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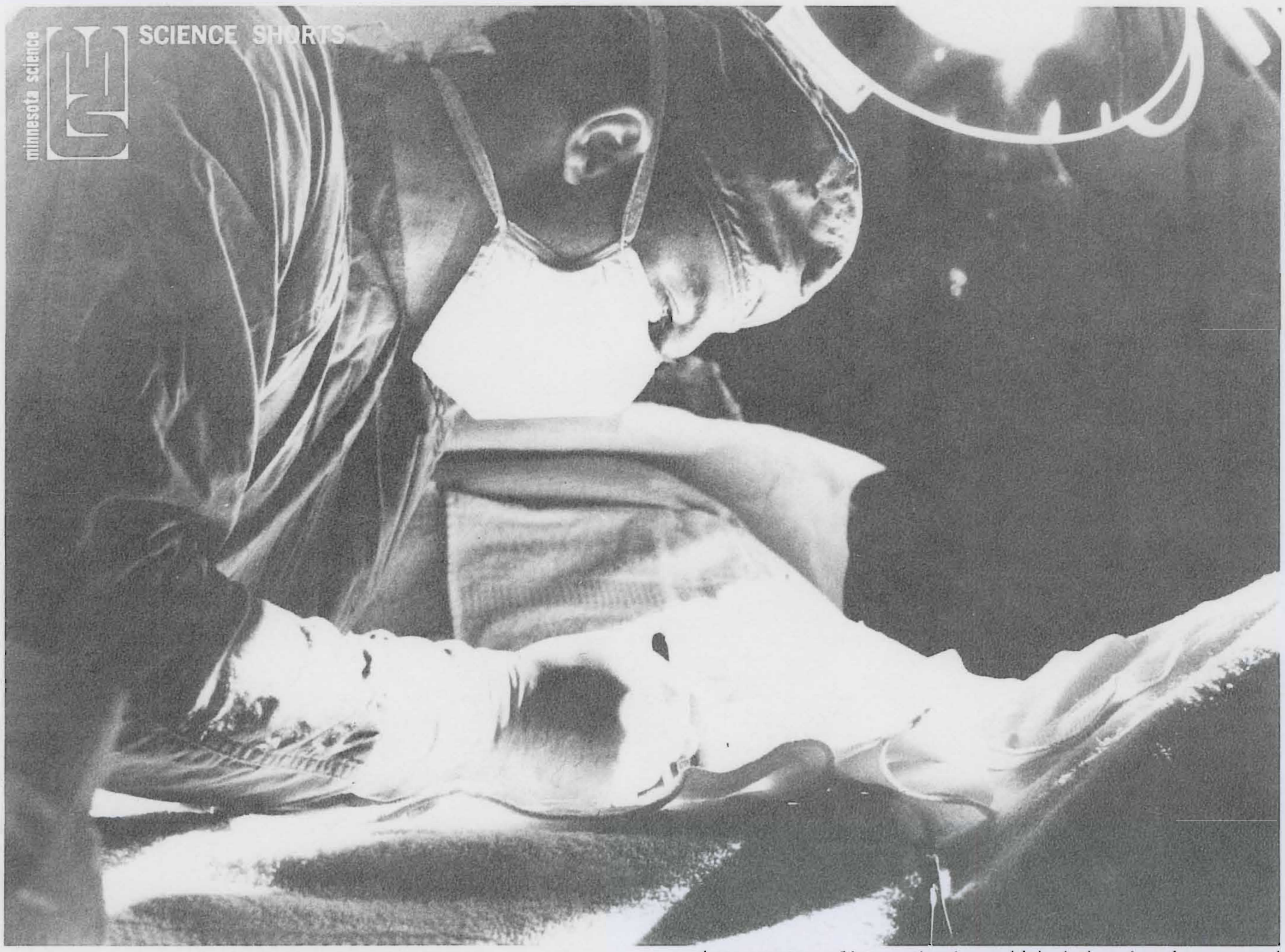

photo courtesy of international cryo-biological services, incorporated

An ova transfer in process. Eggs will be flushed from the reproductive tract of a genetically superior female cow. In a subsequent operation the eggs are implanted in another female to be carried through pregnancy to birth.

OVA TRANSFERS: A NEW GENETIC TOOL

Ova transfers may soon equal artificial insemination for improving genetic progress in cattle, predicts Experiment Station animal scientist Edmund F. Graham. Ova transfer is the practice of removing large quantities of fertilized eggs from a selected, genetically superior female cow and placing them in other females to be carried through pregnancy to birth.

"Ova transfers will make it possible for outstanding females to reproduce large numbers of offspring. The average cow produces only 3.5 calves per lifetime, and superior cows may produce from six to 10 calves. But with ova transplants, the potential number of offspring from a superior cow would be many times that number," according to Graham.

"What we need to make ova transfers work is the same foresight, ambition, and pioneering spirit that made artificial insemination work," says Graham. "For example, C. E. Cole (former chairman of the University's Department of Animal Science) first demonstrated that large numbers of cattle could be bred artificially in 1938." Cole was convinced that exciting possibilities lay ahead in extending the use of top sires to scores of dairymen. "The successful insemination of 1,000 or more cows per year is possible," Cole said at the time.

"Many 'doubting Thomases' said artificial insemination would never work," Graham recalls. Yet today, 70 million cattle are inseminated annually throughout the world. It's common to inseminate 20,000 to 50,000 cows per sire in a year.

"Although ova transfer is extremely promising, we're hearing many of the same things that we heard about artificial insemination in its infancy—it's too expensive, too few eggs are available, eggs can't be stored, surgery is necessary to collect and implant the eggs—in short, there are too many problems. Even though ova transfers require sophisticated surgical techniques, they will be practical in the future," Graham believes.

"But the practical application of ova transfers in cattle should not be an end in itself. This breakthrough should help make progress in controlling the estrus cycle, preserving fertilized eggs at low temperature, and enhancing superovulation—the release of large numbers of eggs. In 20 or 30 years we'll be able to control the estrus cycles of cattle so they can all be bred at the same time—a tremendous development for the beef industry, especially."

"We knew ova transplants would work over 10 years ago—now it's up to someone to refine the art," says Graham, who successfully transplanted an ovum in 1960 with other Experiment Station co-workers. A group of Wisconsin scientists first transferred an ovum in 1951. Graham, along with co-workers T. L. Avery, M. L. Fahning, and V. G. Pursel, was the first to confirm the Wisconsin work with another successful ovum transfer. The healthy calf was born March 18, 1960.

GYPSY MOTH HITCHHIKES ACROSS STATE BORDERS

Minnesotans visiting eastern states this summer may return home with an unwanted hitchhiker, the gypsy moth. In large numbers, the moths are capable of defoliating entire forests.

Cars, camper trailers, tents, and mobile homes can transport all forms of the moth to untouched areas, says David Noetzel, University entomologist. Tourists inspecting their vehicles "have a good chance" of finding the uninvited traveling companions.

Last year a live adult female was found in this state for the first time. It arrived in the state on a tent trailer from New Jersey. A mobile home moving from New York State was also found carrying an egg mass into Minnesota. State Agriculture Department officials believe Minnesota has no established moth populations, but added checks are being carried out this year.

The National Campers and Hikers' Association is cooperating with the USDA's Animal and Plant Health Inspection Service (APHIS) in maintaining a system of traps attractant to male gypsy moths. Minnesota is one of 37 states participating in the survey. Trapping with the attractant is being done to determine is the gypsy moth is already established in this area.

