the Rockies, Glacier County lies in the fertile wheat belt that extends southward to Texas and northward into Canada. Up this great corridor, traveling as the grain ripens, rumble the big custom combines, their drivers powdered with gritty dust and chaff (above). Multiplied across the land, they and their machines and the amazing results of agricultural research team up to produce a bounty unparalleled in world history.

himself and 11; today it has leaped to himself and 42. The superabundance from our fields comes from a dwindling number of farmers working fewer and fewer farms."

This incredible productivity of man and land yields bumper crops that make surpluses a problem. It sets American tables with food of a variety and quality unrivaled anywhere on earth. It has figuratively taken seasons out of the calendar. You can have strawberries in January, fresh oranges and lettuce the year round. And you can choose from a veritable cornucopia of products. Of the 6,000 to 8,000 items in the typical supermarket, 40 percent were not there a dozen years ago.

Scientists Spy on a Steer's Digestion

How has all this become possible? Simply because in a single lifetime United States agriculture has advanced more than in all the preceding millenniums of man's labor on the land. To witness this revolution firsthand, I traveled the length and breadth of the Nation.

In Maryland I saw a steer with a window in its side, through which scientists can study how different foodstuffs fare in its rumen—basic research that counts as one of the ingredients of our agricultural transformation.

In California I watched a factory-on-wheels move down celery rows—severing, trimming, washing, crating, doing the work of forty men. On such mechanization has depended part of our spectacular progress in farming.

I talked to a country banker about the credit advantage that has helped American farmers outdo their counterparts around the globe. I handled tomatoes bred for machine harvesting in one of today's amazing developments in plant genetics. I learned about heating cables buried underground to warm the soil so asparagus can grow in December—one of the changes that abundant electricity for rural America has wrought.

Research, mechanization, insect and weed control, credit, genetics, electricity, fertilizers, better communications and marketing, new food products, advances in soil and water conservation—these are major components of our farm upheaval. I explored them and marveled. And I ended my travels staggered by the idea that the revolution is just beginning.

Actually, there have been three agricultural revolutions. The first came when man began substituting animal power for human muscles. The second brought machine energy to replace animal energy and put the fruits of research into application on the farm. The

third, the farmer's adoption of skilled management techniques to capitalize on today's technology, still wears swaddling clothes.

"The successful farmer today is as much a businessman as he is a tiller of the soil," Secretary of Agriculture Hardin said to me. "The sophisticated enterprise he runs calls for a wider range of managerial decisions and skills than does the average family-owned factory or business in the city."

To the farmer we nonfarming Americans owe much, the Secretary declared—more than for the food we eat and the fiber we wear and the farm products that find use in such things as paints, lubricants, and plastics.

"Because only one person in 43 is needed to produce food, others can become doctors, teachers, shoemakers, janitors—even Secretaries of Agriculture. Without agricultural advances that free people from the drudgery of limited production on the land, there would be little labor available to man the factories, stores, museums, and all the other places that make our life so rewarding."

The revolution farmers have fashioned may even be a major weapon in the battle

KODACHROMES BY JAMES P. BLAIR (ABOVE) AND JACK FIELDS © N.G.S.

against one of the gravest problems facing the world: the population explosion.

Earth's numbers now stand at 3.6 billion, and could double in 35 years. This mounting pressure against food supplies raises the specter of a famine more catastrophic than the world has ever seen. Already constant hunger or malnutrition is the lot of half the

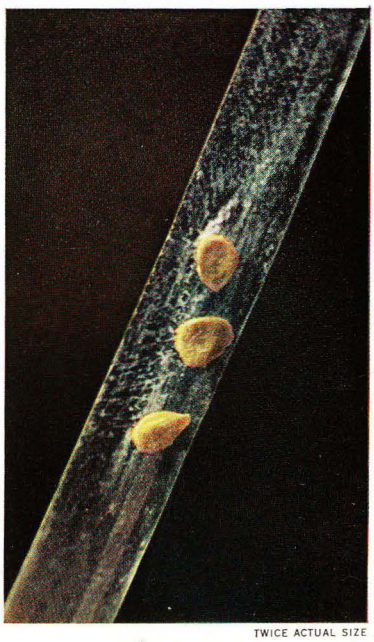
Mass-producing the tomato

Like an open-air trolley gone astray, a 6½-ton behemoth traverses a field near Yuba City, California (left). Behind the driver, second from right, 14 women passengers busily sort tomatoes, shaded by awnings and serenaded by taped music. Their vehicle: a $23,000 harvester that picks and bins 15 tons of tomatoes an hour, once the backbreaking work of 100 migrant laborers.

The machine cuts plants underground, pulls them up with metal fingers, and gently shakes off the fruit. These tomatoes are miracles of plant genetics, bred to ripen all at once and having an easy-to-snap stem for bruiseless picking. As women cull, a conveyor feeds fruit into bins.

Like picking, planting has gone modern. Factory assembly lines slip tomato seeds into plastic tapes at precise intervals (right). Reels of tape on a planter thread down through a digging tube (above). Within a few minutes of planting, soil moisture dissolves the tape.

Pulling a six-tape rig, a lone operator can precision-plant an incredible 30 acres a day. Manufacturers foresee a day when many suburban gardeners will also seed by tapes.



TWICE ACTUAL SIZE

people on earth. In the 8.6 seconds it takes the average reader to scan this paragraph, someone somewhere dies of starvation or of disease stemming from malnutrition.

Many view darkly the race between man's fertility and that of the soil. Others see hope in the fact that the land surface of the earth receives enough energy from the sun every day to grow—theoretically at least—enough food for more than sixteen times our current numbers.

Most of the world's farmers till the soil with methods little changed in a thousand years. The spread of modern agriculture can help assure the underdeveloped two-thirds of the world the freedom from hunger it gives the economically advanced one-third. It can help us buy time against world famine while we press efforts to control the mounting population. As Dr. George W. Irving, Jr., research administrator of the U. S. Department of Agriculture, put it:

"Our agricultural revolution is setting up things so that other nations can telescope what we have done." And he pointed to Mexican wheat and Philippine rice as examples of how our revolution is spreading.

Tailor-made Grains for Hungry Lands

Mexico used to import wheat, its farmers scratching only eight or ten bushels an acre out of their fields. Then a program supported by the Rockefeller Foundation crossed Mexican wheats with a dwarf Japanese strain. Slowly at first, then burgeoning, use of resulting varieties spread. In little more than a decade Mexico became a wheat exporter; farmers could brag of yields of more than forty bushels an acre.

Mexican wheat, crossed in Pakistan with native strains adapted to local soil and climate, has revolutionized grain production in that part of Asia.*

Ford Foundation and Rockefeller funds have made possible an equally dramatic advance with rice in the Far East. At a research center in the Philippines, scientists bred a strain they named IR-8. It boosts harvests three- or fourfold and can yield a crop in two-thirds the normal growing time.†

Mexican wheat and IR-8 rice and their descendants aren't the only genetic developments with startling impact. In my travels I heard talk of tailoring cotton plants to grow fewer leaves so shade-loving boll weevils would be discouraged. And I saw how scientists and engineers revitalized California farming and saved a canning industry by creating a tomato plus a machine to harvest it.

White-haired, genial Professor Coby Lorenzen, of the department of agricultural engineering at the University of California's Davis campus, sketched the background for me.

"In farming, as in industry, laborsaving devices make jobs easier and cut costs," he said. "It didn't take too much foresight to realize that the stoop work of tomato-picking would one day be a prime target. My colleague G. C. Hanna—he's a plant breeder—first sparked my interest in the problem.

"We knew we couldn't develop a machine to handle the

*See "Pakistan: Problems of a Two-part Land," by Bern Keating, NATIONAL GEOGRAPHIC, January 1967.

†This project was described by Robert de Roos in "The Philippines, Freedom's Pacific Frontier," GEOGRAPHIC, September 1966, and by Peter T. White in "The Mekong, River of Terror and Hope," December 1968.

Research, yeast of the revolution

As an ap
ple nests on an electronic vibra
tor, a recorder rolls out a mes
sage that tomorrow's shoppers
will welcome. Registering the
passage of sound waves through
the fruit, the instrument tells
whether the Red Delicious is
too green, too ripe, or a juicy
just right. When perfected for
use by packers, the device could
do away with the doubting
squeezes that shoppers bestow
on fruit.

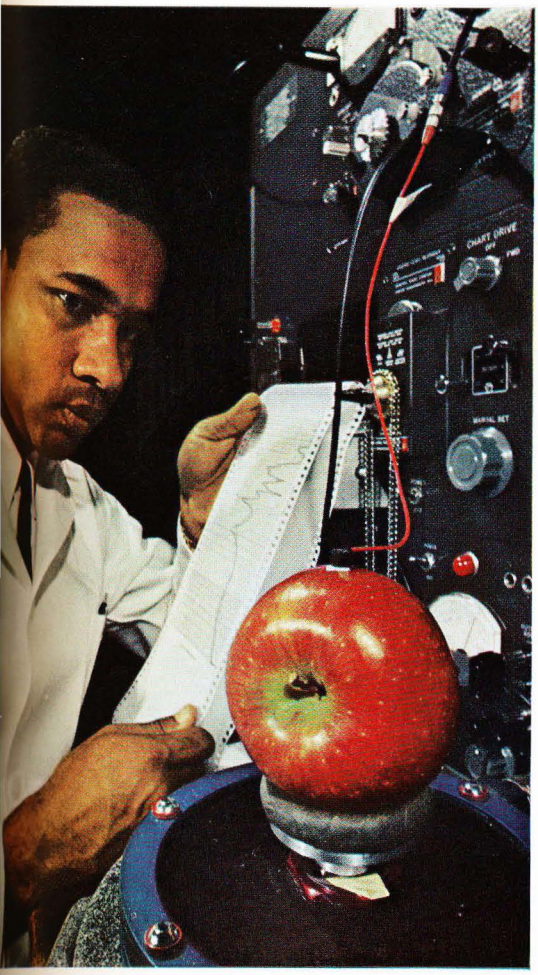
Here an agricultural engineer
seeks to improve the vibrator
at the U. S. Department of Ag
riculture's research center in
Beltsville, Maryland.

