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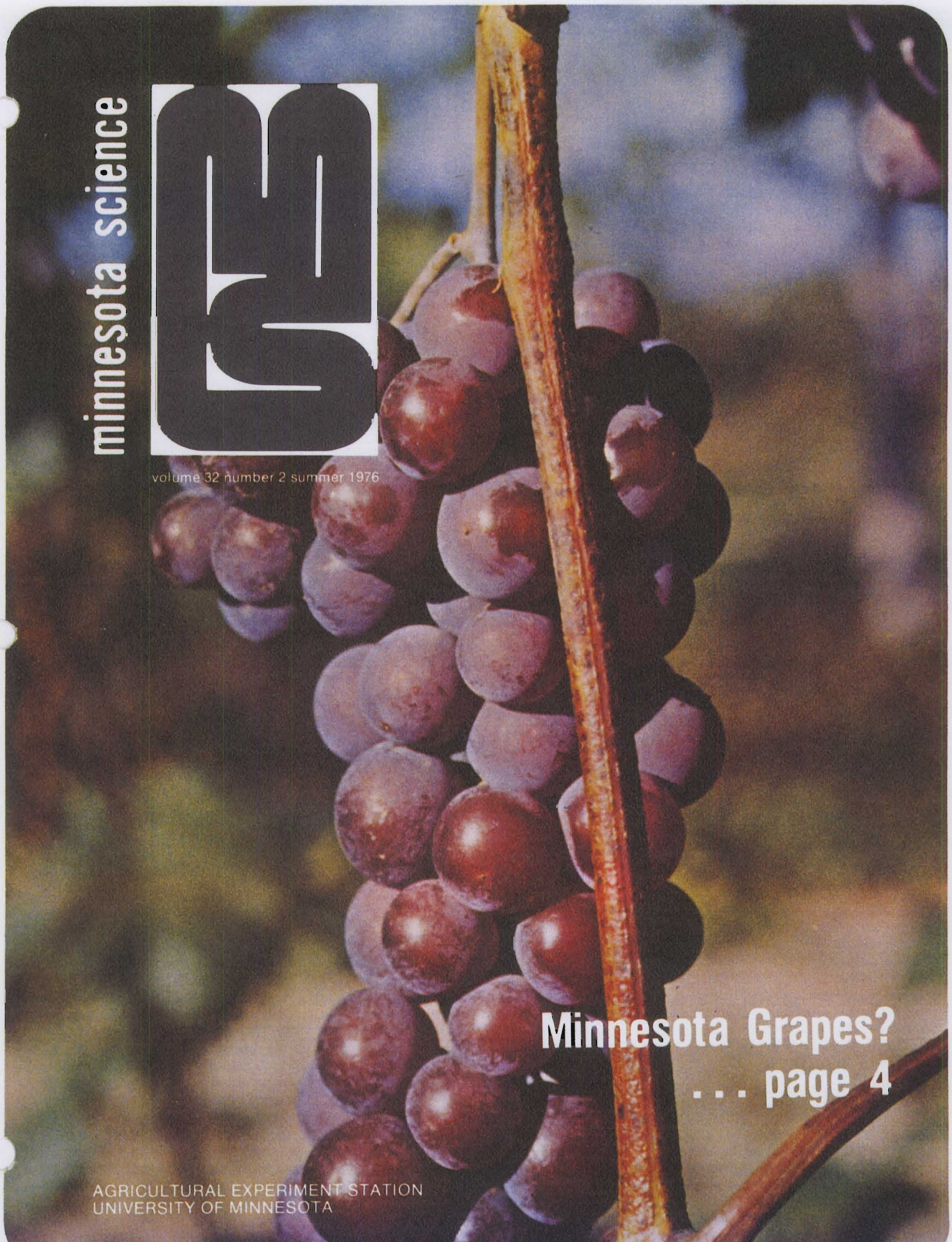

Minnesota Grapes?

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AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA

Minnesota Science Interviews the Director

Director Huston points out the strength of the foreudder attachment of a high-producing cow at the UM Northwest Experiment Station, Crookston.

Q. *Can profitable applications of specific research results be guaranteed?*

A. Spending tax dollars wisely for research requires careful choices, planning, and coordination. Research is an uncertain venture: No one knows at the outset how those searches into the unknown will progress, which paths they will take, which scientist will make the most significant discoveries, or how long they will take to make those discoveries. Yet despite those uncertainties, our past experiences reveal through countless examples—hybrid corn, artificial breeding, vaccines, herbicides, soil tests—that research pays off handsomely. New knowledge is useful, valuable, and worth seeking!

Q. *Who gains most from Minnesota agricultural research?*

A. Those who first control new knowledge or the technology resulting from it often gain most from it. Private corporations invest heavily in research with that expectation. Minnesotans invest in public research in agriculture and forestry and elsewhere with expectations of improving the state's economy, creating new jobs, and enhancing food and fiber supplies. But even so large a state as Minnesota hasn't the resources to research every topic likely to strengthen the economy or improve standards of living. Choices must be made. Costs must be shared with other states even at the risk of losing some of the benefit of being first.

Q. *How do experiment stations decide upon which projects to fund?*

A. Some choices are made easily. It is not difficult to choose between corn, soybeans, or wheat that are grown widely in Minnesota and peanuts, cotton, or rice that are not. But choosing between corn, forests, or dairy cattle—all so important to the state—is difficult. And choosing between breeding or disease control or management techniques research for a single crop such as corn requires even more careful analysis. Choosing between research that may pay off quickly but modestly and that which may pay off years later but handsomely involves even more difficult decisions.

In recent years, cost-benefit analysis as a means of choosing research topics has been promoted by executives, economists or accountants accustomed to dealing with business ventures involving much less uncertainty than research. Simple cost-benefit analyses long have been used in making choices between broad areas of agricultural research. But when used in making choices of research involving multiple and high degrees of uncertainty, the mathematical elegance and completeness of the cost-benefit technique may cause one to falsely overestimate its reliability.

At all levels of organization in the Minnesota Agricultural Experiment Station scientists and administrators work together, relying on the special insights of the most knowledgeable experts in each area, to choose research most valuable to Minnesota. Annual planning conferences are held to evaluate past research and to plan for the future. Each scientist prepares a broad-based research plan every 3 to 5 years.

Q. *How are research efforts coordinated?*

A. Each year, the scientist updates plans with specific experiments to be conducted during the year.

Rigorous experimental "designs," oftentimes quite complex, are used to enable scientists to secure maximum information: At the end of the year, experiment station scientists report on their accomplishments so that others may use those discoveries.

In annual regional and national meetings, scientists in each discipline exchange information about their current work and discuss ways of obtaining new answers. Groups of scientists and administrators from every state experiment station and the USDA research agencies annually discuss broad fields of research; and they plan ahead to achieve necessary replication of experiments, and yet to avoid unnecessary duplication. Through an extensive computerized information retrieval system, every scientist has available the annual report of the accomplishments of every other agricultural scientist in the United States. In these ways, research is effectively coordinated locally, regionally, and nationally. □

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COVER: This experimental red grape, Swenson 439, shows promise and may be released as early as the spring of 1978 (see related story, page 4). It is not now available.

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"In Minnesota," says a mellow voice from the television, "grapes drink deep of the warm summer sun."