Hatching in April or May, the two-inch caterpillar is the destructive stage of the moth. He can chomp through a square foot of leaf surface every 24 hours. July is cocoon spinning time, and adults emerge in August. Eggs are laid before winter sets in.

The female moth is wingless, hence she cannot be trapped or travel far without "hitching" a ride. However, transfer of eggs and cocoons on cars and trailers far exceeds transfer of adults.

Gypsy moths like to attach cocoons and lay eggs in sheltered areas, notes Noetzel. Tourists parked in forested areas in eastern states might check trailer hitches, both sides of wheels, inside propane gas caps, under rims of gas bottles, under trailer steps, under loose metal at trailer and car bottoms, under camper trailer extensions, and at the juncture of truck cab and camper.

Caterpillars have long, flattened, pale brown bodies with long tufts of stiff brown and yellow hairs attached to the sides. The half-inch long cocoons are greyish-tan with a rough-tough silky cover. Egg masses are darker, compact and three-fourths to 1 inch in length.

"Once gypsy moths are loose in a forest much less can be done to stop them," says Noetzel. DDT was an effective control measure, he explains, but its use was discontinued for this purpose about five years ago because of public pressure. Pest controllers then turned to another insecticide called Sevin. When Sevin proved to be toxic to honey bees, public pressure led to its reduced use.

Insecticides have been the main method of keeping gypsy moth populations in check. Decreased use of insecticides in response to environmental objections has led to enormous increases in moth populations. Biological controls utilizing attractants, bacterial diseases and/or hormones have not as yet become feasible.

"The potential for spread of gypsy moth is much greater than it was five years ago," says Noetzel, "because of the greater eastern population of moths."

WILDLIFE TRANSMIT DISEASE

Wild mammals can transmit infectious diseases, such as leptospirosis, to persons engaging in water sports, and to hunters and persons eating meat from killed animals, warns a University veterinarian

Little is known about the extent of infectious diseases in Minnesota wildlife. However, evidence of leptospirosis was recently detected in the state's moose population, says Dr. Stanley Diesch, whose interest is diseases transmitted between animals and man.

Leptospirosis is caused by an organism called a leptospire, which is a type of bacteria. In early stages, the organisms are found in the blood of the affected animal. In later stages they are concentrated in the kidneys, and sometimes they are shed in the urine. Because the disease is often transmitted by natural waters contaminated with urine of shedding animals, swimmers, fishermen, and other watersportsmen are possible leptospirosis victims. Hunters may be exposed to the bacteria while field dressing their kills.

Certain measures will help protect hunters and their families from exposure. "Avoid puncturing the urinary bladder in field dressing, and don't use the kidneys for food," recommends Dr. Diesch. "Avoid splattering of body fluids upon yourself. If you have cuts or lesions on your hands, wear rubber gloves in dressing game. Outer clothing helps protect against possible infection. This would be a good routine to use at all times against a number of diseases."

"In the home, properly cook the meat to at least medium done. Temperatures of 140° F. will kill leptospires in laboratory culture medium in 10 seconds. Do not depend upon freezing of meat to kill the leptospiral organisms. Studies indicate that leptospires can survive in meat for an indefinite period of time at freezing temperatures."

"Leptospirosis is a major disease problem in cattle and swine in Minnesota. However, very little research on this disease in wildlife has been done in this state," notes Dr. Diesch. A number of species of game animals căn contract leptospirosis. In the United States it has been identified in squirrels, raccoons, deer, and opossums. Domestic animals also are susceptible. Research evidence indicates that the disease is transmitted among different animals species.

A recently completed study of moose killed in the 1971 hunting season provided some information on the wildlife situation. Researchers tested blood samples for evidence of leptospirosis and brucellosis and attempted to isolate leptospires from kidney tissue. Cooperating in the study were the Minnesota Department of Natural Resources and the University's College of Veterinary Medicine. Of 328 blood specimens analyzed, 6.7 percent had a significant number of antibodies against leptospirosis, an indication that moose had the infection at time of blood collection or had been previously exposed. Blood test results were "essentially negative" for brucellosis, says Dr. Diesch. Tests of kidneys from 173 moose were negative for isolation of the leptospires.

"A much higher prevalence of leptospirosis was found in northwestern Minnesota (about 10 percent of harvested moose) than in the northeast (about 1 percent)," he adds. "It is interesting to note that much greater cattle and swine populations exist in the northwest." "Hopefully, if future moose hunting seasons are developed, we will be able to participate in the research studies. We need a better definition of the leptospirosis problem in wild animals to help prevent disease in other animals and man."

Forest Fires
Effect on Animals and Habitat

MIKE RAHN
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Minnesota's largest wildfire in recent history has provided the setting for a study of how moose and deer and forest habitats respond to fire. The fire in question was officially named the Little Sioux Burn. It swept over nearly 15,000 acres in northeastern Minnesota in May 1971. Nearly 40 percent of the burn area was within the Boundary Waters Canoe Area (BWCA), renowned as a prime wilderness area.

The Little Sioux Burn left a charred and blackened landscape in its wake. But within 2 weeks after the fire subsided, grasses and other plants began to sprout. Shortly afterward, University researchers undertook a study to determine the relationship between fire and the community of plants, animals, and organisms residing in the forest. They hope to find out what role fire plays in maintaining a healthy and dynamic wilderness such as the BWCA.

Research on the Little Sioux Burn consists of three major focal points. Experiment Station wildlife specialist James Peek is studying how moose and deer have adapted to the burn. Miron Heinselman and Lewis Ohmann of the North Central Forest Experiment Station are documenting the various stages of revegetation and plant succession. Albert Swain, project associate from the University of Wisconsin, is studying the fire history of the BWCA and surrounding area.

Moose-Deer Study

James Peek has observed moose and deer populations and recorded these data since shortly after the fire occurred. Besides recording forage and shelter preferences of the two species, he is also noting the way in which animals colonize an area after a fire. It has long been known that moose and deer respond to burns, but the initial means by which the response occurs has not been evaluated. This information has a direct bearing on what adaptations moose and other animals make to survive in fire environments where habitats are rapidly created and destroyed.

Moose are generally believed to characteristically inhabit mature coniferous forests. But population density figures and other data gathered by Peek suggest a somewhat modified view. Moose are better equipped than deer to survive in mature forests, but they also prefer a habitat in which immature stages, such as brush and hardwood shrubs,

Postfire census figures gathered in the BWCA burn area showed moose preferred immature forest stages. Over a 2 year period, before and after the fire, the moose population increased from 1 moose per 2 square miles to 2 animals per square mile.

are present. Postfire census figures showed an increase from one moose per 2 square miles to more than two per square mile over a 2 year period. Peek also observed that the great influx of moose into the burn area could be attributed to immigration from surrounding areas rather than increased production and survival of calves from adults residing in the burn area.

Peek also determined what segment of the moose population, other than the returning residents, was most attracted to the fire-rejuvenated area. His census figures showed that the greatest number of incoming moose were yearlings. This appeared at first to be a contradiction because in the well-defined social structure of the moose, adults lord it over the yearlings. Young bulls often are not even allowed to breed. Normally, adult animals might be expected to assume control of the burn area. Peek believes this hasn't happened because once a young moose selects a particular range for its home, it rarely moves to a new range unless forced to. So it may be that the immigrant moose are dispossessed yearlings, looking for a range to establish themselves on.