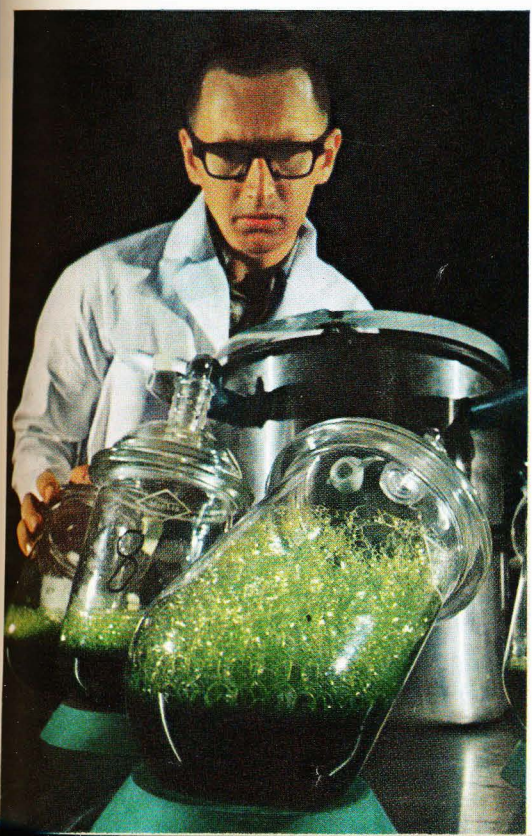
Bare hands fleece a sheep
painlessly in an experiment at
Beltsville. Researchers give the
sheep an anti-tumor drug which
sometimes causes the hair of
human cancer patients to fall
out temporarily. The technique
would call for care on a farm
er's part to harvest his wool
before it dropped off in the field.

Frothy alfalfa juice bubbles
in a freeze-drier at the Deere &
Company Technical Center in
Moline, Illinois (lower left). The
center seeks a low-cost way to
extract alfalfa's abundant pro
tein for human consumption.

Far-spreading roots of a soy
bean plant are laid bare at the
National Tillage Machinery
Laboratory (lower right) in Au
burn, Alabama; a squirt bottle
cleans matted rootlets. Deter
mining soil conditions that bring
optimum growth helps agron
mists design better plows.

In the unending struggle to
keep research a long jump
ahead of food and fiber needs,
state and federal governments
invested almost $500,000,000
last year, while private industry
surpassed that amount.





KODACHROMES BY JAMES P. BLAIR © N.G.S.

Spinning a morning mist, a helicopter sprays an orange grove for rust mite near Waverly, Florida. Nozzles on the boom eject diluted chlorobenzilate, a pesticide of little danger to man or animals. Wash of the blades drives it down on the fruit.

To lessen the hazard of more toxic insecticides, farm scientists experiment with airborne atomizers that spray ultrasmall droplets of undiluted chemicals, reducing the quantity needed.

conventional tomato plants; we'd have to develop a plant to fit a machine. Ideally it would be a vine on which all the tomatoes would ripen at the same time, because, for efficiency, the machine should harvest plant and all on a 'once-through' operation.

"The tomatoes should stay ripe on the vine longer," Professor Lorenzen said. "That would give more leeway at picking time. Skins and interiors should be a bit sturdier to withstand machine handling, and there were other requirements."

The two men began their work in 1949. Mr. Hanna bred plant after plant. Professor Lorenzen tried dozens of machine designs. Finally, in 1960, a suitable tomato and an experimental machine were ready. J. Bernell Harlan, who with a partner farms 1,500 acres near UC's Davis campus, tested both.

"Lots of things went wrong," Mr. Harlan recalled. "Tomatoes got crushed. Too much dirt came up with the vines. Breakdowns were frequent. But we could see possibilities."

And just in time. Congress ordered an end to the bracero program which permitted migrant labor from Mexico to enter the U. S. This had been the major source of field hands.

Said Mr. Harlan: "Many tomato growers figured they'd have to give up farming. Canners made plans to move to Mexico. But by 1965, when the bracero ban went into effect, most of the bugs had been worked out of the harvesting machine, and we had learned what cultivation practices the new tomato plant required. The way this saved the tomato business in California reminds me of those cavalry rescues in Wild West movies."

Machines Multiply Farmers' Output

Today 90 percent of the state's tomato crop is picked mechanically (pages 152-3). Indeed, mechanization is one of the key inputs of America's agricultural revolution. The average farmer has more horsepower working for him than does the average factory employee. It helps him produce with each hour's labor seven times as much as he did 50 years ago.

"Machines do replace labor," G. E. VandenBerg told me when we discussed farm mechanization in his office at the USDA's Agricultural Research Center in Beltsville, Maryland.* "However, it is the scarcity of labor that really spurs adoption of machines. For example, tractors didn't get into widespread use until the U. S. Army took horses and mules off the farms to meet the needs of World War I. The corn picker and the hay baler had been around before World War II, but they weren't widely used until farm youths went off to fight and farmers had to have machines to get the work done."

Then he described an incredible parade of

*See "Beltsville Brings Science to the Farm," by Samuel W. Matthews, NATIONAL GEOGRAPHIC, August 1953.

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machines at work today on U. S. farms: Acre-eaters that in an hour can plow a hundred times as much land as a farmer with a string of oxen. Self-propelled combines that permit a man to ride in an air-conditioned cab to harvest a crop of corn that used to take a crew of 80 hands. Monster road-building machinery to level terraces or shape rice fields. Helicopters to spray cucumber fields. In all, such a host of devices that today U. S. farmers are investing eight times as much capital as they did thirty years ago.

I got other insights into mechanization when I talked to a peach grower in Georgia and a wheat harvester in South Dakota.

"We used to thin peaches by hand at a cost of as much as a dollar a tree," William J. Wilson said as he drove me around his orchards at Fort Valley, Georgia, county seat of appropriately named Peach County. "Now a mechanical shaker does the job at a labor expense of only a few cents. The machine cost $10,000, but I saved almost enough in labor the first year to pay for it."

A thousand miles away, on the rolling prairies of South Dakota, I rode the platform of a wheat combine with wiry, 74-year-old J. D. Davis. Dust sifted through my clothes and turned my underwear gray. Grit from the chaff reddened my eyes. Its constant rubbing had given the ironwork of the cutter bar a mirror polish.

"I've been doing this for 39 years," the World War I ex-Marine told me over the combine's clanking. "The first machines I owned were like toys compared to this thing. Then, 20 acres was a good day's work; today one combine can cut more than 100."

Behind us five more combines in echelon chewed a widening swath through the golden grain. Davis is a custom combiner, working on contract for wheat growers (pages 148-51).

"I started with one combine. Now I have six. Growers keep increasing their acreage, and so I have to expand."

This trend to bigness and specialization finds no sharper examples than in the Nation's poultry industry. I dug out part of the story in the red-clay hills of Georgia, and part from southern California's citrus-dotted slopes.

"Twenty years ago broilers sold for 65 cents a pound, and fried chicken was a treat for Sunday dinner," Ralph D. Mobley said in a soft Georgia accent. "Most farms had a little flock that helped provide the farmwife with butter-and-egg money. Now chicken is cheaper than hamburger, and coops on the average farm are empty because the farmwife can buy dressed birds in the supermarket for less than it would cost her to raise them herself. The reason? Research and greater efficiency in the broiler business."

Tenth of a Cent Spells Profit or Loss

Mr. Mobley has watched those changes come tumbling. He is director of broiler and hatchery operations for the Cotton Producers Association, a cooperative based in Atlanta, Georgia. It is a major producer of broilers in the state which leads all the rest of the U. S. in this field.

"It used to take 14 weeks of growing time, plus 4½ pounds of feed for each pound of weight gained, to raise a chick to broiler size," Mr. Mobley said. "Nowadays the average is 8 weeks and 2 pounds. Part of the improvement comes from genetic development of a breastier, meatier, tastier bird. Part comes from better feeding—scientists know more about chicken nutrition than they do about that of humans."

And he showed me a page-long list of the ingredients in a broiler formula, everything from alfalfa meal to xanthophyll—a plant compound used to give chicken skin a pleasing yellow tinge. Computers, he explained, figure the items on a cost-per-nutritional-element basis. They help decide whether to substitute, say, fish meal from Peru if the price of domestic meat and bone scrap goes up a mere dollar a ton. Such factors can be of vital importance, since a tenth of a cent per pound in the market price of broilers can mean the difference between profit and loss.

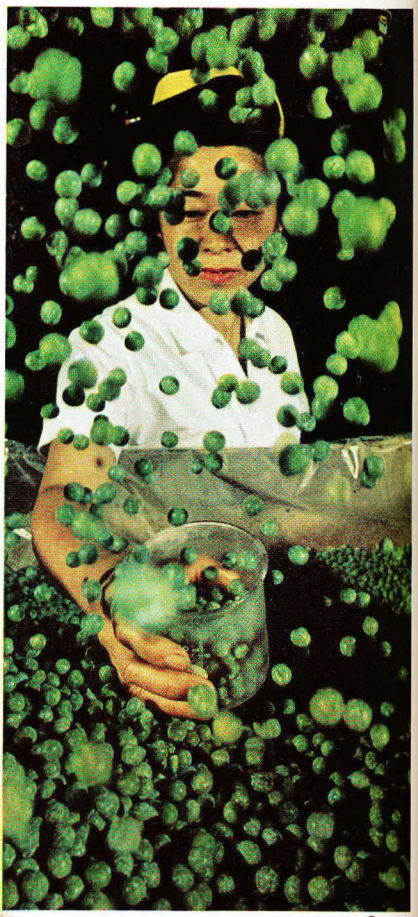
"The producer also has to pay attention to little things like how full the automatic feed troughs are kept," added Dr. Donald H. Sherwood, chief scientist at the cooperative's research farm in Talmo, Georgia. "The birds may scatter

From field to freezer—fast!

Dislodged by a workman's rake (right), peas fresh from the field slide down sloping wagon sides onto a conveyor belt at Seabrook Farms in New Jersey. Flowing into a processing plant, the green flood will swirl through cleanings and cullings to emerge in only 20 minutes, quick-frozen for the table at the moment of prime ripeness.

From a hailstorm of frozen peas, an inspector scoops a sample to scrutinize for color and maturity (below).