Sparkling Future Seen for Minnesota Wines

MIKE FINLEY
University Relations

"In Minnesota," says a mellow voice, "grapes drink deep of the warm summer sun. The product is a wine that connoisseurs the world over have come to cherish and respect.

"Today, you can enjoy any of these wines at prices you can afford. Hiawatha Vineyards' fine wines—with dinner, or all by themselves. Drink them with someone you love."

Of course, that's all in the future. In 1976, Minnesota wines are still an alien, noncommercial commodity. Except for a few stray bottles of dandelion, chokecherry, and apple wine stashed away in some home vintner's tool shed, wine made in Minnesota has not only been scoffed at by connoisseurs, it has also been confiscated by the revenuers (unless it's for home use).

But that doesn't have to be the case, says Cecil Stushnoff, viticulturist with UM's Department of Horticultural Science and Landscape Architecture.

"Up until now, few people have given wines in Minnesota much thought," says Stushnoff. "For one thing, the growing season is not long here; and for another, no commonly known varieties of wine grape can make it through our winters without special protection."

Stushnoff explains that there are several grape families which are cultivated in the US: "One is *Vitis vinifera*, a grape that was brought here from the Old World, where it has been cultivated for thousands of years. Attempts by the English to grow it on the east coast met with disastrous results; and the plant was ravaged by the winter cold, disease, mildew, and root lice."

When the vinifera grape was introduced in New Mexico and California, however, vintners were pleased to find that the wine produced there, in many ways, equaled the best wines of Italy, Germany, and France.

Another domestic grape, *Vitis labrusca*, also called the Northern Fox grape, has been grown with excellent results in the United States. And it can withstand temperatures down to -25° F; so it is much hardier than the vinifera grape.

"The only trouble with most labrusca grapes," says Stushnoff, "is that they have a foxy flavor, which is tasty in jams and jellies but makes a mediocre, strong-flavored wine."

Finally, there grows in Minnesota a small-clustered, acid-sour wild grape called *Vitis riparia*, the riverbank

This Swenson 40 experimental white grape may someday (as early as the spring of 1978) be used as a dessert grape, or for a fruity wine. It is not now available.

grape. It's not as good, being so puny and sour, but it can withstand some incredibly cold weather—as low as -50° F.

This is where Elmer Swenson comes in: Swenson, a dairy farmer in Osceola, Wis., for many years, had a hobby of hybridizing different kinds of grape vines. He wondered why no one had ever tried crossbreeding Minnesota riverbank grapes with a better-tasting grape.

Already, the University of Minnesota experiment station had produced a riparia-labrusca hybrid back in the '40s, but the labrusca part made it taste like sweet grape juice—fine for dessert but not fine with a meal.

It was in 1967, at an experiment station field day at the UM's Horticultural Research Center in Excelsior, that Elmer Swenson brought in, as a curiosity, a few dozen hybrids he had bred by crossing the riverbank riparia grape with the more dignified European vinifera cousin. The horticulturists were impressed. Soon after, Swenson joined the research facility as an experiment supervisor, and he is still working at UM.

About 50 selections of Swenson's grapes are being tested as wine grapes, with a few already showing exceptional promise.

"We've had several bottles in the aging process," says Stushnoff. "And some of the samples we've taken so far are very encouraging.

"Although it's too soon to pass any final judgment on the wines we've been making, one fact of winemaking is on our side: from here on, nothing can go wrong. It can only get better."

The greatest challenge in the plant-breeding process, says Stushnoff, is to keep breeding until different qualities—some of which tend to fight each other—combine to make the best possible wine grape. "The cold-hardiness problem is being licked," says Stushnoff.

Now the UM horticulturists have to try to cut the natural acidity that characterizes the riparia half of the hybrids.

Minnesota's short, hot summers usually end before the leaves on the grapevines of many existing varieties produce a palatable amount of sugar for the grapes. It does seem as if the best Minnesota wines are likely to have a dry quality about them.

That Minnesota will compete with California in the wine industry, is seriously in doubt, says Stushnoff. But it is not in doubt that the state stands a good chance of developing a strong new home industry. □

Dairy Facilities:

PHILLIP M. PARSONS*

Northfield, Minnesota Dairyman and UM graduate, M.S., agriculture

AN AGRICULTURAL ENGINEER from the University of Minnesota once told me: "Most Minnesota livestock housing was constructed for the weather conditions we have for 8 months of the year."

Since we have both extremes in our climate, you can choose which months he felt unsatisfactory; but I can assure you from experience that both hot and cold can cause problems.

I depend upon engineers to develop for me the statistical requirements of square footage and cubic feet of air movement. There is no way for all these measurements to be made experimentally by the farmer.

Farmers who are pioneers in their field will be far ahead of the engineers as creators of ideas in livestock housing; and part of the obligation of those who would remain expert in their field must be to observe what is being created and to criticize, correct, and pass along those ideas which show promise. All of us have seen the operation of a building or feeding system which the experts insisted would never work. This is no implication that the expert involved was wrong—the expert may not have understood the things being done to make the system work, or more likely, the expert may have doubted its general application.

In the dairy industry during the early 1950's, the mechanical simplicity of loose housing, and a simple milking parlor to milk a larger herd, seemed attractive to many farmers. Inevitably, conversions of existing structures were made. A few of them were successful because most of the principles required for a good loose housing system were followed by accident or intent. But, by and large, those conversions were failures because the buildings would not accommodate the needed design features of the new system and could not be modified to do so. Conversions that were made during that time had the effect of eliminating from the dairy business those dairymen who weren't innovators. By now, the inherent shortcomings of loose housing have caused it to pass out of common use. The same risks exist today for those who would convert their old facility to heifer or calf barn if they are not clear in their understanding of the elements required by its new use. One of the facilities on my farm was remodeled as a calf barn with what we thought were clearly defined principles, but some of the problems of the old structure still remain.

That brings to focus one of the requirements in planning any change in facility or management. The goals of the change must be clearly defined. When a farmer comes to a UM agricultural engineer and indicates a desire to construct a dairy facility, what does the farmer have in mind?

Does the farmer want to house 80 cows?

Does the farmer have in mind a specialized facility designed to house dairy cattle that will suit their needs and create an effective and productive working environment?

Planning of the building itself should not begin until that farmer's goals have been clearly defined and several plans considered before the right one is uncovered, or also eventual failure will result.

I'd like to enumerate some important considerations before a new dairy facility is constructed: Although not always recognized, in some measure the operator expects gains in each area which will help pay for the structure and produce added profit, which are goals of such changes. *In my estimation, they are:*

Improved animal health. Many dairy facilities are unsatisfactory, and animal health often gets slight consideration. Almost always, ventilation can be improved.

When a real estate person was asked what the 3 most important considerations in a property's value are, he responded that they are Location—Location—Location. In the same way, the 3 most important considerations to animal health are Ventilation—Ventilation—Ventilation. Satisfactory ventilation in warm buildings depends on adequate insulation and sufficient heat production in the structure. In our

*The author is grateful to John F. Anderson, Chief of Field Services, College of Veterinary Medicine, University of Minnesota and to Donald W. Bates, Department of Agricultural Engineering, University of Minnesota for assistance in preparation of this paper. Both participated in planning the structures described.

Where We're Going

climate, supplemental heat may be required in addition to the animal heat produced. This is by no means saying that a certain temperature must be maintained or that a mechanical ventilation system is needed in all livestock shelters. One of the best buildings I have ever built, from an animal health standpoint, depends on natural air circulation and an inside temperature no more than 10°F above outside temperature. Engineers can calculate the R values needed for certain temperatures, and know the heat and moisture production of livestock, but, even so, I believe ventilation has not yet advanced to an exact science.