Peek is watching the relationship between moose and and deer on the Little Sioux Burn with interest. Deer seem to prefer low, moist areas between ridges, where species such as jewelweed, fireweed, willow, and mountain maple are abundant. Land features seem less important to moose, but browsing preferences are more narrowly defined. Quaking aspen, willow, and fire cherry are favorites. Competition between moose and deer has not been observed, partly due to differences in diets, and partly because moose and deer browse at different heights. For instance, white-tailed deer in the burn area fed almost exclusively at the 12 to 30-inch level. Moose, on the other hand, fed at the 48 to 72-inch level. It is possible, however, that competition could arise later as forage preferences change when vegetation matures.

Peek is also interested in seeing whether a parasite carried by deer has an influence on the expansion of moose and deer over the burn area. The parasite is harmless to deer, but when transmitted to the vulnerable moose, it destroys brain tissue. In many cases, it results in crippling death. Close contact between deer and moose with the parasite present could eventually favor the deer population.

Revegetation Study

Understanding the vital role of fire in forest systems may help to preserve natural wilderness areas in the future. Miron Heinselman and Lewis Ohmann hope to add to that understanding by documenting the appearance and behavior of post-fire vegetation. The two researchers found that within a few days after the fire, plants, grasses, and sedges sprang up from scorched litter on the forest floor. Even though the fire burned with high intensity, the layer of duff and litter was not extensively damaged. Small mammals, insects, and microorganisms inhabiting the forest floor came through largely untouched. Most larger forest dwellers did equally well, fleeing to safe ground until the fire passed. Many animals were seen back in the burn area almost before the landscape cooled.

Three to four-foot vegetation covered much of the burn area by the end of summer 1971. Aspen was much more abundant than pines. Bracken fern, bunchberry, and large-leaved aster were seen frequently. Tall shrubs included mountain maple, juneberry, pin-cherry, honeysuckle, and willow. Low growing shrubs observed were sweet fern, blueberry, and raspberry. This lush post-fire growth provided ideal forage conditions for several animal

The greatest number of immigrating animals into the fire-rejuvenated area were yearling moose. Researchers believe the immigrants were dispossessed yearlings looking for range on which to establish themselves.

species, and moose and deer benefitted most.

Long-range plans of the vegetation study involve: (1) investigation of tree regeneration, (2) changes in the composition and structure of plant communities during the first 5 post-fire years, and (3) changes in plant biomass.

Eight plant community types common to the area were chosen for study: (1) jackpine on a dry granite outcropping, (2) aspen-birch on a dry ridge, (3) aspen-birch on a moist north-facing slope, (4) jackpine on sandy soil with crown fire, (5) jackpine on sandy soil with ground fire, (6) old red and white pine, (7) spruce-fir-white pine, and (8) white pine-fir-birch. These plots will be observed and and indexed each summer for 5 years, and once every 5 years thereafter to record changes in vegetation.

Fire History

Albert Swain is sampling sediment from Lake of the Clouds in the BWCA to learn the fire history of that area. His method consists of sinking a hollow tube down through the depths of the lake's sediments. Just as a tree's rings indicate its age, layers of sediment indicate the age of a pond or bog. One dark and one light layer comprise one year's deposits. Pollen found in the layers tells what vegetation was present in a particular year. Presence of charcoal grains indicates years when fires occurred. By reading the layers, Swain can follow the general pattern of plant succession following these fires.

Results of Swain's research indicate that most forested areas in the region burned at least once in the last 300 years. Large fires occurred every 10 to 50 years at some location in the BWCA until 1920. Thereafter, fire control measures greatly decreased the incidence of fire.

An historical study of this type gives a true picture of fire's traditional role in maintaining forest communities. It undercuts the notion that maintaining forests in a mature state is natural. With this knowledge, comes the responsibility to learn why fire may be a necessary and valuable natural agent in maintaining our wilderness areas.

Research assistant Rick Weires uses a vacuum sampler to gather insects from alfalfa plots. Over 36 species or groups of insects were monitored.

Insect samples from alfalfa fields are frozen, sorted, counted, and recorded by research technicians.

Alfalfa Management

A Team Approach

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More than 2 million acres of alfalfa are grown in Minnesota. Among the state's agronomic crops, only corn and soybeans have a greater economic value. Alfalfa's importance to the agricultural economy of the area is more impressive when one realizes that nearly 40 percent of the nation's 27 million acres of alfalfa is grown in Minnesota and the four adjacent states.

Alfalfa hay yields in Minnesota average just under 3 tons per acre. With good management of the best varieties, however, average yields could be in the 4.5 to 6 tons per acre range. Low yields can be caused by such things as poor stand, low fertility, and improper cutting schedule. However, losses from diseases and insects are substantial. Recent national estimates suggest that diseases cause a 25-percent yield loss in alfalfa. Insects cause another estimated 15-percent loss. At this rate, more than $85 million of potential alfalfa production in Minnesota would be lost annually to pests. This estimate still would not take into account losses that reduce the concentration of digestible energy, protein, carotene, and other quality traits.

A thorough understanding of the alfalfa pest problem in Minnesota is needed so that corrective measures can be

Table 1. Populations of pea aphids and spotted alfalfa aphids associated with five alfalfa varieties.

Variety	Number of aphids/3.5 sq. ft. during 7-15-71 to 8-5-71	8-19-71 to 9-10-71	5-4-72 to 6-1-72	6-8-72 to 7-7-72
	Pea aphids			
Team	5.6	22.5	5.8	50.9
Kanza	7.7	51.0	6.4	80.3
MSB-11	13.9	83.5	11.2	152.2
Weevlchek	12.6	107.8	11.7	281.0
Ranger	12.5	119.9	12.3	303.3
	Spotted alfalfa aphids			
Team	Not present	163.8	0.2	12.8
Kanza	Not present	14.8	0.0	0.3
MSB-11	Not present	58.2	0.1	5.8
Weevlchek	Not present	92.6	0.1	2.9
Ranger	Not present	61.9	0.1	2.3

developed. Past research has been conducted on many specific pest problems, but the total problem has not been studied. In 1971 a group of scientists in agronomy, entomology, plant pathology, and remote sensing developed a plan for studying the alfalfa ecosystems. This research project has developed into one of the most comprehensive studies of its kind ever conducted in the United States.

Five alfalfa varieties were chosen to include those both resistant and susceptible to most of the state's major alfalfa pests. Individual plot size was about 1/3 acre. The entire study required nearly 9 acres. Beginning when seedlings were 2 weeks old, fungicide treatments were applied weekly to part of each plot to control foliage diseases. (Note: These fungicide treatments are not registered nor recommended for forage production, but were used to experimentally assess losses from foliar diseases.) Weekly treatments were continued until fall freeze-up and started again in spring at first growth. Besides weekly fungicide treatments, weekly samples of insect fauna in each plot were taken. Plants were sampled weekly to study disease and plant-growth patterns. Aerial photographs were taken bi-weekly. Total forage yields were recorded for three cuts per season. Incidence of alfalfa mosaic virus infection, and severity of crown rot and root curculio injury were also noted. Climatic data were available throughout the study.