Vegetables and fruits, unlike meats, posed a problem to early processors by deteriorating even when frozen. In the 1920's came the discovery that a brief



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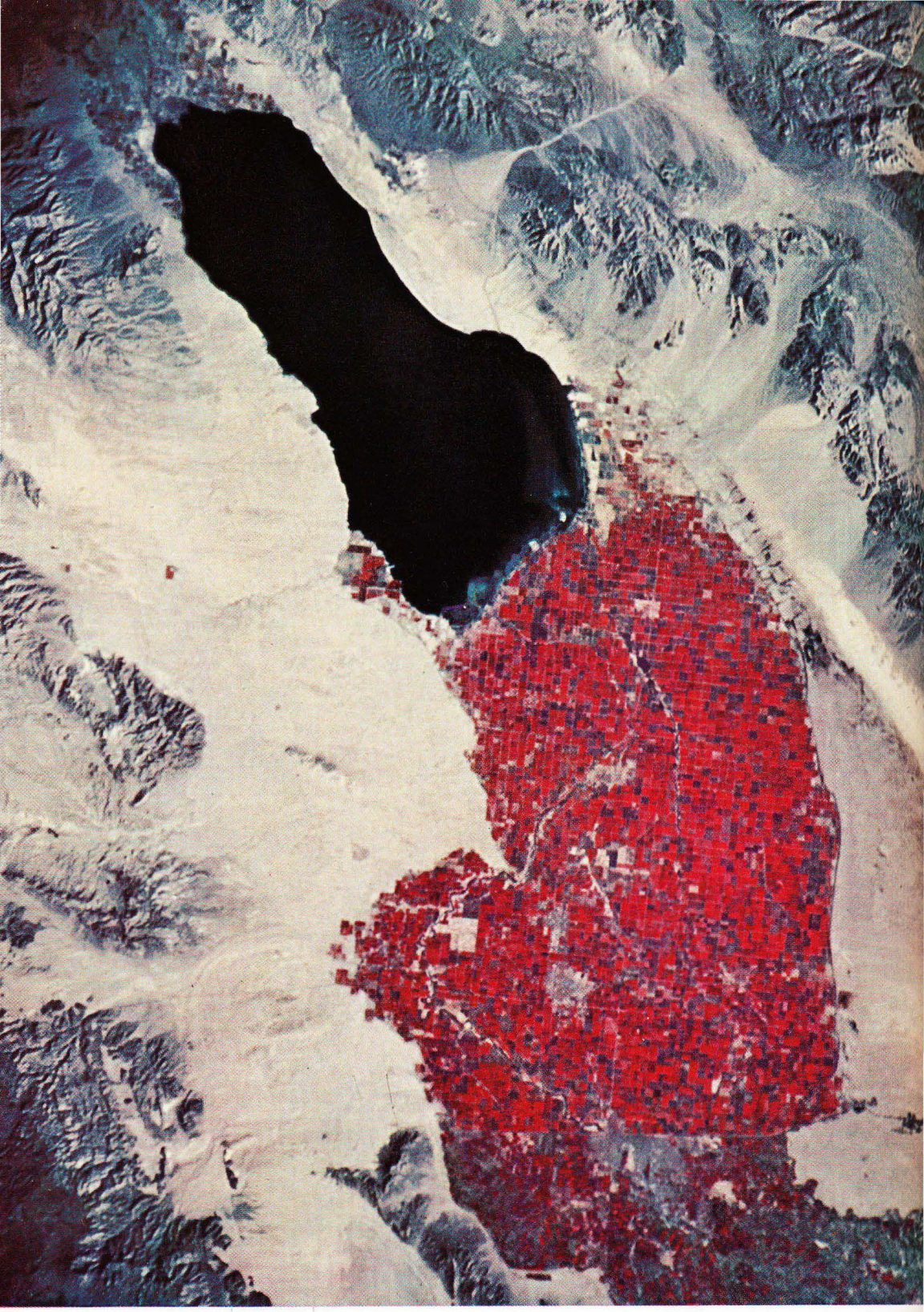
dunking in hot water inactivates quality-damaging enzymes that defy subzero temperatures. Faithfully preserving the food's flavor, appearance, and nutriments, quick-freezing wrought one of the early innovations of the agricultural revolution.



Like rubies spilled from a black silk bag, fields of the lush Imperial Valley flow from the d Salton Sea; infrared film turns healthy vegetation red in this photograph taken 150 miles above C fornia, Arizona, and Mexico by the astronauts of Apollo 9. Irrigation waters from the Colorado Ri far right, run along the dark lines of the All American Canal to convert the desert into a greenh of vegetables, cotton, sugar beets, alfalfa, and other crops. To carry away salts borne in by the r

EKTACHROME, NASA

waters, California farmers bury miles of drain tiles. In Mexico, where growers are less able to afford tiling, the salinity withers crops. The result appears here with grim clarity as California's lushness ends on a line that sharply marks the international border.

and waste a third of the feed if troughs are full, compared with only 1 percent if they are one-third full. And with a flock of 10,000 birds, that could mean a saving of nearly a third of a ton of feed a day."

Automated feeders, waterers, ventilators, and other labor savers make it possible for one man to take care of 100,000 broilers at a time, Dr. Sherwood added. The average producer handles about 20,000. Altogether in a year farmers in the United States raise more than two and a half billion birds—a dozen for every man, woman, and child in our population.

The competitive pressure for efficiency has led to specialization among poultrymen—one growing broilers, another raising chicks to egg-laying age, another keeping breeding flocks, a fourth producing eggs. My grizzled friend of the plastic boots put it succinctly, "It's gettin' so there's too much to keep track of in one part of this business, 'thout tryin' to know 'em all."

River of Eggs for Los Angeles

I saw this specialization dramatized in Julius Goldman's Egg City, 50 miles northwest of Los Angeles. One of the world's largest egg producers, it has two million hens.

Julius Goldman got into the egg business in 1951. An immigrant from Germany, he invested in 5,000 chickens to have something to do while he polished his English enough to pursue his regular profession, metallurgy.

"In those days a farmer might make only a dollar or so a year per bird," Mr. Goldman said. "Now he's lucky to make half that. To gain efficiency, we had to expand."

With Ben Shames, Egg City's Executive Vice President, as my guide, I saw what that expansion has required: A mill to produce the 250 tons of feed a day needed for the craws of Egg City's layers. Two wells to supply a daily demand for 100,000 gallons of water. A packing plant that cleans, inspects, and packages a million eggs a day. Block-long buildings, each housing 90,000 White Leghorns, cooped five birds to a 16-by-18-inch cage, and with row after row of cages suspended three feet above the floor (pages 172-3).

Wire-mesh bottoms of the cages slant, so eggs when laid roll out to a collection rack at the front. Fascinated, I watched employees push carts down the aisles between rows, shoving them ahead with their chests and loading the eggs onto plastic trays with both hands. And I followed a little battery-powered

truck as it moved along, pumping feed from a hopper into troughs before the cages. A dial indicated amounts delivered.

Mr. Shames explained: "We keep track of the feed eaten and the eggs collected in two rows of cages among the 110 rows in each building. When production drops to the uneconomic point, all 90,000 birds are sold to processors for potpies or chicken soup. It doesn't pay to keep track of every row in the house, let alone individual hens; with two million birds on hand, you have to rely on statistical sampling."

Droppings Pose a Problem

Just then a little tractor came by, equipped with an arm that plowed through the droppings on the floor beneath the cages.

"We used to spend thousands of dollars on insecticides to keep down flies," Mr. Shames said. "Now blades on the arm windrow the droppings, speeding drying and thus curtailing fly-breeding. At the same time the material is moved in stages toward the center aisle, where the tractor picks it up. We've just about solved the fly problem, but not what to do with the collected manure. And we have 120 *tons* a day to contend with."

This was a facet of farming I hadn't imagined. I got a more jolting awakening when I roamed the feed lots of the Blair Cattle Company in Blair, Nebraska.

"One cow produces as much waste as 16 humans," Harry J. Webb, the company's president, said matter-of-factly. "With 20,000 animals in our pens, we have a problem equal to a city of 320,000 people. But we kept that in mind when we bought this place."

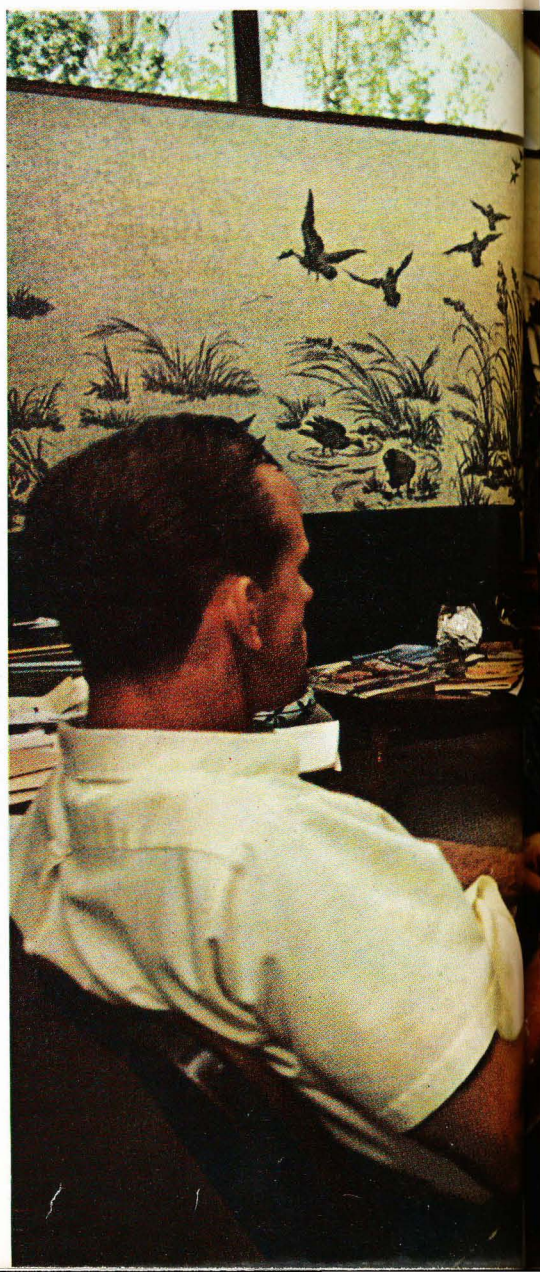
Details of how this energetic cattleman and his associates put together their feed lot epitomize the keen management involved in successful farming today.

"The company started in 1965," Webb told me. "We began with feasibility studies, using computers, to pinpoint an ideal location in relation to sources of feed and cattle. It also had to be central to slaughterhouses, on a major highway, and near a railroad. The land had to be hilly, so quick runoff would leave dry footing for the cattle after rains. The slopes should have a south exposure, so the winter sun would work for us, and we wanted a prevailing breeze for coolness in the summer. Lastly, there had to be pastureland where manure could be spread, and a place to build a drainage pond which would keep runoff from polluting nearby streams.

Farmer-executive Airplane and office are as familiar as the field to this modern American farmer of Marysville, California. Gesturing behind his long desk (below), burly Earl Blaser maps a harvesting campaign with his son and son-in-law. Working as many as 75 hands and $250,000 worth of equipment, they farm 2,300 acres planted in tomatoes, cucumbers, rice, and fruit. Diversifying like other businessmen, they also operate a farm-equipment agency and a duck-hunting club.

Piloting his own plane, Blaser inspects crops —and prospects for more acreage (right).

"Dad kept his farm records in a cigar box," chuckles Blaser, who today employs a full-time accountant. For decisions on planting and efficiency, he consults a computer, nowadays the progressive farmer's almanac.



KODACHROMES BY JAMES P. BLAIR © N.G.S.