Health of the animals also depends on adequate floor space, feeder space, waterers, and so forth.

We have a new concept in building design with total confinement. Such buildings have their own space requirements.

There must be a clear distinction between the space capacities for one method of management as compared to another: A loose housing barn of a given size will not house the number of cattle that could be put on slats. Each class of dairy cattle has certain environmental requirements. A calf must be sheltered in an environment that is draft-free and dry. A moderate temperature will improve rate of gain and reduce management problems. A milk cow is capable of good production in a temperature range between -15° and 85° F, when sheltered from precipitation and draft. The udder, the production machine, deserves special protection from cold and damp. Heifers and dry cows are capable perhaps of withstanding greater extremes, but are deserving of proper care because they are the source of future returns. Whether done for health reasons or in the name of efficiency, handling and treatment facilities for moving and treating animals are a must.

These dairy calves at the Phillip M. Parsons' farm were saved from pneumonia by John F. Anderson, Chief of Field Services at UM's College of Veterinary Medicine where scientists put research and teaching into the dairy barns. Donald W. Bates, UM agricultural engineer, advised Parsons on an experimental ventilation system for Parsons' older building to make the environment better for the calves.

Improved efficiency. One of the principal reasons that dairy barns are replaced is to improve the efficiency of the operation. This may take several forms such as reduced labor per animal, larger numbers, better manure handling, and easier feeding and handling of the animals.

In my view, there is no single contribution to efficiency as great as some kind of slotted floor and liquid-manure storage. This principle makes all other methods of handling manure obsolete and widens the gap in labor efficiency between a farmer who recognizes it and others who do not.

By the same token, basic layout decisions determine total labor efficiency more than labor-saving devices. Many dairy farmers are still constructing or remodeling stanchion barns because they don't believe that labor savings are significant in a parlor and free-stall system. There are plenty of reasons for planning a stanchion barn, but the goals for that facility must clearly require stanchions or tie stalls for handling purposes to the exclusion of some efficiency. Efficiency requires group feeding of roughages at the point of storage or access by the transport unit. Efficiency requires minimum movement for the man on repetitious jobs. Efficiency requires thoughtful layout of areas where cattle will move to make fewer bottlenecks and easier handling.

Operating costs must be considered especially in these days of higher energy costs. We installed a pressure ventilating system in our calf barn when it was remodeled a couple years ago at the end of the low-priced energy era. By the time it was operating the following winter and LP gas had reached 32 cents a gallon, I winced at the $200 a month operating cost. The same is now true about electrical cost, and large numbers of motors—to move material or air—extract their toll. The less obvious operating costs are more severe. They include unnecessary hand labor, wasted feed or bedding, and most severely, lost production. Planning low operating costs is possible if the goals are defined.

Increased production. When any facility, be it farm, industrial, or retail, is being planned, its purpose is production. Capital, labor, and

Phillip M. Parsons chats with UM scientists John F. Anderson (left) and Donald W. Bates (middle) about the improved health of his animals in Parsons' remodeled old barn. The remodeling "reduced calf mortality to a low of 3 percent in its first year," says Parsons.

management are brought to bear with increased production as the goal. Dairymen respond to these same objectives, necessarily. Whatever is done in planning a housing facility must have high production as its central theme. There are compromises made with maximum production due to lack of capital or a thousand other things; but the goal of maximum production is central. In this case, good housing demands maximum comfort for the animals to produce at their best. The cow or calf needs a comfort zone around her, a good place to rest, and adequate space for feed and water. The manager is then responsible for maintaining good conditions that will result in high production.

Care in planning the facility requires knowing the size of animals to be housed, their needs for comfort, and necessary space for feed and water. These needs are well documented, and the number of compromises made will only increase the demands on management in future years. The farmer who has a facility and wants to expand or build a new one implies the need for increased production.

Better cattle handling. In the past, too little attention was paid to how you got the cow into the pen, where the heifer was to be contained for breeding, and how animals could be moved from one area to another. This was adequate for a family farm with 20 cows, but numbers have increased and the farmer is busier.

One of the most useful things on a farm is a convenient pen area where cattle can be sorted and contained. If combined with a treatment facility, this can become the center for veterinary care and reduce costs of treatment. Elements of this area are lanes to one or more pens for holding cattle, a holding chute with easy access, and a discharge pen. If an isolation pen is available one more step has been made toward good health care.

Too often the cows are expected to know how to enter a door opened in the center of a long barn and to go where treatment is done without any lanes. Cows are no different than people and will take the easy way out every time. Corral and chutes don't

have a modern sound; but they are as modern in their purpose as next year's car.

A Problem of Disease Prevention

Two years ago, on my farm, the process of expansion and need for improvement resulted in new housing for calves and replacement cattle. With some reservation, I am pleased with the results. I have a cold free-stall barn for 80 milking cows with a double-six herringbone milking parlor. Through the years, we had used the old stanchion barn for housing calves and had operated conventional loose housing sheds for heifers and dry cows. Both calves and heifers suffered consequences. The calf barn had woefully inadequate ventilation. In winter, frost covered the ceiling and concrete block walls. Manure was hard to remove, and large amounts of bedding were used to counteract the moisture. Calf health was at best a chancy thing, and 18 to 22 percent calf mortality resulted. The heifers had fared better because there was more space, but I needed to be able to group them according to size for better growth. This was not always possible, and moving animals from one pen to another was difficult; the free-for-all approach. In addition, I had a 40 to 60 head steer operation which shared a long, open barn with the heifers. When we purchased feeder cattle, all their disease entities passed directly over the feed bunk to the heifers and then to the cow herd.

Minnesota Vets to the Aid

During this time I became affiliated with "Doc" John Anderson, Chief of Field Services, College of Veterinary Medicine, University of Minnesota, in a herd health program where UM veterinary students participated in all phases of veterinary practice.

When he began working on a regular basis in the herd management, the problems with housing—that had always been there—became much more apparent. We had pneumonia almost constantly in the calves in the calf barn. It resulted in heifers with reduced lung capacity who never produced to their potential. In addition, facilities were pressed when we began working more with the cattle.

The first improvement in the facility was the installation of a headgate and simple chute in a portion of the old barn to use as a treatment area. It was quite centrally located and good enough to use as an isolation area even if too close to young calves.

The second improvement was to take those young calves out of that barn and separate them. We got 4 used portable hog farrowing buildings and located them nearby. They could be conveniently divided into three 4 by 4 pens with an entry area. Sanitation was simple—we moved the building ahead to new ground. We tried using these all winter, but that proved difficult. It had no real manure pack and even when wrapped with paper there wasn't enough heat retention to keep a calf comfortable. Nonetheless, it was a vast improvement and we could bring a healthy month-old calf back to that old barn. The calf could withstand the conditions there; and herd health was improved. With a simple treatment area, we could work with the cattle more efficiently and at less risk to ourselves.

The need for new facilities was obvious. During one summer the UM veterinarian and I considered both a prefabricated calf house and a single replacement unit for all of our young dairy animals. Both were dropped.

I was anxious to make use of the old stanchion barn because it was in the ideal location and the overhead hay storage was still needed.