After 2 years' work, data are available, and the job of analyzing this information is under way. It will not be possible to complete the study until 1973 data are ob-

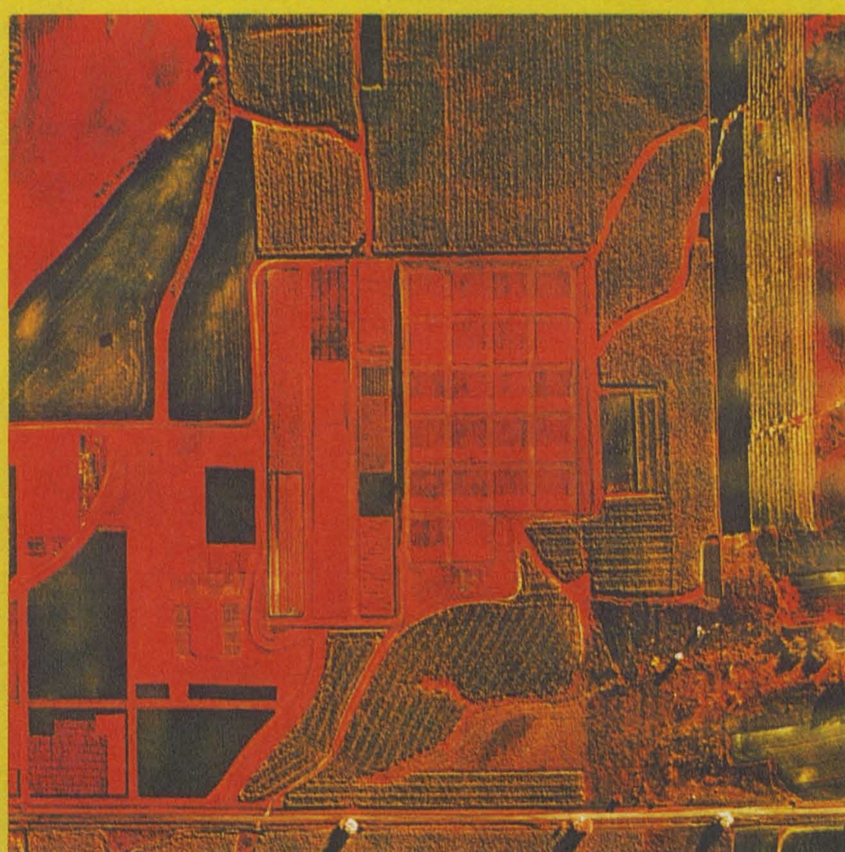
Table 2. Effect of fungicide applications on aphid populations in alfalfa.

Treatment and date	Number of aphids/3.5 sq. ft. Pea aphid	Spotted alfalfa aphid
Aug. and Sept. 1971		
No fungicide	70	75
Fungicide	85	81
June and July 1972		
No fungicide	164	4
Fungicide	184	5

Table 3. 1972 alfalfa hay yields on fungicide and nonfungicide treated plots

Variety	June 3 No fungicide	June 3 Fungicide	July 24 No fungicide	July 24 Fungicide	August 30 No fungicide	August 30 Fungicide	Season yield No fungicide	Season yield Fungicide	% yield loss caused by fungi:
Kanza	1.72	2.13	1.73	1.86	1.23	1.45	4.68	5.44	16
MSB-11	1.59	1.95	1.87	2.10	1.23	1.41	4.69	5.46	16
Ranger	1.59	2.09	1.51	1.94	1.13	1.43	4.23	5.46	29
Team	1.85	2.16	1.95	1.81	1.28	1.53	5.08	5.50	8
Weevlchek	1.66	2.15	1.49	1.99	1.20	1.51	4.35	5.65	30
Average yield	1.68	2.09	1.71	1.94	1.21	1.47	4.61	5.50	
Percent yield loss	24		14		21		19		

(Tons hay per acre for three cuttings)



Effects of fungicide treatment on various alfalfa plots are shown in this color infrared photo. Fungicide-sprayed areas show up as red portion, indicating presence of healthy vegetation. Unsprayed areas show up as black, indicating leaf drop from plant diseases.

tained, but many important findings have already been uncovered.

Entomologists have monitored more than 36 insect species or groups of species. Varieties and seasonal climate were both important in the differential buildup of insect populations (see table 1). Resistance of team alfalfa to pea aphid and susceptibility to spotted alfalfa aphid illustrate that resistance to one pest does not confer resistance to another. Much variation of insect numbers appears to result from interactions among insect species. As aphid populations increase, certain aphid parasites and predators increase until aphid populations are reduced.

Fungicides also significantly affected some insect populations (see table 2). Fungicides increased both pea aphid and spotted alfalfa aphid populations. This is important because increased aphid numbers are associated with increased incidence of plant viruses. The cause for these fungicide effects on insect populations are still being studied. From past experience we know that fungicides reduce fungal diseases that act as natural control agents of aphids. Fungicides also affect other insect populations by altering the amount of foliage present through disease-control action. This year plots will be further subdivided to study the effect of insecticides on the alfalfa ecosystem. Ecosystem studies are the only way to determine the total impact of chemicals on the environment.

Agronomists and plant pathologists have obtained data that compare yields on fungicide-treated and non-treated forage (see table 3). In 1972, substantial yield losses were attributed to foliar diseases. These losses among varieties ranged from an 8 percent loss in the variety Team to about a 30 percent loss in the varieties Ranger and Weevlchek. Average yield loss per cutting was 24, 14, and 21 percent for first, second, and third harvests. Seedling-year losses were also substantial in late fall, and their effects contributed to 1972 yield differences. Since fungicide treatment primarily controlled only foliar pathogens, we concluded that more than 25 percent of the potential alfalfa yield was lost to diseases. This increased loss figure includes losses caused by bacterial wilt, viruses, and the various root and crown rots as well as foliar pathogens. Losses in forage quality would be additional.

Aerial remote sensing was used to monitor changes in the alfalfa ecosystem during the last 2 years. Coordinating remote-sensing imagery with ground-truth data on insects, diseases, climate, and plant growth is just beginning; however, the potential of this technique appears great. The color infrared aerial photo on page 9 illustrates differences in disease injury among fungicide versus nonfungicide treatments. Color enhancement of this photo, using density-slicing techniques (see cover photo) greatly increased detectability of vegetation-stress variations caused by treatments. We anticipate that remote sensing may be used in the future for routine surveys of alfalfa production problems and yield potentials on a statewide scale.

Knowledge of a crop ecosystem is necessary to develop agricultural practices that maintain a desirable environment and produce a profitable crop. A multidisciplinary approach to solving complex crop production problems of modern agriculture is the best guarantee of success. Future plans for research include obtaining forage quality measurements in 1973. All available data will be integrated so that mathematical models describing the influence of various factors can be constructed. From these models, new pest control procedures will be developed. These results also will make it possible to orient breeding programs toward developing new alfalfa varieties that maximize production.