"When this 320-acre place twenty miles from Omaha measured up, we bought."

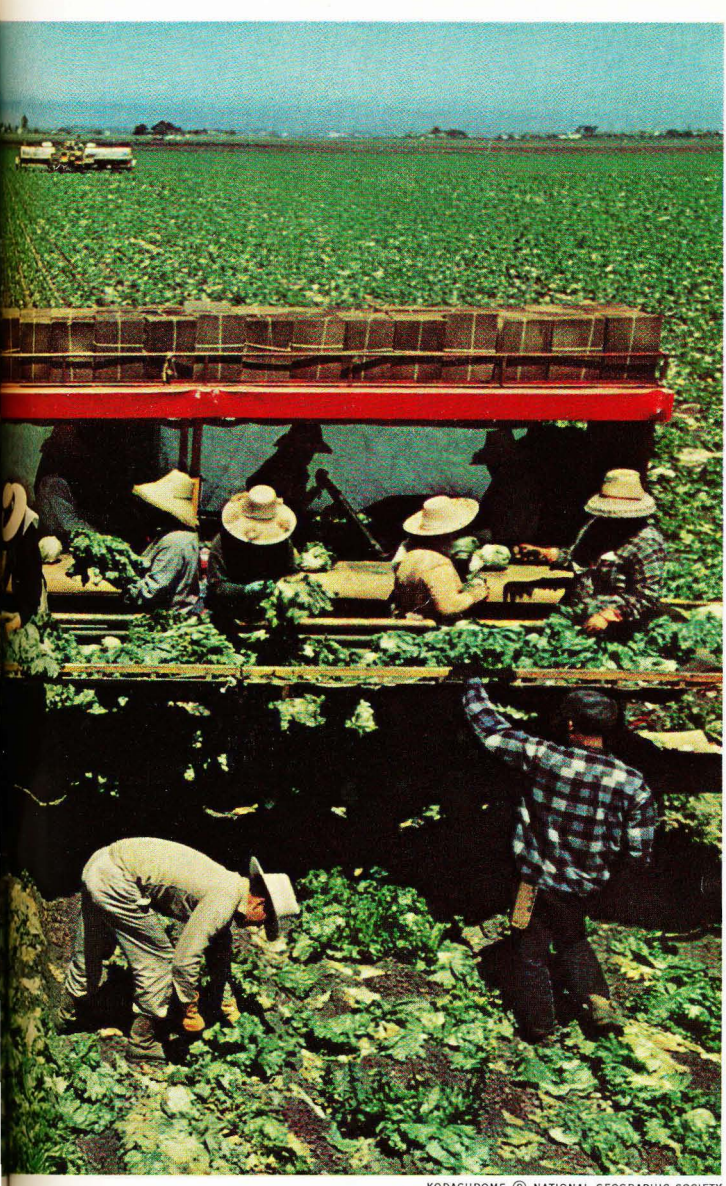
Now four miles of feed bunkers and concrete roadways to service them lace the one-time grain farm. A quarter-million-dollar feed mill rolls corn into tasty flakes and mixes a molasses-flavored ration that puts 2.7 pounds of weight on a steer every day. Calves bought for fattening grow to slaughter size in as few as five months; in the 1930's cattlemen figured on two and a half years.

Another revolutionary development in cattle raising unfolded for me when I traveled the hills of west Texas and the flatlands of the lower Rio Grande Valley.

"Used to be you couldn't afford to have calves born between early spring and late fall," a rancher told me. "Chances were that three out of four would die from screwworms getting in unhealed navels. Now that the screwworm eradication program is working, you can drop calves year round."

The screwworm, I learned, is the larva of a fly that lays its eggs in open wounds of animals. Hatched maggots eat the living flesh; a severe infestation can kill a full-grown steer in ten days. The insect's eradication is one of the brilliant achievements of our agricultural revolution.

"The female screwworm fly mates only once in her life span of three to four weeks," explained Dr. S. C. Gartman, director of the USDA's Screwworm Eradication Program facility at Mission, Texas.



KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Factory in the field

Its crew a precision team, a lettuce packer trundles along endless rows in California's Salinas Valley. Developed by Bud Antle, Inc., a mammoth growing and shipping firm, the machine packages the lettuce for market in a "once-through" operation that typifies the efficiency of today's large-scale truck farms.

As the machine crawls at 1½ miles an hour, men follow on foot cutting ripe heads. Women riding the harvester lop off outer leaves and wrap each head in transparent plastic. A heated "shrink tunnel" tightens the wrapper. Men at center pack 200 cartons an hour and leave them for trucks that will rush them for shipment to food stores across the Nation and in Europe.

After the harvester finishes the field, it will fold its outspread "wings" and propel itself at 45 miles an hour down California's freeways to reach the next crop.

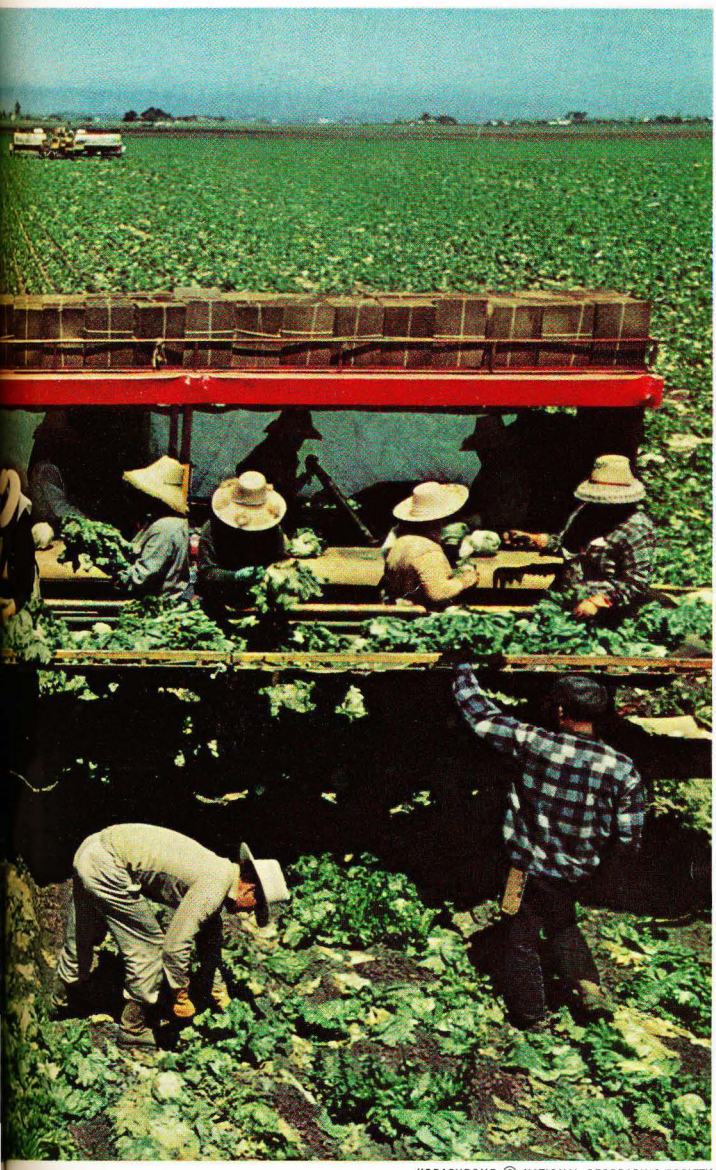
"Back in the 1930's, an entomologist studying the fly's life cycle suggested that if the female could be mated with a sterile male, all her eggs would be infertile. No progeny would result. Continuous release of an oversupply of sterile flies would progressively increase the odds against a fertile mating. In time, eradication would result."

Naked in a Fly Factory

Not until 1951, Dr. Gartman added, was a way—irradiation—found to sterilize the males. Tried in a test program on the island of Curaçao in 1954, the technique wiped out the pest in four months. A bigger-scale operation rid Florida of screwworm flies in less than two years. The plant at Mission, dedicated in 1962, currently produces as many as 200,000,000 sterile flies a week for release in a wide strip along the U. S.-Mexican border.

I toured the facility with USDA entomologist Bill Sudlow. Its operations—and security precautions against escape of fertile flies—astounded me. You strip off street clothes in a locker room, then walk stark naked through a double-doored corridor designed to trap errant flies. In an equipment room you don a hospital-white uniform. Three successive fly-trap corridors next have to be passed before you enter the fly-rearing room.

When you leave the factory, you reverse your route, pausing for a shower that washes away any pinpoint-size egg or half-inch larva you might have picked up. Even the notebook



KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Factory in the field

Its crew a precision team, a lettuce packer trundles along endless rows in California's Salinas Valley. Developed by Bud Antle, Inc., a mammoth growing and shipping firm, the machine packages the lettuce for market in a "once-through" operation that typifies the efficiency of today's large-scale truck farms.

As the machine crawls at 1½ miles an hour, men follow on foot cutting ripe heads. Women riding the harvester lop off outer leaves and wrap each head in transparent plastic. A heated "shrink tunnel" tightens the wrapper. Men at center pack 200 cartons an hour and leave them for trucks that will rush them for shipment to food stores across the Nation and in Europe.

After the harvester finishes the field, it will fold its outspread "wings" and propel itself at 45 miles an hour down California's freeways to reach the next crop.

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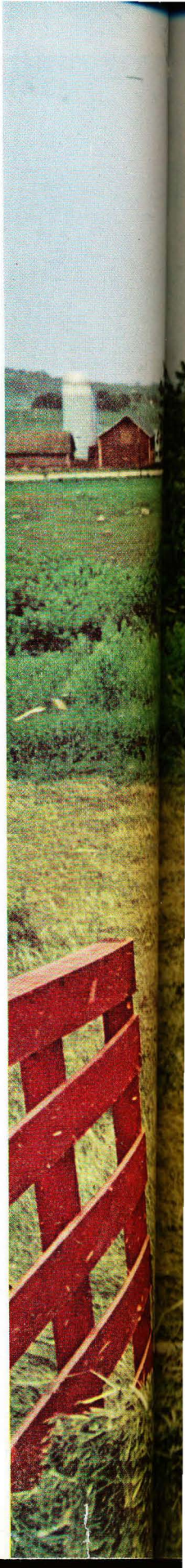
Making hay the acheless way: A bale sails 15 feet high into a wagon at Columbus, Wisconsin. Hydraulic catapult on the baler flings the 60-pounder, saving human backs from one of farming's most onerous chores.

Row-side service: As his wife delivers the lunch pail, Norman Barker empties corn from his combine on the family farm near Le Mars, Iowa. Fertilizing heavily, Mr. Barker raises enough corn on 140 acres to fatten more than 700 hogs and 100 head of cattle. Electrically heated pens permit the hogs to farrow even in winter, when he can tend them free of field work.