The thing lacking in my planning was a clear-cut set of objectives. By the following winter these had evolved. They were:

- —separate housing for calves and for larger dairy replacements
- —a controlled environment with moderate temperatures for young calves
- —liquid-manure handling with concrete slatted floors
- —treatment and isolation area as part of the *dairy* replacement barn
- —individual calf stalls for baby calves, pens for ages 1½ to 10 months, and graduated sizes of free-stall for replacement animals

Remodeling the Old Dairy Barn

It remained for a local farm construction contractor to suggest the actual plan for remodeling the old barn. He had experience with remodeling and installing pits and slats in old barns and suggested 4 feet deep by 4 to 6 feet wide pits, with a 16-foot addition pitted full depth for storage. The only roughage fed is alfalfa hay stored overhead. The building is now 30 by 84 feet and has a planned capacity of 85 animals ranging in size from birth to 10 months.

Remodeling of the old dairy barn to a calf barn was not entirely successful. The ceiling height is only 6 feet 3 inches, which gives too little air space. Within a month of moving in, we had installed a second pressure fan and heater unit. Because of its construction, the old barn leaked air and would not build up the desired ⅛ inch static pressure. We would like to have had more exhaust ports than 2 in the end furthest from the fans, but were prevented by the barn being set in a hill on one side. Subsequently, we added a 5,000 c.f.m. fan on the exhaust when summer airflow proved inadequate. There have been outbreaks of pneumonia, especially in spring and fall when temperatures change. This included one incident of a hot spring wind literally overpowering the system and creating a severe odor problem from a nearly full pit. The pit itself is unique and successful.

The barn provides good working conditions, is convenient, and has reduced calf mortality to a low of 3 percent in its first year. But it is more difficult to manage than I'd like to think necessary.

Building a New Dairy Barn

The replacement facility suggested was a 36- by 100-foot pole-type metal surface. It contains a 30- by 82-foot liquid manure pit 8 feet deep with 3 different sizes of free-stalls (5, 6, and 7 feet long) along the 2 sides. Cattle are normally divided crosswise with side doors for access. There is a center mechanical feed bunk served from silos that also feed the steers. An open ridge 6 inches wide and adjustable ventilation panels in the walls provide natural ventilation. The ceiling is insulated with ⅜ inch polyurethane insulation board (then acceptable by fire insurance companies).

The north 16-feet provides space for a headgate, work area, and isolation pen. The veterinarian can even back his truck inside during bad weather. This barn has a calculated capacity of 68 head, ranging in size from 10-month-old to mature cows.

How has it worked?

Without a doubt, the replacement barn has been the most successful livestock housing building I have ever used. I can't recall a single instance of environmentally induced sickness in 2 years of operation. In severe winter weather, we operate the building with doors and ventilators closed, using only the open ridge for ventilation. It has proved adequate; although some frosting does occur during periods of prolonged subzero temperatures. The characteristic drip of metal buildings is largely eliminated by the ceiling insulation. When temperatures drop below zero, some freezing on the slats occurs, building up to perhaps one-half closure of slat openings after a 2½-week period of continuous below zero temperatures. Manure thaws rapidly as soon as temperatures rise above zero. The pit has proven more than adequate for 6-month storage and empties successfully. As weather moderates, the adjustable panels are opened wider. In summer the drive-in doors are also left wide open. Conditions are more comfortable than in any of my other barns. Adjustment of ventilation is minimal. I will repeat the general features of this barn in a new milk-cow barn as soon as it is possible for me to replace the remodeled solid-floor dairy barn, which still has a ventilation problem.

I am not nearly as concerned with first cost as when the buildings were constructed. I have seen how far-reaching are the benefits of a good facility. With each building project I try to pay more attention to detail and to incorporate more of the desired features. If I had spent $4,000 more for a new building to house those calves, the average annual cost over 20 years would have been only $200, about the amount I think I could have reduced the yearly heating cost with a new and tighter building shell. Without question, I could have had a much more successful calf barn by starting with a flat earth area and building a completely new unit, as was recommended to me by UM agricultural scientists.

One last issue I'd like to raise: Today most livestock housing units in my area are built by company contractors. Their standard plans are usually modified to individual farmers' needs and they generally offer complete construction in a single contract price. The farmer can generally visualize what he is getting, and expects the finished product will work to his satisfaction but this is not always the case. It is the men who plan and sell these buildings who strongly influence livestock housing today. They are often the ones who include desired features or, on the other hand, make compromises that cause problems. It appears to me that these men are in need of all current engineering data available.

In the final analysis, farmers themselves must become better informed in building construction and environment if they are to get individual features in their buildings which will best help them reach their goals. There are many sources of information in addition to the building industry: agricultural engineers, veterinarians (and others of the University of Minnesota), the Midwest Plan Service, the popular press, innovative farmers in the community, local veterinarians, and others.

As I look to where we're going in dairy housing, there are several things that seem quite clear: Farm units are noticeably larger, yet dependent on a single family for operation and supervision. New dairy housing must provide for better animal health, improved efficiency, and the highest possible return to the farm. Liquid manure storage offers significant improvement in efficiency at low risk to animals if well planned. Separate environments need to be provided for young animals, heifers, and the milking herd. Natural ventilation and near-atmospheric temperatures are very satisfactory for mature animals using slatted floors and free-stalls. Adequate pens, a treatment area, and good feeding facilities are required. All these conditions are compatible for dairy replacement cattle or milking cows in a barn such as I have described. I think it represents desirable dairy housing for some time to come. □

Dairy

FOLLOWING WORLD WAR II there was a great resurgence in loose housing. Its chief attribute was that of low cost, which was the delight of many economists, engineers, dairy scientists, the popular press, and others. The fact that loose housing was perhaps the first method used and had been previously abandoned because of inherent shortcomings was overlooked. This system, which was to make the stall barn obsolete, has itself again become obsolete. Yet, the stall barn in my opinion, remains as satisfactory a system as any other for housing high-producing dairy cattle.

An innovative dairyman hit upon the idea of reducing bedding and improving the cleanliness of his cows by breaking the resting area up into a series of separate bedded compartments or free-stalls. This has had a monumental impact on dairy housing as a result of developments by engineers, animal scientists, equipment suppliers, and certainly dairy farmers themselves. Now we have 2 fundamentally sound methods of housing dairy cattle, the stall barn and the free-stall barn, with the latter being better suited for larger herds. It would appear that these systems will remain in use during the forseeable future. In specific instances herd size, the building site including present buildings, and personal preference are likely to remain the primary criteria in making a choice.

With respect to herd size, a clear definition of goals is essential: A primary objective should be the number of pounds of milk produced, not the number of cows milked.

The statement Phillip Parsons made (see accompanying article by Parsons) concerning the importance of ventilation is deserving of reemphasis. It has been my observation that the dairyman, or other livestock producer, finds the principles difficult to understand. He may be unwilling to make a reasonable investment in a structure and in equipment to maintain satisfactory environmental conditions. As a consequence he pays for ventilation in substandard animal performance and possible high death

Facilities: An Engineer's Perspective

DONALD W. BATES Department of Agricultural Engineering

loss although he may not realize it. On the other hand, producers often pay high prices for supposedly carefully designed systems and still experience serious problems. A relatively straightforward problem is often treated as being unduly complex.