DRY FIELD PEAS

High Protein Food and Field Crop

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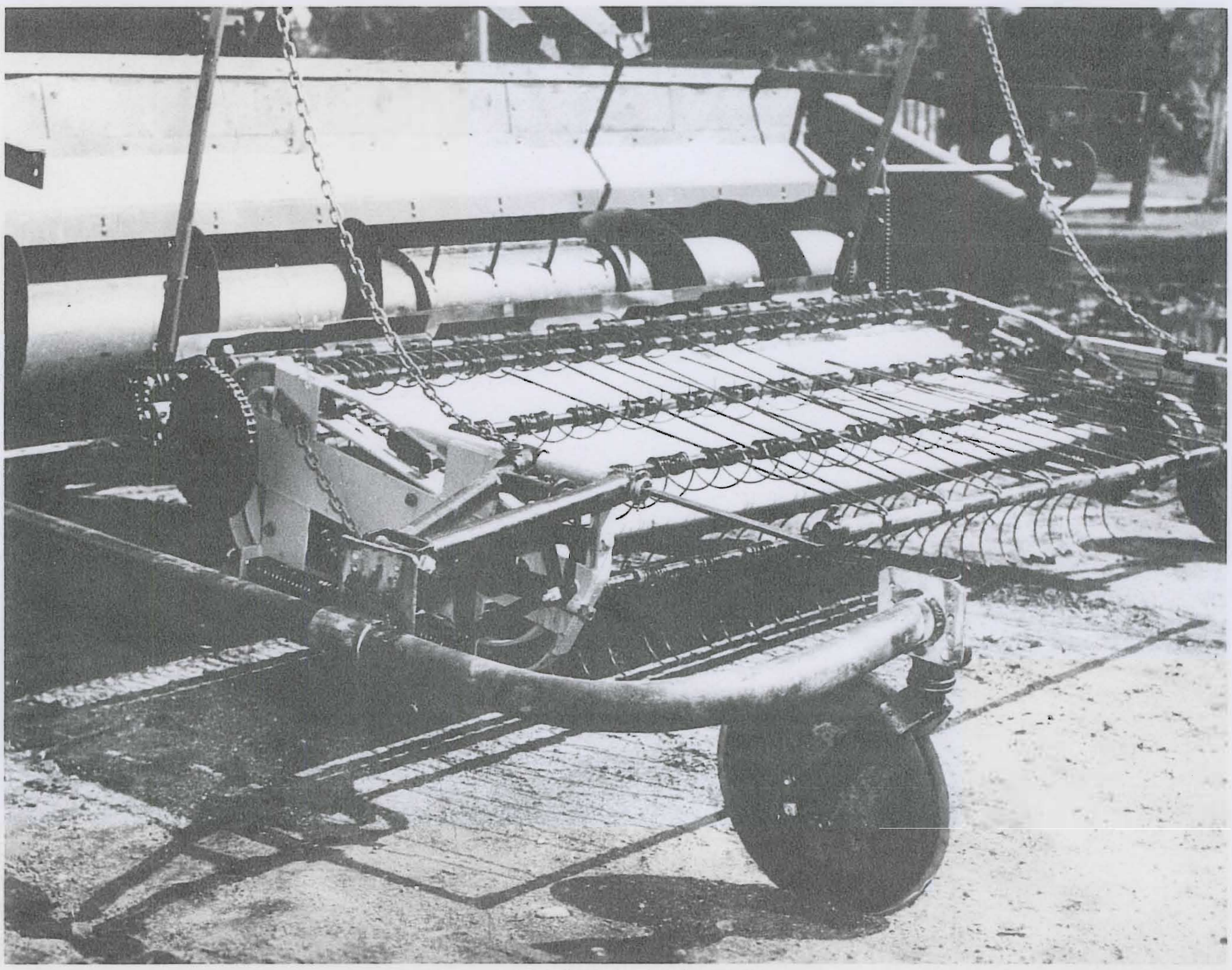
Demand for protein has skyrocketed prices to record highs. This affects not only the family buying meat and milk at the supermarket but also the farmer purchasing protein concentrates for cattle, sheep, hogs, and poultry. Livestock need additional protein to supplement insufficient protein in grain crops.

Protein Concentrates

Protein concentrates purchased by farmers are of crop, livestock, and industrial origin. Those of Minnesota crop origin are the meals remaining after oil has been extracted from soybeans, flax, and sunflower seed. Those of livestock origin include meat, fish, and dairy products such as tankage, fish meal, and dried skimmilk. In contrast to protein from farm products, urea is an industrial product that supplies nitrogen in a form that cattle can convert to protein. Urea is a major competitor of soybean meal for the cattle feeding market.

Farm-Grown Concentrates

Three Minnesota-grown crops of potential protein concentrate use are: dry field peas, dry field beans, and



A raking-type pickup breaks the dry pea vines at soil level and pulls them into the combine auger. The disc (shown in the foreground) separates swaths. Power-saw-like attachments are also available.

soybeans. Field beans and soybeans are cultivated row crops with growing season and temperature requirements similar to corn. Field peas are an uncultivated drill-sown crop with growing season and temperature requirements similar to spring wheat.

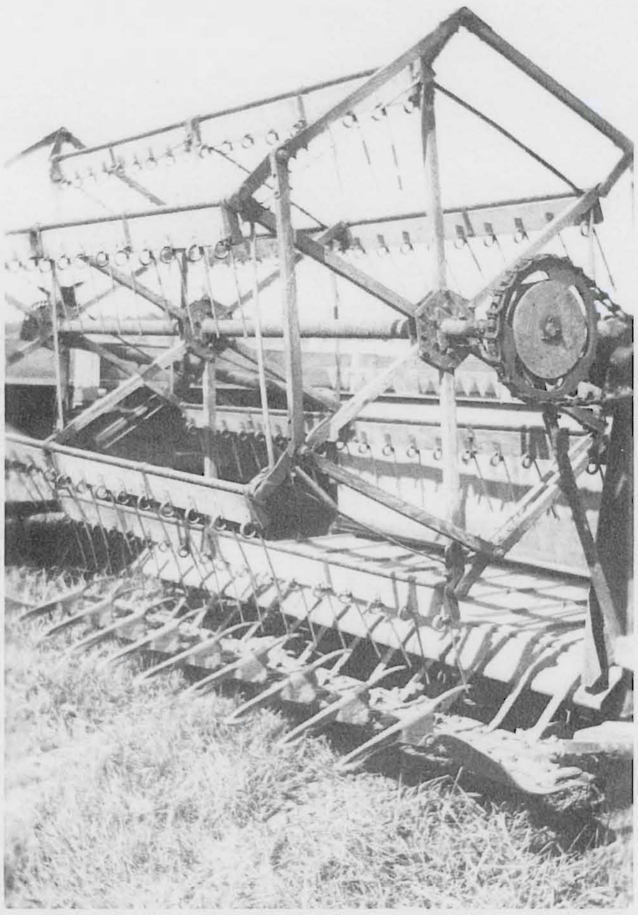
Seed of the three crops contains more protein than is needed for good nutrition and more of the nutritionally essential amino acids than most grain crops. Field peas are higher in protein and the commonly deficient amino acids (lysine and methionine) than field beans, but both crops are inferior to soybeans in these respects. However, soybean seed contains trypsin inhibitor that is detrimental to hogs and poultry. And because of urease enzyme, soybean seed should not be used in cattle rations containing urea. Roasting soybeans destroys these undesirable materials. Soybean roasters are available, but most farmers find it more satisfactory to sell soybean seed for oil extraction, and then buy the roasted meal. Unroasted dry field beans are also undesirable feed for nonruminant livestock.

Peas can be fed without commercial processing and have been used for human food and livestock feed for centuries. They are less likely than dry beans to cause flatulence in the human digestive system and can, therefore, be consumed in greater quantities.

Field Pea–Oat Mixtures

Research has shown that dry field peas in mixture with oats produce "more protein from oat acres" (table 1). In these trials Lodi and Garry oats were sown alone at 80 pounds per acre and compared with a mixture of oats 48 pounds plus peas 90 pounds per acre. The results illustrate several characteristics of peas. Peas are a legume and on sandy soil in Anoka County and on infertile clay soil at Duluth, pea-oat mixture produced more seed per acre than oats alone. But on fertile soil at Rosemount, the pea-oat mixture is not well adapted because lodging is serious with oats alone and even more so with pea vines. In southwestern Minnesota, pea-oat mixture is often not satisfactory because hot, dry weather during June and early July is more damaging to peas than oats.