EKTACHROME (ABOVE) AND KODACHROME © N.G.S.


JOHN DEERE
24T

I carried had to go through a decontaminating "hot room."

I watched tiny larvae grow in racks of trays, eating in waves through a slurry of food made mostly from packing-house waste —"20 tons of ground pork lungs every day," Bill said. Reaching full size in 80 hours, they crawl over the edges of the trays and drop into troughs for mixing with sawdust, in which they transform into hard-shelled pupae.

Five days and 16 hours after pupation, sex cells begin maturing. Precisely then the pupae are exposed to sterilizing rays from radioactive cobalt. I marveled at the mass production of 200,000,000 living things a week with the precision you'd expect in a factory turning out nuts and bolts. And I was impressed by the implications outlined by Dr. E. F. Knipling, now director of the USDA's Entomology Research Division and the scientist who conceived the sterile male idea.

"Insects can't develop immunity to sterilization as they can to chemicals," he said. "There's no harm to beneficial insects, as may be the case with spraying—or residue to affect crops or wildlife. And we are now adapting the techniques to other insect pests."

Science also is learning how to turn other of the insect's own secrets into weapons. Among recent accomplishments in this field:

- Isolation of a hormone that, in a dose of only a billionth of a gram, keeps the young of certain insect pests from developing beyond the juvenile stage.
- Discovery that a hibernation-like stage known as the diapause may be affected by light, perhaps making it possible to trick insects into emerging in killing weather by means of light flashed over a field.
- Synthesis of sex attractants to lure insects to baited traps, where they can be destroyed or chemically sterilized. One substance, similar to that produced by female pink bollworm moths, is so powerful that a single pound would provide enough to bait 100,000 traps.

Researchers seek ways, too, of pitting natural enemies against plant and insect pests that plague the farmer. Wasps that lay eggs in alfalfa weevils have been released in twenty states. Leaf-eating caterpillars and seed-eating fly grubs shape a double-barreled attack against a weed poisonous to cattle on Western ranges. Bacteria fatal to corn borers are being packaged in capsules whose coatings

KODACHROME © N.G.S.

Bland coloring belies a nutritional wallop possessed by a new protein-rich corn strain, shown in cross section beside a yellow kernel of common corn. A team of scientists at Indiana's Purdue University bred the new variety by adding a protein-building gene, opaque-2, to common corn. Although still experimental, the new cereal stirs worldwide excitement: If geneticists can breed grains to rival meats in protein quality, mankind will win a major victory in the war against malnutrition.

dissolve at different rates—like timed-release medicines people take—to prolong the bacteria's effectiveness.

But the war against farm pests is a monumental struggle, Dr. Knipling cautioned. "Experts estimate that 75,000,000 acres of crops each year are lost to insects, weeds, and plant diseases. Biological control using natural enemies has built-in limitations—the parasites cannot eliminate all hosts without also destroying themselves."

Science Lessens Chemical Hazards

New pesticides and safer ways of using them pop from the laboratories: Systemic insecticides, for example, that plants absorb through leaves or roots for built-in protection, or ultralow-volume spraying of undiluted chemicals, which does more with less material (pages 156-7). Teamed with biological controls, such developments may ease problems posed by DDT and other poisons.

Last November the U. S. Department of Health, Education, and Welfare announced the Government's intention to curtail all except "essential" uses of DDT. The move spotlighted national concern over possible risks from pesticide residues in foods and the spread of chemicals in the environment through runoff from fields.

I discussed the subject of farm chemicals and their dissemination with Dr. Irving of the Agricultural Research Service.

"It is in the public interest to minimize contamination of our surroundings," he said. "But the farmer is not the big offender. Much of the problem is associated with industrialization and urbanization."

More phosphorus, with its oxygen-robbing effects on lakes and streams, comes from detergents and other city wastes than from farm soil, where the chemical is relatively immobile. And no cost-conscious farmer loses fertilizer to runoff by putting more nitrogen on his fields than he gets back in crop yields.

We talked, too, about agricultural research and its promise for the future. "Today's advances are based on yesterday's research," Dr. Irving said. "Right now more scientists are working on investigations related to agriculture than ever before. And this progressive accumulation of knowledge can only accelerate the farm revolution."

In laboratories of the U. S. agricultural research system—which reaches into every state—I learned about a changed emphasis in scientific aims. Said one scientist, "What's important now—and farther reaching—is not how to grow corn, but how corn grows."

I found scientists feeding plants radioactive fertilizer to analyze their growth; using chemicals to try to turn wheat straw, soybean hulls, and other waste products into nutritious animal feed; dosing sheep with a drug that enables the wool to be pulled off by hand, eliminating shearing (page 155).

I saw sorghum being popped, like popcorn, as an experimental cattle feed in a specially developed machine; wool being chemically treated so scales on the fibers won't tangle after a wetting—eliminating the cause of fabric shrinkage; wheat being processed into a quick-cooking nutritious form that can be substituted for rice (following page), or be used to make meatless dishes tasting like chicken, beef, or ham.

And I visited industrial plants and university campuses where brilliant minds are at work on other intriguing projects, such as farming the vast reaches of the sea, making protein from bacteria that live on the waxes in petroleum, and producing food for man or his animals from algae, newsprint, and even animal wastes.

City Boys Now Become Farm Experts

At one campus, the University of California at Davis, I was jolted by an unexpected fact. Even though the number of farmers in the United States is shrinking, enrollment in agricultural colleges grows.

"Job opportunities for graduates keep expanding," Dr. James H. Meyer, chancellor of the Davis campus, explained. "Many today are in agri-business—industries such as machinery or chemicals with farms as a market. Others are in rural sociology or environmental toxicology or one of the other fields that colleges have had to add to their curriculums to keep pace with the agricultural revolution.

"Once, only farm youths went to agricultural college. Today, four out of five of our students come from urban areas. We've even had to put in a course to teach city boys and girls such things as how to drive a tractor and what a milking machine looks like."

I had read statistics revealing that a third of the Nation's three million farms produce a gross income of less than $2,500 a year. At the same time, to own a farm requires an

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Wheat for rice-eating peoples: Peeled by lye, wheat gleams near-white beside untreated grain, left. Giving chewy, high-protein wheat the color and "mouth feel" of tender rice, the process makes it palatable to Asians unaccustomed to it. Scientists call the product WURLD wheat for its place of origin: Western Utilization Research Laboratory in Albany, California.

KODACHROMES BY JAMES P. BLAIR © N.G.S.

Walls of wheat rise from the Kansas plains at Hutchinson. Half-mile-long Far-Mar-Co elevator, rear, holds 18 million bushels. Each summer the elevators fill with wheat, then empty again as they feed the Nation's flour mills.

investment ranging from $20,000 for a small North Carolina tobacco farm to $100,000 or more for a well-equipped place in the Corn Belt and as much as $1,000,000 for one in California's productive San Joaquin Valley.

I had been told of some of the perils farmers face. "One year the crop was so bad I got only three peaches on my trees, and the birds and the ants beat me to those," my Georgia friend Bill Wilson had said.

"Just One Big Poker Game"

Why, then, would anyone want to farm? I got the answer from chats and chance remarks all across this productive land.

Ned Tyson, who raises corn and cattle on his Nebraska bottomland, phrased it one way. "Some days you lose, and some days you make it. Farming is just one big poker game, and I guess farmers are all gamblers."

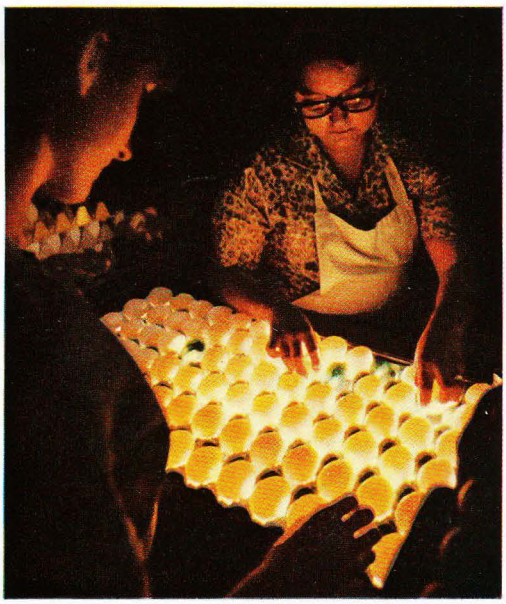
Dairy farmer Fred W. Marshall of Munnsville, New York, put it another way. "Sure I have to get up at 5 a.m. and keep on the go for 12 hours. But there's constantly something different to do—fixing fences, cutting brush, milking, planting, studying computer records, making business decisions, and so on. That's a lot better than tightening the same nut on the same part on an assembly line all day long."

Perhaps, though, the shrewdest summation of why farming attracts was expressed by a veteran farm publication editor in Washington, D. C. "Getting up to go to work in the fields is different from going to an office," he

Egg City, California

With a cart as his basket, a workman gathers part of the million eggs produced each day at an egg factory near Los Angeles. Egg City shelters two million Leghorns that gobble 250 tons of feed a day. When the 90,000 birds in a house slump below a computer-calculated output, all are consigned to chicken soup or potpies to make way for lustier layers.

Bright lights (below) underneath a conveyor reveal defects in shell, yolk, or white.



said. "Nobody makes you do it but yourself. And if you want to knock off at 2 p.m. to go fishing, and come back after supper to finish the plowing, nobody says you can't."

The number of farms with annual gross incomes of $10,000 or less is dwindling. Hard-pressed farmers sell out or lease to a neighbor who wants to expand. Older people retire. Death creates an estate, and the heirs decide the home place is too small to work profitably, so it goes on the block. Paper after paper that I picked up in farm states reiterated the story in poignant want ads: "Leaving farm. Dairy herd to be sold at auction." "Due to health, am moving to town. Machinery for sale." "Farm and equipment offered at sacrifice prices."

On the other hand, farms grossing more than $10,000 a year expand in number, with those in the more-than-$40,000 category increasing rapidly. The family farm figures largest in this growth. It accounts for 95 percent of all farms and 64 percent of total marketings. Corporate behemoths play no greater role today than 20 years ago; the specter of their progressively gobbling up all the farmland and in the end holding consumers at their mercy seems farfetched.

Leonard Warner of the American Farm Bureau Federation told me about limitations to the growth of corporate farms.

"The big corporation has to pay its farm managers and labor before it can count its

EKTACHROME (OPPOSITE) AND KODACHROMES (INCLUDING FOLLOWING PAGES) © N.G.S.

profit. But the individual owner pays himself with the difference between the farm's income and expenses; instead of hiring labor, he takes the hours of sweat out of his own hide. And as long as we consumers reward him with enough to provide the standard of living he aspires to, he'll hold his own against the big corporations."