Manure Handling Problems

It appears that one of the most difficult problems with which dairymen must deal is that of manure handling. The era of daily hauling is rapidly coming to a close and a variety of long-term storage systems are coming into use. The earthen storage pit into which manure is moved through a large underground pipe by a pump (manure baler as I like to call it) for later removal is being widely used. Great emphasis is placed on the low cost of the pit compared to a concrete structure. How long the pumps will last and the maintenance required for them and the pit is yet to be determined. Severe problems have been encountered in manure removal.

The slurry store, or above ground silo, roughly 60 feet in diameter and perhaps 15 feet high, is now being promoted. The same general type of pump is used to fill these storages as is used for the pit. The cost is high but both of these systems are adaptable to existing housing units. Manure stacks have also been rediscovered and in many cases the modern adaptation meets the needs of dairymen, particularly for existing stall barns.

Concrete storage pits beneath the structure to support slatted floors have the most to offer for new construction. To quote Parsons, whom I consider a conservative dairyman: "There is no single contribution to efficiency as great as that of some kind of slotted floors and liquid manure storage."

In the case of a stall barn, manure storage can still be built beneath the barn and the manure deposited directly into it through gutter openings covered with steel grates. The argument given is that these systems cost too much and dairymen can't pay for them. This is refuted by the fact, however, that dairymen do build them and do pay for them. It should be recognized also that the other systems do not come cheap either. Thus the dairyman will be wise to make a careful comparison of the various systems considering all costs before making a choice. To quote Parsons again: "I am not nearly as concerned with first cost now as I was when the buildings were constructed. I have seen how far-reaching the benefits of a good facility are."

Certainly I am not an advocate of spending money needlessly, but time and time again I find dairymen who learn to their sorrow that a supposedly low initial cost is not the only cost. While this statement is directed specifically to manure handling, it applies equally to other phases of building construction. The old saying, "Saving $5 now will cost $10 later," is a valid one. Dairymen need to take heed in expanding existing facilities or building new facilities.

Milk Quality and Quantity

To date, little has been said about milking parlors. There is often too much emphasis placed on the number of cows milked per hour and too little on the quality of milking. For example there is increasing discussion of the carousel system, and various types are available. In my opinion, much more development will be required before this general arrangement replaces the herringbone.

Future for Dairy Housing

As we look down the road, better cooperation between manufacturers of ventilation equipment, agricultural engineers, veterinarians, animal scientists, and contractors who install equipment is essential. Often persons selling ventilation equipment and those who install it are quite uninformed of fundamental principles. For example, recently I visited a new dairy barn with an expensive and rather complex ventilation system. The complaint was about high barn temperatures in the summer. A manometer reading showed a negative static pressure of 0.9 inch of water in the building. This might be considered a tribute to the quality of the exhaust fans, but hardly to the adequacy of the fresh-air intake system.

The increased cost of energy for moving air through so-called environmentally controlled buildings and the difficulties sometimes experienced in maintaining satisfactory environment, makes it seem reasonable to predict that there will be greater use made of natural ventilation systems in severe climates such as in the northern dairy areas of the US. At a recent meeting of the Midwest Plan Service Dairy Committee we had a rather extensive discussion about the possibility of insulating the walls and the underside of the roof of a slat floor free-stall dairy barn to produce an R value of approximately 15 and leaving the ridge open in combination with adjustable wall openings. True, such a system might require additional management but the initial cost of a ventilation system and the continuing cost to operate it would be eliminated.

In predicting future developments it is usually popular to predict bigger and better things. There is no doubt that dairy herds will increase in size. As many small dairymen, perhaps with 20 cows or less, retire, their facilities will go out of use and thus bring up the average. Good dairymen—those in the production range of 15,000 pounds or more of milk per cow per year—will also expand, most likely, to efficient 2-family units. It appears to me that, at least in the Midwest, it will be a long time before there are many herds that will go beyond the 200- to 300-cow range. The vast majority of herds will be in the range of 100 cows or less. Herd size will be governed in part by the fundamental relationship between cow numbers and available acres of supporting land.

Most people are intrigued by cow numbers, and there is a tendency to believe that bigger is better. It is my view that the most severely limiting factors are high-quality labor and excellent management. Management problems seem to increase geometrically with cow numbers. This fact is inescapable despite the degree of mechanization and will determine more than anything else where we are going in dairying. □

PSS Vs. Pigs

BOB DRECHSEL Department of Information and Agricultural Journalism

PORCINE STRESS SYNDROME (PSS)—a strange but common disorder—kills thousands of pigs annually. PSS is responsible for low-quality meat in approximately 20 percent of all pork carcasses. Losses attributable to PSS have been estimated in the tens of millions of dollars.

Now PSS's days may be numbered:

Led by food-and-animal science researcher Paul B. Addis, scientists at the University of Minnesota and a private laboratory have developed a simple blood test which they believe can help to eliminate PSS.

A puzzling disorder of genetic origin, PSS has become a serious problem only in the past 15 years. No one is certain why, says Addis, but animal scientists believe the trouble somehow began as breeders began selecting pigs for larger loin eyes and less fat. The syndrome is triggered when a PSS-susceptible pig is exposed to some type of stress. Almost any kind of excitement can set it off—for example, handling, crowding, or transportation.

There is a typical pattern to the symptoms: First the pig becomes difficult to handle and begins to tremble. Then red splotches appear on its skin, its breathing becomes labored, and its body temperature rises. Finally, the animal collapses and shock-like death results. Once the symptoms become manifest little can be done, although death is not inevitable in every case.

What has happened is the result of a normal chemical reaction which, for genetic reasons, occurs abnormally fast in the stress-susceptible animal. In a normal pig, animal starch (glycogen) is used to produce energy, heat, and lactic acid. The same thing happens in a PSS pig, except that the animal starch is "burned" so rapidly that a great deal of heat and lactic acid are created—so much that the animal's body temperature may reach 110° F or more.

Pork from such an animal is often pale, soft, and exudative (PSE). Compared with normal pork, it is more acidic and will shrink more, thus losing juices containing nutrients, vitamins, minerals, and protein. Little or no marbling will be visible; and the pork will be soft, mushy, watery, loose-textured, and pale. Such pork is perfectly wholesome, but it is less desirable than normal pork.

For example, the purchaser of a canned ham made from PSE pork may be disappointed to find a ham which shrinks and leaves a mass of watery gelatin. Or the person who bakes or broils a PSE pork chop will notice that the chop shrinks significantly more than a normal one. In other words, there is a yield loss not only in the carcass itself but also in the final products.

Not every PSS animal will produce PSE pork. If the hog's glycogen happens to have been depleted at the time of slaughter, there is no lactic acid build-up and the resulting pork can be dry, firm, and dark (DFD). Although its qualities are generally the opposite of PSE pork, DFD pork is unacceptable to most consumers primarily because of its dark appearance.

There is not a one-to-one relationship between PSS and PSE, emphasize UM researchers.

The incidence of PSE pork is apparently widespread: One major US packer has found the condition in 18 percent of all the hams it processed during a year—perhaps not a surprising finding in light of evidence that an estimated one-third of all US hog producers have encountered PSS problems. And a national survey 4 years ago indicated that 44 percent of US market hogs come from herds which have experienced PSS death losses.

Such problems have led to a variety of attempts to predict which animals are stress-susceptible so they can be removed from breeding stock. There have been attempts to catalog obvious visual signs of susceptibility using such cues as muscularity, anxiety, tail tremor, abnormal skin redness, and elevated body temperature.