Although data in table 1 show an advantage of pea-oat mixture over oats alone, peas alone are better for pea seed and protein production because oats are too competitive for peas. Oats in the mixture control weeds and partially support pea vines for harvesting. Now that herbicides to control weeds and satisfactory harvesting equipment are generally available, pure stands of dry peas may be an economic feed crop for eastern, central, and northern Minnesota.



If windrowing is needed, pea guards on the swather cutter bar slip under and raise lodged pea vines.

Table 1. Comparative yields per acre of oats alone and oat-pea mixture

Locations & years	Seed yield per acre Oats	Oats-peas	Protein yield per acre Oats	Oats-peas
	pounds		pounds	
Rosemount 1955-57, 1961-65	2273	1831	285	360
Duluth 1959-63	1555	1747	198	382
Anoka County 1955-57	1220	1529	165	289
Southwestern Minn. 1955-57	1600	1230	216	265

Table 2. Yields and protein percentages of dry field peas at four locations with comparative yields and protein percentages of oats at two locations

Locations, years, and varieties	Seed yield per acre	Protein
	pounds	percent
Rosemount, 1972, Century peas	2993	26.5
Rosemount, 1972, Lodi oats	2457	14.7
Elk River, 1969-72, Century peas, dryland	2031*	24.0
Elk River, 1971-72, Century peas, irrigated	2725*	24.0
Duluth, 1959-61, Chancellor peas	1414	28.2
Duluth, 1959-61, Garry oats	1557	13.2
Crookston, 1966-68, Century peas	1958	25.2

*Alleys between plots were included in the yield areas in 1972, so yields of the areas occupied by peas were higher than those reported.

Dry Field Peas Grown Alone

Seed yields and protein percentages of dry peas grown alone at four locations and with comparative yields and protein percentages of oats at two locations are shown in table 2. These results indicate that peas are sufficiently high in yield and protein for consideration as a high protein feed crop. Although a pea yield of 1 ton (24 percent protein) per acre will not replace 1 ton (45 percent protein) of soybean meal, it can replace part of it, and the nonprotein parts of the pea seed are equivalent to feed grain carbohydrates in nutritive value.

History and Problems

Minnesota produces 6,000 to 9,000 acres annually of dry field peas for human food plus a few hundred to few thousand acres in mixture with oats for forage. The usual price has been $3 to $3.75 for 100 pounds of seed. Certified seed has generally been available in northwestern Minnesota at about $5 per 100 pounds.

Weeds and difficulty in harvesting are two reasons peas are not more commonly grown. In contrast to canning peas, which are harvested by the canner before weeds mature and often before the peas lodge badly, dry peas lodge flat and are frequently overgrown with weeds before they are dry enough for combining.

Herbicides are now available to reduce the weed problem. Improved pickup attachments have made direct combine-harvest of the lodged vines practical (figure 1). Or if windrowing is needed, self-propelled swathers are generally available (figure 2).

In most of our trials, spraying for pea aphid control was not necessary. But it is occasionally needed. Malathion, parathion, demeton, dimethoate, diazinon, mevinphos, or naled insecticides are approved for postemergence use on peas.

Varieties and Rate and Date of Sowing

Century is the highest yielding variety and should be sown with a grain drill at about 200 pounds per acre. Trapper is a lower yielding, small-seeded variety grown for pigeon feed and forage and is sown at about 120 pounds per acre. It often matures less uniformly than Century.

Peas are resistant to frost and should be sown early—even in late March if the field is ready. Harvest is in late July or August.

Weed Control

Weed control is needed for satisfactory yields and harvesting. Trifluralin (Treflan) at 0.5 pound per acre was used preplanting in the trials on sandy soil at Elk River and 0.8 pound on silt loam at Rosemount. Other herbicides approved for use in dry field peas include barban, dalapon, diallate, dinoseb, and MCPB.

After peas emerge, the spike-tooth or coil spring harrow, rotary hoe, or weeder may be used to uproot and kill small weeds in the "white" stage without injuring larger peas.

Summary

Dry field peas are a nonperishable, high protein food and feed crop. Farmers can use dry peas to supplement the protein in farm-grown grains and thus reduce cash outlays for protein concentrates. Families can use dry peas for a significant part of their energy and protein requirements and greatly reduce grocery bills.

NEW MEATS LAB
An Art Becomes a Science

Shortly after World War II, the nation's swine industry started to undergo a revolution that reshaped the modern day hog. At that time, the average hog carried about 50 pounds of lard to the marketplace. Over the years, breeders selected for heavier muscled animals with a higher lean/fat ratio and by 1972 the average hog had only 21 pounds of lard at slaughter time.

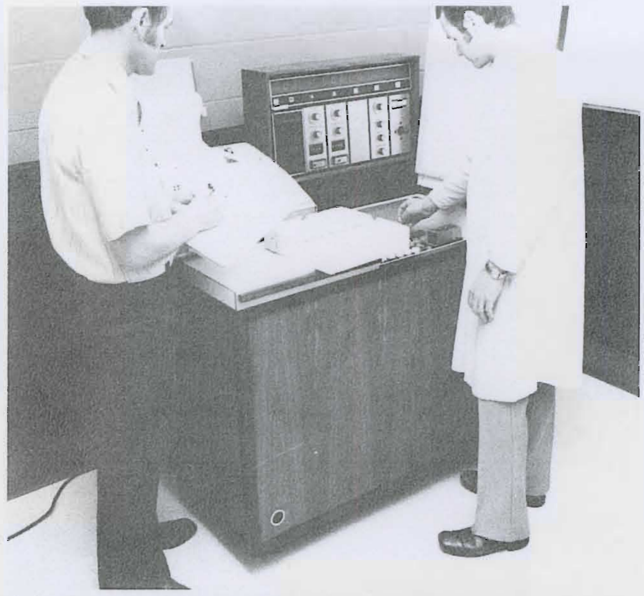
The accomplishment, however, was not achieved without some costs. Some of the meatier hogs became extremely susceptible to being handled and transported or even being moved from one pen to another. Carcasses of these animals frequently yielded pale, soft, watery meat that became dry and chewy upon cooking.

Today, this condition is recognized in the living animal as porcine stress syndrome (PSS) and the pale, soft, exudative meat is referred to as PSE pork. Discovery of the underlying physiological causes of PSS and the exact metabolic mechanisms that lead to poorer quality in pork is just one of many important contributions made by a growing group of researchers who call themselves "meat scientists."

Meat science traces its origin to a single course before the turn of the century at the University of Minnesota. The course in dressing and curing meats was the first offered by any school or college in the U.S. and Canada. But these early courses were largely instruction in the art of preparing and processing meat for human consumption. It has only been during the last decade or two that a sizeable body of technical information on meats has developed.

Since its modest beginnings in 1894, though, Meat Science at the University has come a long way. Dr. Andrew Boss, the first meats instructor, taught classes in a renovated silo. By 1901 the value of the meat course was so well established that the Regents authorized construction of a "modern and up-to-date laboratory." The new meat house was completed and equipped for a modest $7,500. Though little larger than a country school house, that structure remained the home for meats work until April 1973, when the new Meat Science Laboratory was dedicated.

The new $3.5 million, three-story brick facility houses laboratories on two floors for chemistry, microbial, and histological research. Offices, a teaching lab for 36 students, and a 120 seat lecture amphitheater occupy first floor quarters. The ground floor contains complete facilities for slaughtering and processing beef cattle, hogs, sheep, turkeys, and chickens. Spacious chilling and holding coolers, a cutting room, a processing and curing area, and physiology and quality control labs are located close at hand. All slaughter and product areas were designed to meet federal meat inspection standards.