Is She or Isn't She a Farmwife?

That standard of living has changed greatly. Once it was fairly easy to tell a farmwife because of her ill-moded attire and drudgery-hardened hands. Today she's as likely to be mini-skirted as her city sister, and as likely to own a dishwasher or self-cleaning oven or color television set. And her husband, who drives a tractor with automatic transmission and uses power tools to eliminate back-straining labor, is as likely to have gone to college as his town cousin.

Out where the Bearpaw Mountains rise against Montana's skies, and where wheatlands and cattle ranges stretch for empty miles, I discovered how profoundly life has changed for the farmer.

"Electricity has played a tremendous role," ebullient cigar-smoking Harold C. Ebaugh said. As manager of the Hill County Electric Cooperative, he bought its first pole in 1946 and shepherded its growth into a 2,990-mile network of power lines supplying ranches and farms around Havre, the county seat.

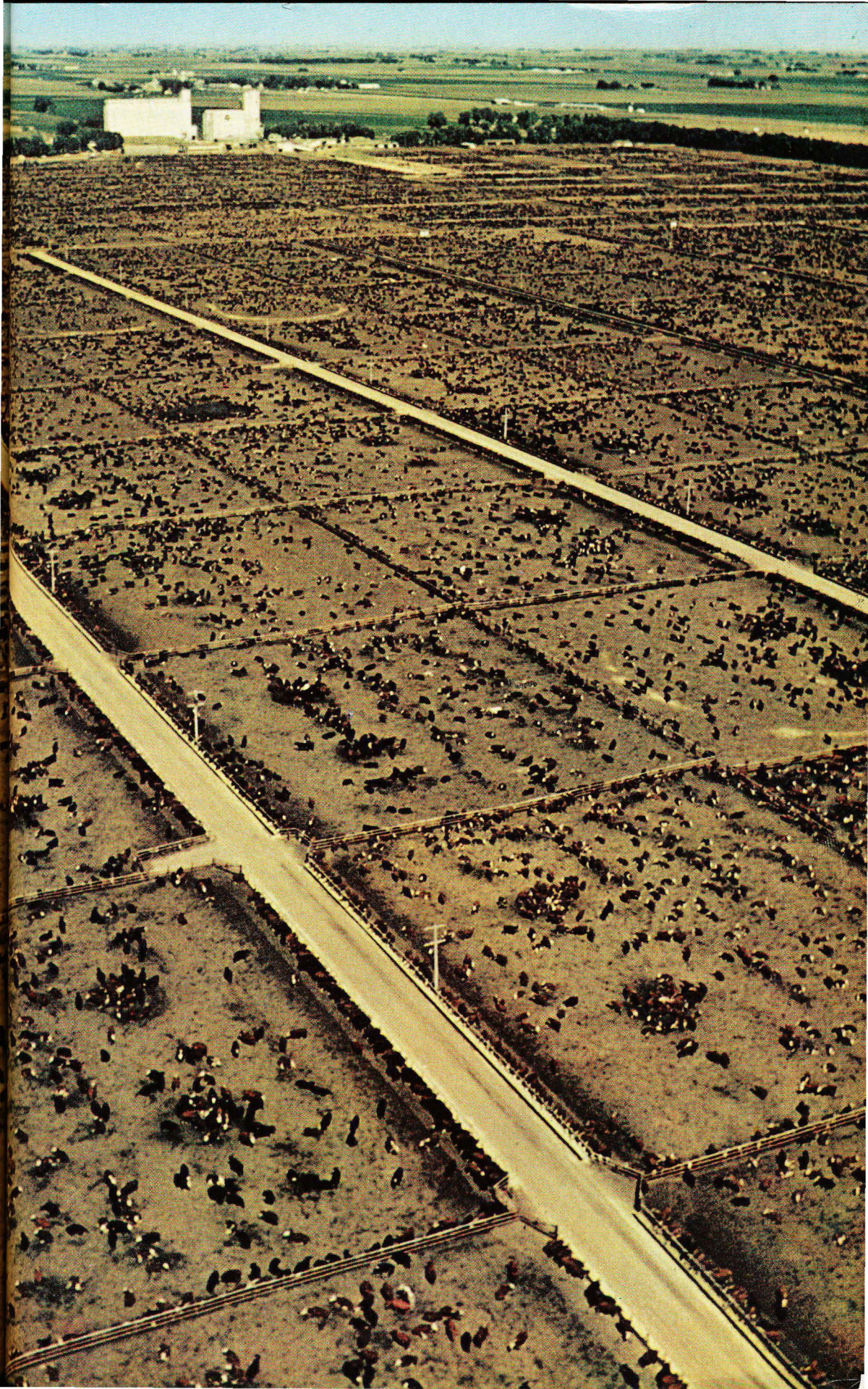
"Before we started, only a few farms had wind chargers or gasoline-driven generators, and they were adequate for no more than a few lamp bulbs and maybe a small water pump. Today our typical customer uses half again as much electricity as the city dweller. At least 35 different electric appliances and a hundred other machines with electric motors are being used on U. S. farms these days."

Electricity offers surprising niceties—having radiant heat in the concrete floors of pigpens, for example. I learned about this when I visited the 440-acre corn-and-hog farm of Norman Barker in the rolling prairie country of northwestern Iowa.

"Makes possible farrowing in the wintertime," he explained. "With insulated buildings, electric heat, and thermostatically

Beefburg, Colorado ▶

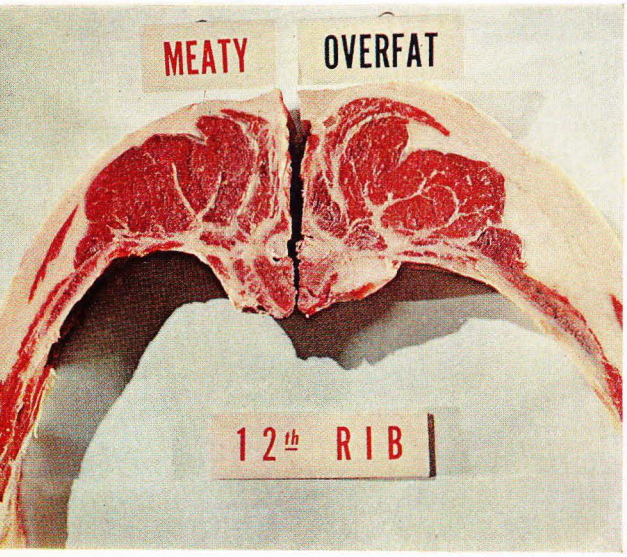
Sprawling Monfort Feed Lots near Greeley form a teeming bovine metropolis (following pages). Here 100,000 steers fatten, largely for Eastern restaurants and hotels. In a marvel of automation, computers prescribe formulas of ensilage and hot corn flakes for each pen; trucks distribute the rations into troughs lining the roads. Responding to such attention, a Monfort steer gains 2½ pounds a day during its three-to-five-month stay.



EKTACHROME (ABOVE) AND KODACHROME © N.G.S.

Her work its own reward, a technician at Beltsville samples beefsteak for tenderness and flavor. Red light eliminates appearance as a factor. She participates in a Department of Agriculture test to determine the effects of feeding methods and animal maturity on the quality of meat.

Fat is out, lean meat in. A demonstration at Iowa State University in Ames shows changing consumer tastes. The rib at left harbors 25 percent less fat —a result of intensive experimentation in genetics and selective breeding.



controlled ventilation I can manage four or five farrowings a year. That means labor and income spread over 12 months and a better average market price.

"My dad farrowed pigs in the spring, and they all had to go to market at the same time in the fall. When he raised 200, he was doing pretty good. I usually raise 700 to 800. But then farmers in dad's day didn't pour on fertilizer the way we do now to grow feed corn."

Farmers' Magic Touch: Fertilizer

Fertilizer has been one of the basic ingredients of the agricultural revolution. In a sense it replaces land, since it can multiply the yield of a single acre dozens of times. With more and more fertilizer, U. S. farmers reap record harvest after record harvest—and in the process get back as much as $3 in income for every $1 worth of chemical nutrients they spread on the soil. In 1968 they used nearly forty million tons—260 pounds for each acre under cultivation.

By contrast, the average cultivator in the underdeveloped nations had available a paltry five pounds. Yet American farmers aren't the world's heaviest fertilizer users. Europeans often use double what we do, and Japanese farmers four times as much.

I talked fertilizer and farming with slim, bespectacled Wayne M. Hansen while he harrowed a field near Dorchester, Nebraska. My perch on the tractor's fender made my notes a sawtooth scribble even when, out of compassion, he slowed to three miles an hour.

"You've got to keep getting more efficient to stay ahead in farming," he said. "Take that silo of mine over there."

Its vinyl-coated steel gleamed white on the brow of a hill.

"I used to have to drive from building to building picking up ingredients for the feed troughs in my cattle pens. With that silo they're brought together and mixed automatically. Takes me 20 minutes now to feed 200 head. I used to spend more time than that feeding 50.

"Of course, my feed set-up cost $30,000, and I haven't finished paying for it yet. But I'm already planning on expanding it. Perhaps I'm lazy; I use credit to save labor."

In a bustling county seat with the wonderfully rural name of Grundy Center, Iowa, I learned other things about farm credit from Wes Heckt. White-haired Mr. Heckt is board chairman of the Grundy National Bank.

"Credit has done a lot to help the farmer

take advantage of mechanization and other factors of the agricultural revolution," he said. "In 1920, when I started banking, $5,000 was a big loan, and people hesitated to borrow. Now a $40,000 loan is commonplace, and having mortgage after mortgage is an accepted thing. I occasionally wonder whether the average farmer will ever be out of debt."

With credit, daring, and managerial skill, today's farmer can build a substantial stake.

Earl Blaser started out on his father's 300-acre farm near Live Oak, California, teaching vocational agriculture in the winter and working the orchards in summer. Today he owns or leases 2,300 acres, flies his own plane to keep check on a multiplicity of crops (pages 162-3), and has at least $250,000 invested in machinery.

"Dad kept his farm records in a cigar box. I have to have an office, hire a full-time accountant, and use a computer to help me make decisions and measure my efficiency."

Deane F. Stahmann in 1932 added pecans to his cotton farm straddling the Rio Grande near Las Cruces, New Mexico.

"A nursery got stuck with a load of trees, and I couldn't resist a bargain," he explains. Now he has 200,000 trees, grows cotton in the sunny spaces between orchard rows, and raises 450,000 chickens in shaded areas. His multimillion-dollar investment includes 10 airplanes, a cotton gin, a feed mill, a pecan-shelling factory, and egg- and chicken-processing plants—to say nothing of a large maintenance shop for the farm's equipment.