The unreliability of these indicators has encouraged animal scientists to develop more sophisticated tests. Attention has been given to such factors as blood pH (acidity or alkalinity), blood hormones, reaction to halothane, and cortisol-binding capacity. But for the most part these efforts have either been less than successful or fraught with complexities which make them less than practical. The halothane test, for example, is accurate but difficult to administer and potentially dangerous to the hog. It is based on the knowledge that a PSS hog given halothane—a common medical anesthetic—will exhibit rigidity.

Minnesota's Addis believes the blood test he and others have developed overcomes such problems. It is accurate enough to be useful, and is simple enough to be practical on a large scale.

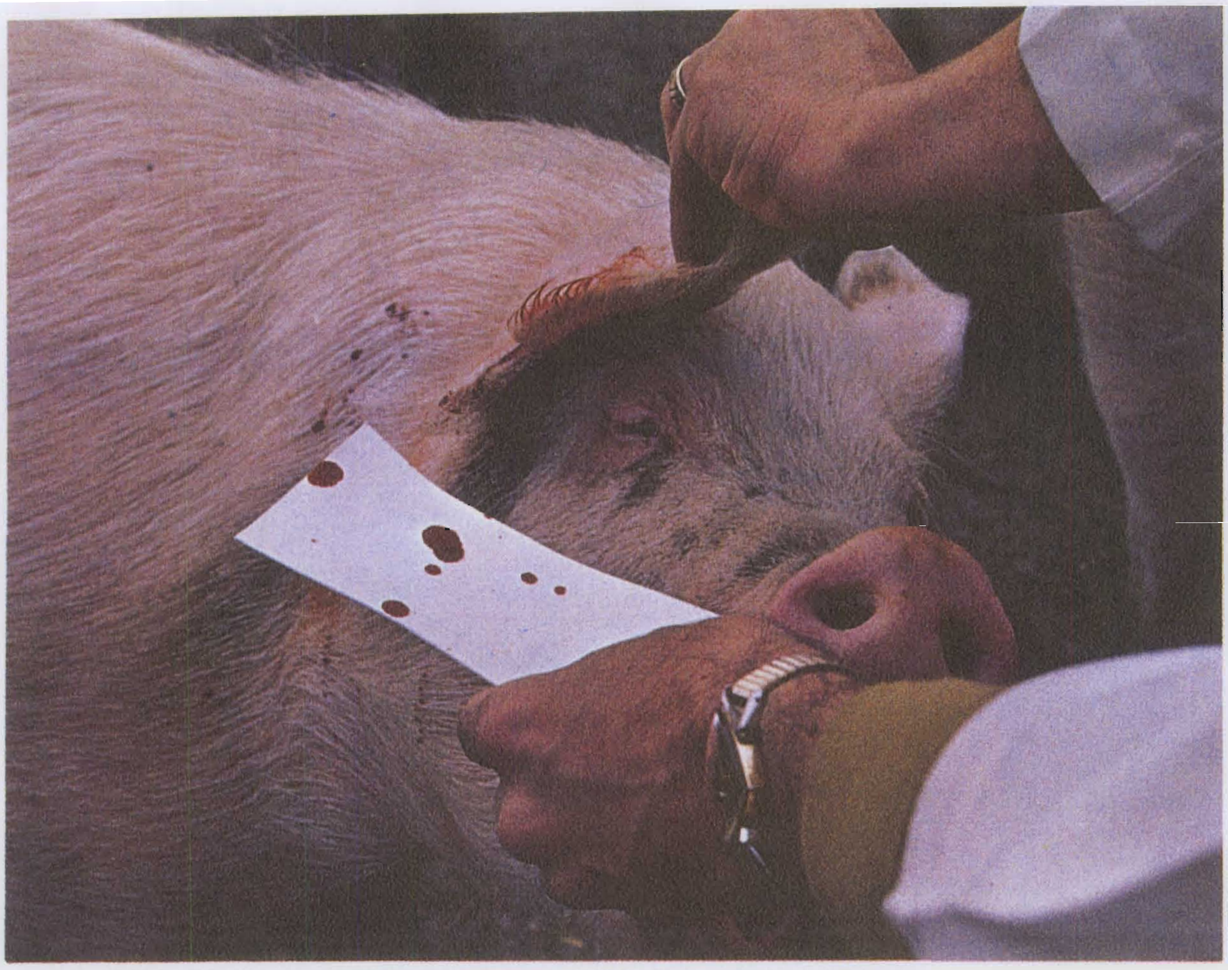
The theory behind the test is that a change occurs in certain blood components after an animal is exposed to stress; and that this occurrence should indicate stress-susceptibility. Addis has been concentrating on creatine kinase (CK)—an enzyme found in the brain, heart, and skeletal muscle, and in tiny amounts in the bloodstream. For some reason—no one is sure exactly why—elevated levels of CK are found in the blood of PSS animals after they are stressed.

Addis has been working with such enzyme testing for nearly 9 years. He began at the Max Planck Institute in Germany with another enzyme called lactate dehydrogenase (LDH). Meanwhile, Dutch scientist Watse Sybesma, and researcher Glen Schmidt of the University of Wisconsin—working on the same concept—concentrated on CK. That enzyme proved superior for testing since it is more specific to muscle tissue and thus less vulnerable to error than LDH.

The next step was development at UM of a technique for drawing blood samples from pigs' ears. The ear was a logical choice since the lack of muscle tissue there reduces the likelihood of unreliable test results. Should a sample be drawn from a more muscular part of the body, the puncture required could itself damage muscle tissue and cause the release of CK into the blood even though the particular animal might in fact be stress-free. Result: a false-positive PSS indication. The ear method is simple, quick, and is harmless to the animal.

But there were still drawbacks, not the least of which was the complexity of the laboratory analysis of the sample: A large blood sample—at least 10 cubic centimeters—was required. It had to be stored frozen and then spun in a centrifuge to separate blood constituents. It was awkward, time-consuming, and expensive.

That changed less than 2 years ago when Addis read about a bioluminescence test (developed by Antonik Laboratories of Elk Grove Village, Illinois) to screen new-born babies for muscular dystrophy. That



The PSS test begins when hogs are stressed by making them run approximately 100 yards. Here, 6 to 8 hours later, a blood sample is taken from a suspected hog by means of a small cut on the hog's ear.

test was adapted into a PSS test which was achieved with a much smaller sample and no frozen storage.

The Antonik test is made with only a few drops of blood on a slip of paper. Light-producing enzyme systems extracted from firefly lanterns are used to measure the amount of CK in the blood sample. The amount of light produced is proportional to the amount of CK.

"It's revolutionary, really," says Addis.

Researchers have conducted about 200 tests successfully isolating pigs with PSS, by using the firefly bioluminescence extract.

The test begins when hogs are stressed by making them run approximately 100 yards. Six to eight hours later, a blood sample is taken from each animal via a slight cut on the ear. The delay between stress and sampling is important because researchers have discovered that it takes some time for the CK to move into the bloodstream in quantity sufficient for successful testing. Samples can then be analyzed by Antonik Laboratores. The farmer can use the results to eliminate PSS-positive pigs from his breeding stock.

Pork producers may, however, be reluctant to use the test so long as it requires some stressing of the animals. Indeed, such a "provocative diagnosis" could end in death for some PSS animals. Furthermore, the CK test can produce false-positives if muscle tissue is accidentally damaged during stressing. And while a false positive is definitely a "better" error than a false negative, it could lead a producer to unnecessarily and unwittingly eliminate some stress-free animals from his breeding stock.