Animal scientist Eugene Allen (left) checks on figures from a scintillation counter being monitored by research fellow, Gene Thompson. Allen uses radioisotope tags in his study of obesity and fat deposition in beef cattle and swine.

Joint Research Efforts

Three departments share facilities and cooperate on research projects currently underway in the Meat Science Laboratory. Animal scientists Eugene Allen and Richard Epley; food scientists Paul Addis, Charles Morr, Ted Labuza, and Sita Tatini; and James Libby of Veterinary Microbiology and Public Health comprise the present Meat Science staff. This unique mix of teachers, researchers, and extension personnel from different disciplines permits a broad-based program for meat animals. For the first time, experts in physiology, chemistry, microbiology, food processing, meat hygiene and other specialties are working together under one roof. This means that variations in meat products can be studied in their entirety–the genetic background, feeding history and environmental factors, ante- and post-mortem variables at slaughter, and each step in processing and storage until meat products reach the consumer.

Meats research projects reflect various and sometimes overlapping concerns of producers, processors, retailers, and consumers. Some examples of research currently underway include:

1. Pork stress syndrome (PSS) and pale, soft, exudative pork (PSE)-Prior research indicates PSS has a genetic origin, but the exact mode of inheritance is unknown. Some breed lines are apparently more susceptible to PSS and PSE pork than others. Heavily muscled animals appear to exhibit a higher incidence of the condition. Susceptible pigs are unable to maintain normal body functions due to hormonal imbalances caused by stress. Death of PSS pigs results from high carbon dioxide and low oxygen levels in the bloodstream as well as high lactic acid levels due to altered metabolism in the skeletal muscle.

   Studies indicate confinement rearing of pigs is more stressful than open lots. In Experiment Station swine herds, PSS-prone pigs have been lost upon weaning and movement to open lots, during transport, breeding, and even during mating. Losses can be reduced by minimizing stress, but steps must be taken to eliminate the genetic origin of the problem. Research is directed toward devising techniques to detect PSS in living animals. Paul Addis is working on a blood test that would detect high levels of certain enzymes and serve as an indicator of PSS pigs.

A freeze drier is readied by food scientist Ted Labuza (left) and research fellow Henry Warmbier to adjust moisture levels in food. Labuza aided in the development of several intermediate moisture foods being tested in the nation's space program.

2. Dark cutting beef-Researchers hope to reduce the incidence of dark-cutting beef, a condition caused by prolonged physiological stress before slaughtering. Dark-cutting beef has a dark and sticky lean surface and is sometimes confused with beef that has been displayed in retail meat cases too long. It is discriminated against by consumers and seldom goes to retail markets. Economic losses can amount to as much as $3.50 per hundredweight of carcass.

   Recommendations for reducing the incidence of dark-cutting beef have been developed and are available from your local Extension agent. (Ask for Animal Husbandry Fact Sheet No. 17-"Dark Cutting Beef.")

3. Fat deposition in meat animals-Researchers hope to learn what factors control the deposition of fat. Work with obese and lean strains of pig has revealed the surprising finding that lean pigs have more fat cells, but the cells are not as large as those in obese pigs. Eugene Allen is investigating the possible harmonal and enzymic control mechanisms within fat cells that determine the ultimate size of the cell. This work has added importance because of the possible implications of these findings to human obesity.

4. Muscle growth and development-Basic research is being conducted on developmental biology of muscle fibers from fetus to adult. How muscle develops, what fibers develop first and the sequence of later-developing fibers, the effects of inheritance on light and dark muscle formation, and many other answers are sought in this research effort. At the cellular level, studies are being directed toward determining the possible role of inutero nutrition on development and growth of muscle in the pig. A second aspect of this study is what role genetics plays in determining the number and size of muscle cells. Several different breeds with different degrees of muscling are being studied in cooperation with other animal scientists.

5. Palatability characteristics of meat-Tenderness, juiciness, and flavor are the three characteristics under study. Major thrust of research is on tenderness of turkey meat. Rapid processing of turkeys is a major cause of tough meat. Often turkeys are frozen within 1-2 hours after they have been slaughtered. As a result, rigor mortis has not run its full course. The process may be completed weeks or months later when the housewife thaws the bird. However, muscle that is frozen pre-rigor may undergo extensive contraction upon thawing and will most likely be tough. In some muscles, such as PSE pork and some breast muscles of turkeys there is a high buildup of lactic acid due to post-mortem muscle metabolism. Lactic acid denatures muscle proteins and allows juices to escape from muscle fibers. This results in loss of water-soluble vitamins and other nutrients as well as causing the meat to be dry.

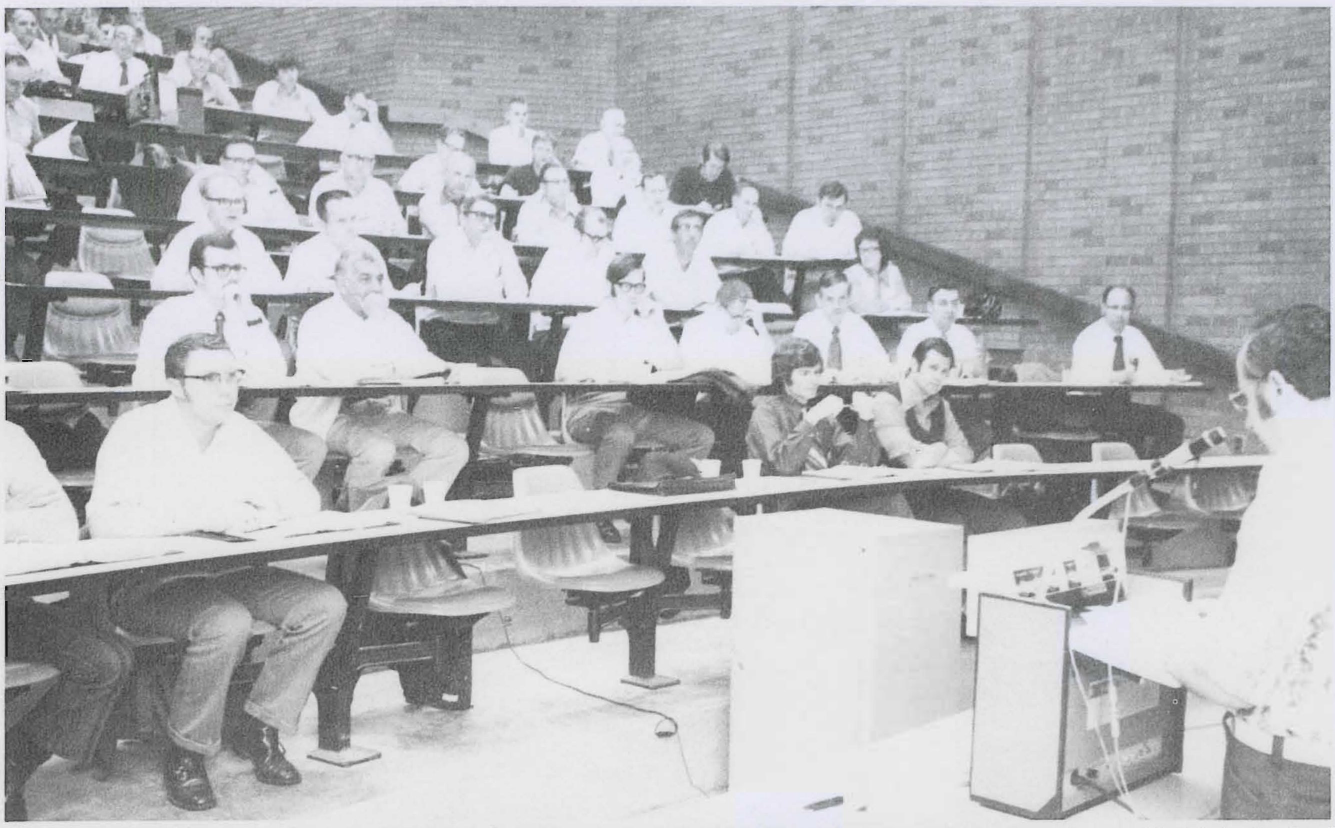
   Researchers are also looking at the time periods of rigor mortis and other variations between red and white (dark and light meat) muscle. Fibers of these two muscles vary greatly in their metabolism and properties as meat. Red muscle contains more connective tissue because its blood supply is more extensive (walls of blood capillaries are made of elastin connective tissue). It also has a higher fat content, which influences its flavor and storage characteristics. Red muscles use fat for energy during contraction and these muscles are generally located in areas of the body that are used frequently for work. This is why wild birds such as geese and ducks have dark breast meat: red muscle is required for long flights. Short-flight birds, such as the pheasant, have white breast muscle.