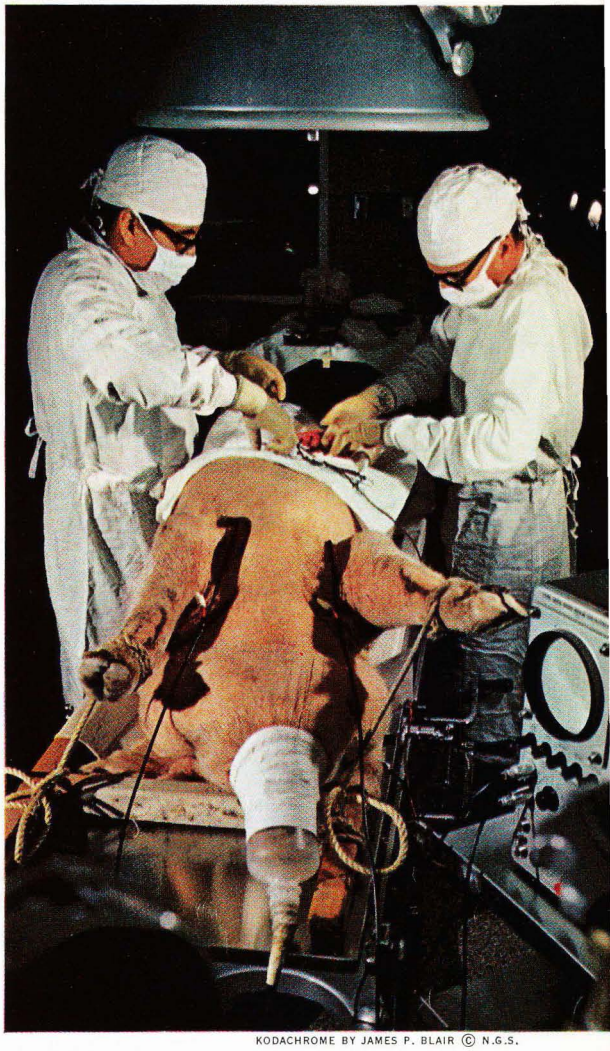
John and Henry Elmore took turns in alternate years, one going to college and the other staying home to run the family farm.

Today the two towering brothers—both are 6 feet 5—work 15,700 acres near Brawley in California's sun-flooded Imperial Valley. Their fields are half a mile square, and they raise cotton, canteloupe, lettuce, and other crops with tractor-plow combinations costing $65,000 apiece. And they've turned a melon shed into a factory producing 15,000 feet of flexible plastic drain pipe a day.

Irrigated Fields That Stay Fertile

Around that drain pipe hangs a story of one of the developments in soil conservation that have highlighted today's remarkable change in agriculture.

Irrigation water carries salts. The Colorado River brings to the Imperial Valley 1.25 tons in every acre-foot. Spread over fields, the water could deposit the salts through evaporation under the hot sun, eventually turning the land to saline desert. Drains laid beneath the surface make it possible to carry off the water with the minerals still in solution.

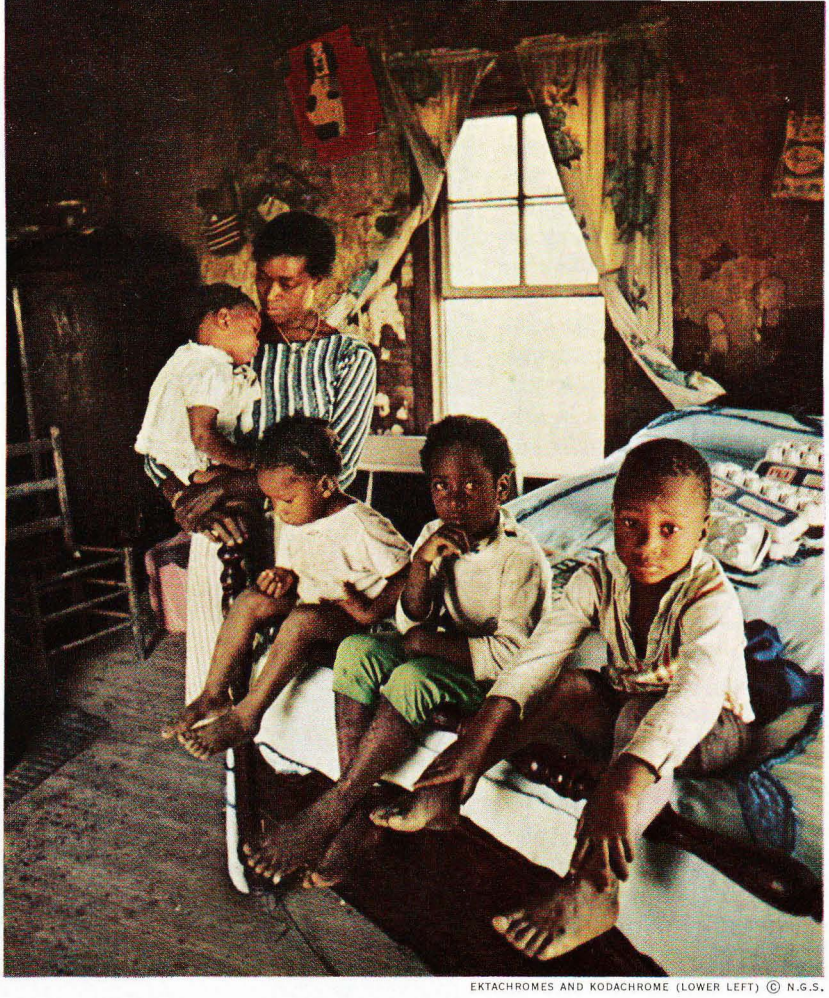


KODACHROME BY JAMES P. BLAIR © N.G.S.

Sow in surgery: An anesthesia mask on their patient's snout, a team at Iowa State University determines changes in a pig's ovaries during pregnancy. Such studies could lead to healthier litters.

"Growing cotton around here takes eight acre-feet of water a year," Henry Elmore said. "That means putting 1,600 tons of salts on a 160-acre field. If it weren't for the drains, we might face the same problem that helped erase ancient civilizations."

"When we began farming, drains were made of tile and spaced at 300-foot intervals," John Elmore told me. "Now the spacing is 100 feet, and in some fields, 50. It used to take six men to lay 300 feet of tile pipe, weighing more than a ton; a 300-foot coil of flexible



EKTACHROMES AND KODACHROME (LOWER LEFT) © N.G.S.

When machines displace people

Through the years, Ruth Anderson's husband had worked the sweltering cotton fields around Isola, Mississippi. In late spring Ed Anderson chopped cotton—hoeing weeds and thinning the plants. Summers he picked the cotton at $2.50 a hundred pounds. Between having her nine children, four of whom she tends above in the family's one-room shanty, Mrs. Anderson worked beside her husband. During picking season they brought home as much as $10 a day, and they got by.

Then onto the fields rolled machines (left) that harvested as much in a day as could 80 men. Picking jobs vanished. Herbicides came on the market to kill weeds; they killed the chopping, too.

Lacking a skill for steady work, the Andersons joined the hapless millions of rural refugees who, uprooted by mechanized farming, often drift to big cities seeking jobs.

To help stem this flow, civil-rights groups, foundations, and the National Council of Churches support a self-help community called Freedom City near Greenville, Mississippi. Determined to better his lot, displaced cotton worker Acie White (right) learns to read and write as he also masters the plumbing trade.

plastic pipe weighs only 65 pounds. We've developed a machine that slices the ground and lays the pipe as it goes, without digging a trench."

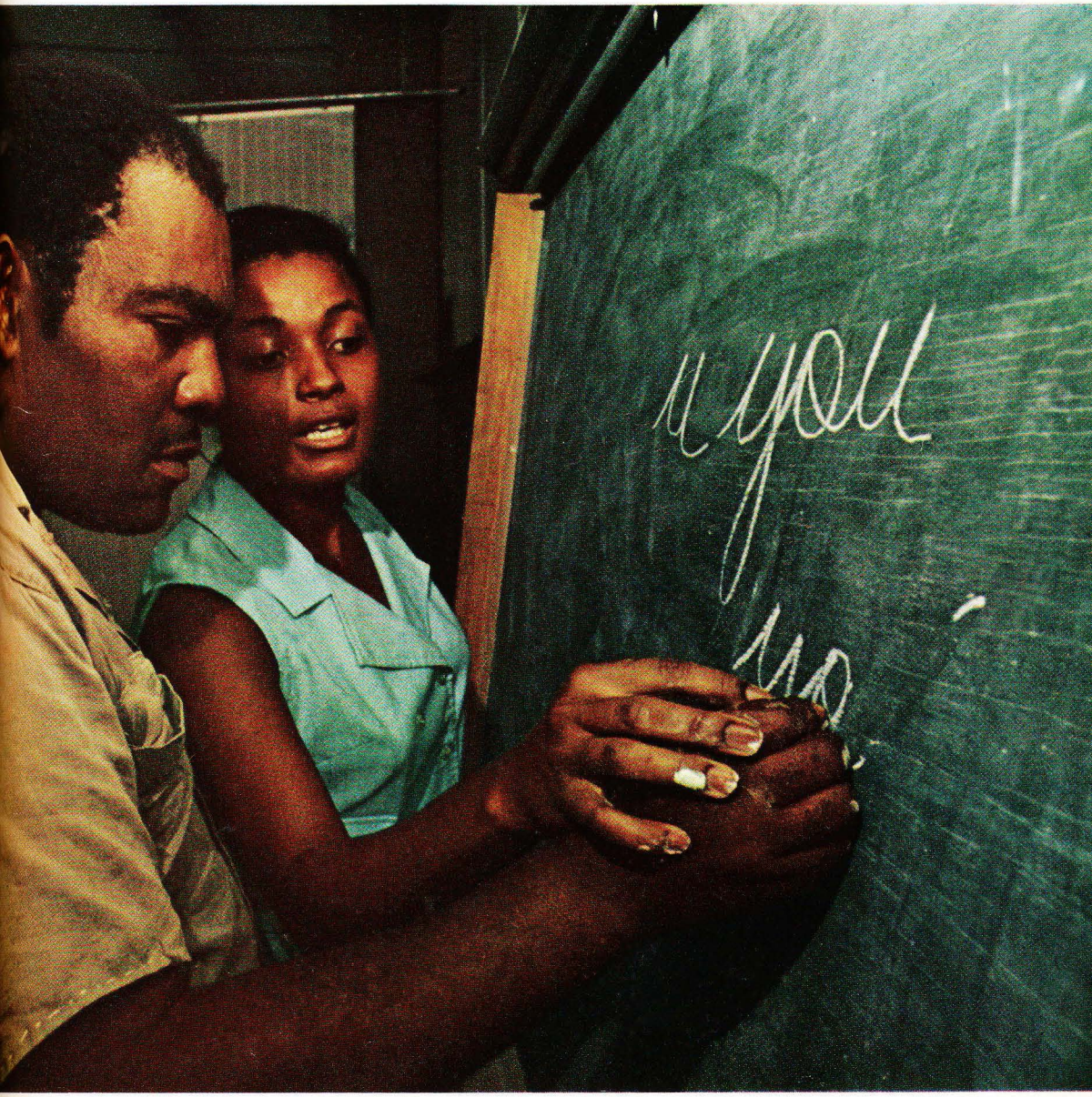
Other developments in soil management hold new promise for the farm. For example:

- Spraying hillsides with low-cost petroleum chemicals that prevent rainfall from soaking in, diverting it instead to reservoirs for use on thirsty fields.
- Spreading various materials in a covering layer on ponds to cut down evaporation.
- Replacing contour plowing with bench terracing that capitalizes on natural erosion to fill gullies and straighten fields, yet prevents loss of soil into waterways and streams.