Addis is also beginning to focus on CK isoenzymes. That is, CK itself can be subdivided into skeletal muscle, heart muscle, and brain types; yet the CK blood test measures only total CK activity regardless of the type of isoenzyme involved.

It had been reported in the medical literature, says Addis, "that humans afflicted with malignant hyperthermia (MH) have an abnormal isoenzyme pattern in muscle: Some of the 'brain' isoenzyme appears in adult muscle." (For more information about MH, see accompanying article on PSS, in this issue of *Minnesota Science*.)

Addis and graduate assistant P. T. Hwang have developed "an improved procedure for CK isoenzyme analysis and the results indicate that the halothane-sensitive pig does not have an abnormal pattern. Follow-up studies on human muscle biopsy samples, obtained from the University of Toronto, also indicate a normal distribution—when analyzed by Addis and Hwang. Thus, further studies are planned on both human and pig muscle samples," according to the UM scientists.

Addis is optismistic that stress-free hogs can be bred without sacrificing the large loin eyes and leanness which has been associated with PSS. For example, UM scientists have crossed Pietrains, a highly stress-susceptible breed, with Minnesota No. 1, a breed notable for stress resistance. They found that a cross which is 87.5 percent Pietrain and 12.5 percent Minnesota No. 1 is lean, muscular, has good meat quality and is apparently stress resistant. But it is not a practical cross commercially because of the large number of matings required to produce it.

One problem with the whole PSS question is that the genetics of PSS is not known:

"We don't know how it is inherited," says William Rempel, a UM animal scientist who has been cooperating with Addis on the PSS research.

"Part of the problem is that at best we have only poorly defined exactly what stress susceptibility is. But I think outstanding pigs can be bred stress-free, and, in fact, I think they have been for some time."

Rempel also believes the seriousness of PSS has been exaggerated; and he challenges the validity of data to the contrary:

"Meat science people have been quite shrill about this problem for years," points out Rempel, "and have made competing claims of being on the verge of solving or having solved the problem. Meanwhile, producers do not rate this as one of their main problems. This is indicated by the listing of research needs by the National Pork Producers. Their list is based on a survey of member producers."

Addis points out that, "Most producers are like GMC or any other producer of consumer items; they are very secretive about their problems."

Rempel believes many losses attributed to PSS may not be due to PSS at all.

While Rempel is skeptical, he also believes Addis and his colleagues are on the right track with their isoenzyme work and in their efforts to find the optimum time for taking blood samples after stressing.

"I think we are at a stage where we must sort out what we have and get this thing straightened out," says Rempel.

"Our test can be practical on a massive basis," says Addis. "Its key advantage is that any farmer who carefully follows the simple but important directions provided by Antonik can take the samples himself.

"It means we can breed pigs with desirable meat qualities but without stress susceptibility."

Agreeing with UM researcher Addis is a University of Missouri-Columbia biochemist:

"By eliminating genetic carriers of the porcine stress syndrome, we will be able to reduce losses now occurring on swine farms," says Charles H. Williams, UMC biochemist.

But this is true of just about any condition that has "genetic carriers," points out Rempel.

"Furthermore it says nothing about the relative cost. We may have a situation where the cost of screening all these animals is greater than the loss of an occasional pig."

Addis, who says such statements have "no basis," is more optimistic about the values of screening for PSS. □

Science Notes

ENZYME TEST MAY BE USED TO SCREEN PATIENTS

Halothane is a common medical anesthetic which makes life-saving surgery possible. But for one person in 25,000 halothane is a killer.

Unfortunately, at least until now, there has been no way for a person to know to which group he or she belongs. The exceptions are persons coming from families with known halothane-sensitive members, and even such family background is not a certain predictor. Yet once halothane is administered and the fatal symptoms become manifest, little can be done.

Now, however, University of Minnesota food and animal scientist Paul B. Addis believes the blood enzyme test developed to detect Porcine Stress Syndrome (PSS) in pigs may be used to screen halothane-sensitive humans. According to Addis, the enzyme used is common to both humans and pigs (for related article see "PSS Vs. Pigs").

PSS is essentially the same disorder as malignant hyperthermia (MH), the genetically-based disorder from which halothane-susceptible humans suffer. High body temperature and blood salt imbalance are the killers in both PSS and MH.

Like PSS, MH is a relatively new medical problem; physicians were puzzled by it as recently as the mid-1960's.

"Malignant hyperthermia probably began to show up then," says Addis, "because halothane began to replace ether as an anesthetic about that time."

He admits that some studies suggest that blood tests for MH are unsuccessful, but says he believes such tests can work on humans if proper conditions are applied and if blood is sampled at the correct time. He points out that PSS researchers at UM discovered that timing is crucial in the creatine kinase (CK) enzyme test for pigs. After pigs are stressed for testing, blood sampling must be delayed to give the enzyme time to build up in the bloodstream.

"The same delay might be necessary for human testing," says Addis.

Evidence confirming Addis' theory has recently come from an anesthesiologist-researcher at the University of Toronto who, working with Antonik Laboratories, used the bioluminescent CK enzyme test to screen human patients for MH. Anesthesiologist Beverley Britt tested 300 patients with known halothane sensitivity and found the enzyme to be a fairly accurate predictor.

The correspondence between PSS and MH can be seen in the similarity of animal-directed and human-directed research. At Iowa State University, researchers Lauren Christians and Dave Topel are using halothane testing to screen PSS pigs. Meanwhile, UM anesthesiologist Gerald A. Gronert from the Mayo Medical School in Rochester has been trying to find a way to save pigs once they have become adversely affected by halothane. He hopes thereby to find a successful way to save humans once MH symptoms have set in.

"Malignant hyperthermia may be a very rare condition," says Addis. "But that is no consolation to the person who has it."

The syndrome can also be triggered by giving the patient other anesthetics for routine surgical or dental procedures, according to Missouri investigators: Cases have been occurring in the Wausau, Wisconsin, hospital since 1922 because there is an extended clan of genetic carriers of the enzyme defect living in that city. The known carriers of the genetic defect are widely scattered throughout the US and other countries.

"The enzyme defect causes an excess activity of norepinephrine hormone," says Charles H. Williams, University of Missouri-Columbia biochemist. "The excess of norepinephrine hormonal activity causes several things to happen, nearly any of which can kill the victim."

Body temperature can go as high as 113°F in humans or 118°F in the pig; muscles get rigid and blood pH drops from a normal of 7.4 to below 6.8.

Victims "self-cook."

"The small arterioles in the muscles constrict very severely so that blood circulation is decreased," says Williams. "As a result, the muscle tissues do not get enough oxygen to live, and the cells begin to die.

"The death of muscle cells causes the release of muscle proteins which can cause kidney failure if the patient survives the hyperthermia."

If you have the genetic defect in your family, you're in real trouble, says Williams:

"There's a family in Nebraska, for example, that has the condition so bad that family members develop a fever and muscle stiffness from riding in a car. Many members of this family have died at an early age.

"The cause of death is usually listed as a heart attack, but the real cause is the inherited enzyme defect."

—Bob Drechsel

TIMELY PLANTING NETS AN EXTRA $1,000 A DAY

UM experiment station workers at Lamberton find that a farmer with 400 acres of corn to plant can save $1,000 for each day he avoids a serious delay in planting.