6. Food pathogens in meat—Three pathogens, staphylococci, salmonella, and clostridium perfringens, are under study. Sita Tatini and Frank Busta are investigating the growth, survival and production of toxins in meat and meat products during and after manufacture. Tatini is looking at a heat stable enzyme produced by staphylococci as a rapid indicator of the likely presence of enterotoxin. This test is inexpensive and can be used as a screening method for routine quality control. Enterotoxin development in meat products does not always take place and current testing for toxin is very complex, expensive, and requires 7 to 9 days.

   Sausage and bologna pose a problem because many companies rely on growth of desirable bacteria to produce flavor and taste, and to inhibit pathogenic bacteria. If desirable bacteria fail to grow, staphylococci can grow and produce toxin. Choosing the right bacterial culture for fermentation or adding a chemical acidulant to rapidly increase acidity, plus keeping products at lower temperatures (below 70° F.) should insure freedom from enterotoxin in sausage.

7. Intermediate moisture foods—A major breakthrough in the pet food industry came with the development of meat foods with a medium moisture content. These products neither require refrigeration nor leave a mess. Under work sponsored by NASA and the University, scientists are using the same principles to test the stability and palatability of foods developed for humans. An example is development of a food based on the composition of the old American Indian trail food "pemmican." It is currently being tested on board Skylab for shelf life. These foods also have significant application in supplying a minimum quantity of high quality protein and water for people on kidney dialysis machines who would like to prolong times between treatments. This would be a tremendous savings to them as tests at Mayo Clinic have shown.

8. Other projects underway involve techniques for rapidly analyzing fat and moisture contents of meat for industry quality control programs, isolation and characterization of a proteolytic enzyme in gingerroot that is an effective meat tenderizer, and methods of combining soy and meat proteins—to mention a few.



Short course participants catch up on the latest information in the expansive 120-seat lecture amphitheater in the new Meat Lab. Overhead projection screen and a carcass rail make the facility ideal for in-service training by University staff.

Future Research

Future research in meats could extend work already in progress, but several areas that have received little attention show promise. For instance, research on animal by-products could boost the value and usefulness of meat animals. Blood is an extremely nutritious animal tissue that might be used in combination with other meat or plant products. Certain federal laws are not conducive to its use now, but in several European countries it is readily accepted as a food product. Blood is rich in iron and researchers believe they could isolate other constituents, such as albumin, to enrich meat or other products.

Connective tissue of animals might also be extended as food. It is the most ubiquitous protein in animals and is presently used in the manufacture of gelatin. However, a microbial process might be devised to convert collagen to a more nutritionally complete protein and extend its use to other food products.

Research will be conducted to find successful ways of using meat and vegetable proteins in nutritional products that are acceptable to consumers. Compared to meat, soy protein products are low in iron, methionine (an important amino acid), and water-soluble vitamins. Soy-meat hamburger has recently appeared in some supermarkets, which emphasizes the need to more fully evaluate the functionality, and advantages and disadvantages of such products.

Long-time, low temperature cooking is another promising research area, despite the emergence of microwave cookery. Low temperature cooking offers several advantages. Meat tends to shrink less at low temperatures; nutrients, such as thiamine, are not degraded by lower heat, and meat is more tender and juicy after cooking. The only hazard is that cooking at too low a temperature might promote growth of food pathogens and other microbes.

Teaching and Public Service

Teaching is a major activity of the Meat Science staff and it reaches a wide and varying clientele. Ten undergraduate and graduate level courses are taught in Meat Science. But the teaching effort reaches an even broader audience through short courses for livestock producers, meat packers, processors, locker managers, food retailers, dieticians, restaurant operators, institutional food service workers, consumers, regulatory personnel, and other educators. Staff answer frequent queries about meat and offer meat science courses through General Extension's night school.

During recent legislative sessions, the staff was called upon to provide expert testimony on impending meat regulations such as labelling and shelf life. Further consumer information is made available in a variety of new publications, fact sheets, research reports, newspaper articles, and frequent radio and TV programs.

Speeches dedicating the new Meats Lab alluded to the importance of Minnesota's $1 billion-plus meat industry to the state's economy. But the tangible and intangible benefits accruing from this facility should reach even further. Consumers can continue to expect and rely on an abundant supply of high quality, nutritious, safe, and flavorful meat in years to come. At the same time, Minnesota-produced meat products will maintain their competitive edge in marketplaces and homes across the nation.

for each year of the biennium gave us a start on breeding, disease, and cultural practices. The 1973 Legislature provided an additional $30,000 each year. With an annual grant of $15,000 from the USDA, approximately $120,000 will be spent annually on wild rice research. New areas of investigation will include engineering and fertility practices in paddies. This new and developing industry of northern Minnesota offers great economic potential for both the area and the state.

EDITOR: What about increased funding for soybean, forestry, and potato research?

HUEG: Well, the increases in these programs were just about taken care of by the growing costs of salaries, fringe benefits, and inflation.

EDITOR: Then you were able to continue most projects and add to the overall program supported by state funds?

HUEG: Yes. The Legislature is to be commended for the attitude they took toward the Station's research program. It is our understanding that many legislators heard from our clientele, who expressed their desire for continued support of our program. We appreciate this support and the Legislature's response to our requests. It will enable us to provide the research backup that has aided Minnesota's food and fiber industry to become a $5 billion enterprise.

FINANCIAL STATEMENT
Minnesota Agricultural Experiment Station

Research Fund Expenditures
Year Ended June 30, 1972

Expenditures by Source

	Percent	Amount
Federal Funds	15.5	$ 1,772,737
State Appropriations	62.6	7,131,635
Gifts and Grants	12.1	1,384,970
Fees, Sales, Miscellaneous	9.8	1,112,505
TOTAL	100.0	$11,401,847

Expenditures by Object Classification

Personal Services	70.1	$ 7,988,676
Travel	1.6	184,815
Equipment, Lands, Structures	5.9	672,208
Supplies and Expense	22.4	2,556,148
TOTAL	100.0	$11,401,847

Expenditure by Location

University Campus—St. Paul	84.4	$ 9,622,120
Branch Stations—within Minnesota	15.6	1,779,727
TOTAL	100.0	$11,401,847

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