I learned about another phase of soil research in the campus-quiet surroundings of the National Tillage Machinery Laboratory at Auburn, Alabama (page 155). Here USDA scientists study earth marked with telltale layers of facial tissue that show how soil behaves when turned by farm tools. Others experiment with such things as Teflon-coated plows for sticky clay fields.

Research goes on even into the side effects farm equipment has on the land—and whether fields actually need to be tilled at all.

"As farm machines become more and more powerful and grow bigger and bigger, they



increasingly compact the earth with their weight," said soil scientist Dr. William R. Gill. "This may even be offsetting the very aim of tilling—loosening the soil to promote plant growth. Hence there's a lot of interest in minimizing tillage by eliminating operations or doing several jobs with one trip through the field. And in 'zero tillage'—putting the seed in the ground amid the stubble and mulch of last year's growth."

We talked, too, about trends in farm planting, such as narrower spacing between crop rows, and precision planting—in which seeds may be placed at exact intervals on a strip of tape which dissolves after it is buried in the ground (page 153). Another innovation involves planting seeds in a capsule that releases fertilizer and water precisely when sprouting will benefit most.

Getting the prodigal abundance of America's fields onto consumer tables has seen marketing developments no less dramatic in their way than farming changes wrought by the agricultural revolution. New foods, too, reach grocery shelves. In 1900 fewer than a hundred different foods were readily available to the public. Today the number is ten times that. More are taking shape in laboratories and experimental kitchens.

Soybean Steaks Made to Order

At industrial plants in the Middle West I learned about soybean products made to look and taste like milk and meat. Highly nutritious, they worry dairymen and ranchers. An acre of grass fed to a steer can produce 43 pounds of protein; planted to soybeans, it yields 450 pounds. Ingenious machines spin the soybean protein into fibers of varying thicknesses, which in turn can be combined into textures resembling seafood, beef, ham, or chicken.

My wife finds temptation in the array of goodies on supermarket shelves. But like many a housewife, she complains about the prices. Her ire is only mildly eased by my citing the fact that, despite such prices, Americans still spend a smaller percentage of their earnings for food than any other people at any other time in history—about 17 cents out of each $1 of disposable income. And despite inflation, today's toil buys more: An hour's work buys you 25 percent more pork, 20 percent more beef, 13 percent more potatoes, 20 percent more milk, 25 percent more peas, 40 percent more eggs than it did as recently as the late 1950's.

Farmers complain that price hikes in the grocery stores seldom mean more money for them. Much goes for "built-in maid service"—processing that adds consumer conveniences grandmother never knew. Squeezed between higher operating costs and what he gets for his produce, the man on the farm must become more efficient or give up.

How many have given up can be seen in such figures as these: In 1910 our farm population accounted for a third of the U. S. total. By 1969 it was a mere twentieth. People leave rural areas at an average rate of 650,000 a year; many drift into cities where they join past migrants in the ghettos—to become added tinder for the riots that can be labeled one of the social consequences of the agricultural revolution.

Pitting bug against bug

Meeting on a cotton leaf battleground, two larvae lock in a combat that could save cotton farmers millions of dollars. Stalking the leaf's edge, a larva of the green lacewing fly nears a bollworm (top). Suddenly the lacewing lunges and sinks its jaws into the bollworm (center). Within five minutes the attacker drains the victim's juices (bottom).

Delighted by the lacewing's rapacity, entomologists at College Station, Texas, seek ways to raise hordes for release against the bollworm, which already has developed immunity to many insecticides. Similarly, scientists battle the cattle-killing screwworm fly by releasing billions of sterilized males. Females, mating with them, lay infertile eggs, rapidly eliminating the species.

When people leave the farm, rural communities that in earlier years had come into existence to serve them likewise wither away. You see it, for instance, in Kesley, Iowa, whose crossroads store did a thriving business before highways took shoppers to bigger centers. And in Cottonwood Falls, Kansas, where I came across a hand-lettered sign on the city clerk's office saying, "Open only mornings through tenth of each month."

"More people died here last year than were born," a waitress in the town's one remaining restaurant told me as I ate a Saturday lunch. "Kids graduating from the high school

go to college and don't come back, or go away to find jobs. But Cottonwood Falls is a nice place to live, and it's hard to find a house to rent because they're all snapped up by older people moving in from farms to retire."

Not all small towns are dying. The smog and the traffic and the social unrest of megalopolis prompts a second look at advantages of living in smaller communities. Industry, freed by jet planes and superhighways from dependence on nearby markets, shifts its plants away from cities. Employees are drawn by such appeals as being able, ten minutes after leaving work, to be out on the golf course, or roaming the woods with gun and dog, or watching kids and crops grow on a handful of acres a man can call his own.

Government programs enable small communities to borrow funds for water systems, sewer plants, better schools, recreation facilities, and other modern amenities needed to hold populations. Towns are pulling themselves up by their own bootstraps—Paola, Kansas, for example.

Paola is the county seat of an eastern Kansas county, Miami, that is predominantly farmland. But Paola benefits from being near enough—40 miles—to serve as a commuter community for sprawling Kansas City.

Recreation: New Source of Income

Paola benefits, too, from being close to Lake Miola Reservoir, a recreational asset that points up another revolutionary change taking place on America's farms.

Marginal farmers, and farmers with marginal land, are turning to recreation as a new source of income. A Maine dairyman, with 230 acres, 30 cows, and no economic justification for expanding, borrowed to turn his

"Do I get bigger, or do I give up?"

The question rides like a shadow with Fred Terry as he drives his tractor on the 130-acre family farm at Orient on Long Island, New York (left). Like thousands of other small farmers, the Terrys stand at a crossroads: Either they mechanize and expand, or rising costs, high taxes, and big-farm competition will drive them from the land.

Each spring, 15 Puerto Ricans fly up to pick the crops. "They're good workers," observes Fred. "They start with the strawberries in June and stay on through the peas and beans [above] and then the onions, cucumbers, and fall crops." More fortunate than many migrants, they enjoy tidy, spacious quarters and good pay.

Gathered for the family's traditional hearty midday meal (below), Fred sits between his mother and his father, who still runs the farm; around the table range his wife, their two-year-old daughter, and Fred's youngest brother.

Will they grow, or will they go? "Part of this farm has been in the family since 1732," says the senior Mr. Terry. "It's in our blood—I can't imagine doing anything else."

Farm of the future: Grainfields stretch like fairways and cattle pens resemble high-rise apartments in a farm of the early 21st century, as portrayed by artist Davis Meltzer with the guidance of U. S. Department of Agriculture specialists.

Attached to a modernistic farmhouse, a bubble-topped control tower hums with a computer, weather reports, and a farm-price ticker tape. A remote-controlled tiller-combine glides across a 10-mile-long wheat field on tracks that keep the heavy machine from compacting the soil. Threshed grain, funneled into a pneumatic tube beside the field, flows into storage elevators rising close to a distant city. The same machine that cuts the grain prepares the land for another crop. A

farm into a golf course; in two years he was earning as much as he had made dairying, and without the long wintertime work. A Pennsylvania farmer, with 150 acres near the Gettysburg battlefield site, put in showers and camping facilities in a wooded corner of his land; instead of growing corn he now caters to tourists—calling square dances for them at night. A Maryland couple takes in summer boarders willing to pay to share in farm chores so that their families may enjoy the wholesomeness of life on a farm.

What will farming of the future be like? Dr. Irving, of the Department of Agriculture, summed up a few of its facets for me.

"Agriculture will be highly specialized," he said. "Farms in one area will concentrate on growing oranges, those in another area tomatoes, in another potatoes—capitalizing on the competitive advantage soil or climate gives for a particular crop.

"Fields will be larger, with fewer trees, hedges, and roadways. Machines will be bigger and more powerful and able to do more operations in fewer trips across the land (painting, above). They'll be automated, even radio-controlled, with closed circuit TV to let an operator sitting on a front porch monitor what is going on.

"It isn't difficult to visualize agricultural plots several miles long and a hundred feet wide. Equipment straddling the strip will roll

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similar device waters neighboring strips of soybeans as a jet-powered helicopter sprays insecticides.

Across a service road, conical mills blend feed for beef cattle, fattening in multilevel pens that conserve ground space. Tubes carry the feed to be mechanically distributed. A central elevator transports the cattle up and down, while a tubular side drain flushes wastes to be broken down for fertilizer. Beside the farther pen, a processing plant packs beef into cylinders for shipment to market by helicopter and monorail. Illuminated plastic domes provide controlled environments for growing high-value crops such as strawberries, tomatoes, and celery. Near a distant lake and recreation area, a pumping plant supplies water for the vast operation.

on tracks or paved runways, swinging around at the end to work the adjacent plot without a wheel-touch compacting the soil in the cultivated areas.

"Weather control may tame hailstorm and tornado dangers," Dr. Irving added. "Atomic energy may supply power to level hills or provide irrigation water from the sea. Satellites and airplanes overhead will transmit readings enabling a farmer to spot diseases breaking out in his crops more surely than he could by walking through the fields.*

"Sensors buried in the soil will tell him when his plants need water, and automated irrigation systems will bring it to them. He may have at hand chemical means of speeding or slowing crop growth to bring harvests to market at optimum times. Such things sound fantastic, but already they exist in pilot form or in the research stage."

My mind churned with the implications of such developments building on the progress of the past. And a remark that I had chanced to overhear in my travels came into focus. It was voiced by an official of the Brazilian Government who had come to the United States to study our farming methods.

"We are concerned about the future of agriculture in Brazil," he said. "In your country, you *are* in the future." THE END

*See "Remote Sensing: New Eyes to See the World," by Kenneth F. Weaver, GEOGRAPHIC, January 1969.