Results of research at Lamberton and other UM branch experiment stations indicate loss in yield on corn planted after the first half of May of one bushel per day per acre for every day of delay. The research indicates that if the soil in the Lamberton area is workable the farmer should start planting corn by April 25 and have roughly 10 days of planting by May 15. Otherwise, with $2.50/bu. corn there is a cost of $2.50 per acre per day for delay in planting.

UM researchers at the West Central Experiment Station at Morris—in a similar study beginning in 1967—have similar results: They found that in the west central area of Minnesota corn yields decline on an average of a bushel per day when planting extends much beyond the second week of May. Full implementation of the research information is this area could increase yields in that area alone by roughly 400,000 bushels per day at a value of roughly a million dollars per day.

HOUSING RESEARCH SAVES MONEY AND ENERGY

A saving of $100 to $200 per head is possible as a result of UM West Central Experiment Station's beef housing studies which show that the most costly facility—warm slot confinement—has no apparent advantage over cold slot confinement. Furthermore, cold slot confinement saves energy because no forced ventilation is needed. The cold slot units are naturally ventilated.

FOR MORE FOOD AND PROFIT: BETTER FEEDING SYSTEMS

UM research at the Southern Experiment Station established the merits of improving the feed of dairy feeders. Before 1962, dairy feeder steers sold for approximately 45 percent of that of beef feeders. With the UM feeding information—and application—dairy feeders sold for 80 to 90 percent as much as beef feeders by the early 1970s.

Depending on market prices, such feed improvement brings $50 to $60 more per steer than steers fed a high roughage or high concentrate ration. In the southern region alone, such improved feeding systems could bring an additional several million dollars to dairy income.

PLOWING VARIATION SAVES TIME, MONEY, AND FUEL

If UM Southern Experiment Station recommendations for chisel plowing were followed in the southern area, farmers could save an estimated 3,690,000 gallons of fuel and much time on the tractor.

Substitution of chisel plowing soybean land for the conventional moldboard plowing could reduce fuel consumption by 38 to 43 percent according to UM field data.

Conversion from moldboard plowing of corn land to chisel plowing could save 10 to 13 percent of the farmers' tractor fuel.

WEED CONTROL SAVES FUEL AND INCREASES FOOD

At times there is talk of doing away with herbicides, or weed killers. This can be done, but at great loss:

Treatment of 6 million acres of corn, 3 and a half million acres of soybeans, and nearly 2 million acres of wheat gave Minnesotans increased yields of 15 bu/A of corn, 5 bu/A soybeans, and 9 bu/A of wheat. This herbicide application meant nearly half a billion dollars increase for farmers at a cost of $118 million, for a gain of $349 million.

An added benefit of such herbicide application is a reduction in fuel use. With such chemical control replacing cultivation control of weeds, a savings of approximately 10 million gallons of fuel can be achieved annually.

In test plots at the UM Southwest Experiment Station, chemical treatment against weeds increased soybean yields by nearly 8 bu/A and increased corn yields by 33 bu/A.

A 5-year comparison of yields at UM's Southern Experiment Station shows that when cultivation is used to replace chemical control of weeds that there is a crop reduction of 20 percent for corn and 36 percent for soybeans. In the 21-county area of the experiment station the value of extra crop attributable to herbicides is some $90 million.

Herbicide application to corn and soybean acreage in south central and southeastern Minnesota accounts for roughly $200 million worth of production more than could be expected if the same crops were only cultivated without chemical control of weeds.

Lack of such chemical control of weeds would skyrocket food costs at the supermarkets.

SWINE CROSSBREEDING SAVES $9 MILLION

Crossbreeding of swine has meant tremendous savings to farmers, along with increased profits and increased food production: West Central Experiment Station and Northwest Experiment Station researchers have worked on the crossbreeding of swine for decades. Today there is wide acceptance of crossbreeding of swine in Minnesota. One benefit derived from the crossbreeding work is the vast reduction of feed required to bring pigs to market. Just figuring the reduction in corn cost alone, these new breeds of swine have saved Minnesota swine producers approximately $9 million per year.

CUT DAIRY CALF FEEDING COSTS

UM experiment station researchers have found that dairy calves need not be fed milk replacer beyond 28 days of age. This means a saving of $10 per calf compared to the 3 or 4 month weaning commonly practiced until the 1960s. For heifer calf herd replacements alone, this can be a saving of $1,500,000 to dairymen in the area.

West Central station researchers point out that colostrum—the first milk of a cow when her calf is born—is often wasted. Colostrum put in barrels for fermenting (or pickling) can be used to feed dairy calves in place of whole or dried milk at a savings of 18 million pounds of whole milk in the west central area alone, at a savings of more than a million dollars of whole milk for other use.

DROUGHT PROTECTION FROM NITROGEN

Fourteen years of UM research shows that yields of corn can be increased by a bushel for each 2 pounds nitrogen applied. But as the amount of fertilizer application increases the point is reached where it may take an added 20 pounds of nitrogen to increase yields by one bushel.

Research on a disease which attacks pigs may be of use in a human disease, according to UM scientist Paul B. Addis: He says a blood enzyme test developed to detect Porcine Stress Syndrome in pigs may be used to screen halothane-sensitive humans (see related stories, pages 12 and 14).

During a drought, corn on low nitrogen soil often wilts and dies. But UM experiment station research at Lamberton shows that with adequate supplies of nitrogen the corn rooting depth increases from about 3½ feet with low rates of nitrogen to 5 feet and greater with adequate nitrogen.

With Minnesota soils near the Lamberton station holding approximately 2 inches of available water per foot, this nitrogen-promoted root depth furnishes the corn plant a tap into an extra 3 inches of water. During drought this could mean a crop saved.

Application of such knowledge, or protection against drought, could make a difference of millions of dollars. More importantly, food and feed production is that much less vulnerable to weather cycles of dryness so much at the forefront of today's agricultural hazards.

ENOUGH SEED CORN TO PLANT AROUND THE WORLD

UM's Agricultural Experiment Station cooperates with other experiment stations and with the hybrid seed corn industry to produce seed corn.

In the old days the farmer would watch for the best looking ears while he picked corn by hand. These corn ears the farmer would hang in a loft in the farmhouse rafters to dry for the next planting season. Results were poor and yields unpredictable. This is one of the many reasons the US farmers demanded experiment stations, to increase yields.

Now, the UM Agricultural Experiment Station—alone—produces enough hybrid seed corn to plant a one-mile wide strip of corn field around the world. These top lines of seed corn are made available to commercial seed companies and to the public.

Farmers get such varieties because the increased yields are a clear net profit.

WHAT SOYBEANS MEAN TO MINNESOTA'S INCOME

Some people do not comprehend the size of the vast Minnesota cropland. The acreage in soybeans alone—2,585,600 acres in 1974—is equal to a strip of cropland one mile wide and more than 4,000 miles long. But more important is what is being done to make the land produce more than ever before. New varieties developed through research is one method agricultural scientists use to increase yields and reduce costs.

For example, the Corsoy variety—in 1973—increased soybean yields by 7 bu/A more than other varieties. In 1974, even though early frost reduced Corsoy yield down to an improvement of one bu/A over other varieties except Swift, the Corsoy variety meant a $15 million increased income to growers. A new variety, Hodgson, is expected to replace Corsoy, with even better production.

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