MINNESOTA SCIENCE

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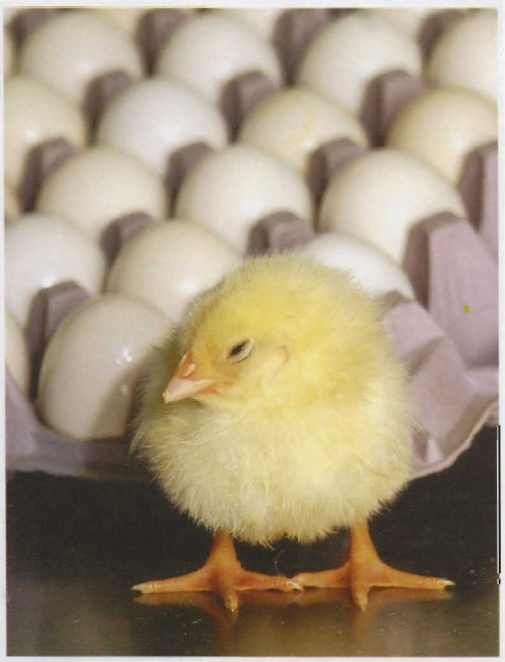
U OF M RESEARCH IS WORLD LEADER

Breakthrough Poultry Vaccine Proves Effective

by Phil Norcross

In the poultry business, most chicks get vaccinated in the egg (in-ovo) before they hatch. Thus they are hatched with immunity to the most serious avian ailment, Marek's disease.

Vaccinating eggs against Marek's provides four times the protection of post-hatch vaccination, largely because it protects on day one as the chick takes its first breath. Vaccinating after hatch means there are about three days before immunity takes hold during which there is risk of infection.



The vaccine protects about 85 percent of U.S. chickens since the process was automated eight years ago. Inoculating eggs in trays by the thousands is also a great deal safer, simpler, and cheaper than sticking a hypodermic into each chick. But thus far eggs get vaccinated against Marek's disease only; other vaccines must still be given after hatching. Veterinary researcher, Jagdev Sharma, co-inventor of in-ovo vaccination while with the USDA, has gone two steps further. He can now produce chicks that are resistant to four key poultry diseases using one injection to the egg. In addition to Marek's disease, this vaccine protects against infectious bursal disease (IBD), pox, and Newcastle disease.

Marek's disease is a viral infection that causes lymphoma and neutral lesions. Laying and breeding hens die young; broiler carcasses are condemned. Before the first vaccine arrived in 1969, an outbreak of Marek's would easily kill a quarter to a third of a flock, often more. In 1984, after vaccination, but before in-ovo delivery, the disease cost U.S. poultry producers about $170 million with losses worldwide of almost one billion dollars.

IBD suppresses poultry immune systems. In Europe in the late '80s, leghorn flocks suffered 90 to 100 percent mortality from IBD. In Europe, Marek's is not the big problem, IBD is. Newcastle disease comes in a confusion of varieties, with symptoms ranging from bleeding ulcers to respiratory infections. It's so contagious that it has resulted in numerous poultry trade restrictions.

Back in St. Cloud, Minnesota, Golden Plump hatches 250,000 broiler chicks a day,

INSIDE

Veterinary researchers have developed a revolutionary in-ovo (in the egg) vaccine that will protect chickens against multiple diseases.

POULTRY
continued on back

RAPID RESPONSE FUND TARGETS ECONOMIC, SOCIAL ISSUES

The 1998 Minnesota State Legislature provided special University of Minnesota funding to address urgent issues challenging Minnesota. Coined the 'rapid response fund,' the first projects funded were spelled out in legislation as, "those affecting spring wheat, barley, canola, potatoes, and respiratory diseases affecting turkeys." All are major players in Minnesota's economy, with billions of dollars at stake.

"What makes this legislative funding different from ongoing research funding is that the Rapid Response Fund is intended for short- and intermediate-term responses to contemporary agricultural and environmental concerns such as animal or plant disease epidemics or for new technology to help our constituents," says Phil Larson, acting director of the University's Agricultural Experiment Station. This new initiative is one of five University-wide priority areas that attracted legislative attention. The others are molecular and cellular biology; design; digital technology and multimedia.

The university also established a system for responding to future requests for emergency research. The colleges participating are: Agricultural, Food and Environmental Sciences; Natural Resources; Human Ecology; Veterinary Medicine; and Biological Sciences.

These projects are underway at Minnesota research sites:

- **Potato virus epidemic**. See story below for details.
- **Avian disease control and eradication.** Sixteen projects are underway focusing on avian pneumonovirus. The project team includes animal scientists and veterinary researchers along with the Minnesota Turkey Research and Promotion Council.
- **Canola as an alternative crop.** This effort includes scientists at the U of M and North Dakota State University. The Minnesota Canola Production Centre was dedicated in July. Scientists evaluated seeding techniques, weed management, fertilizers, variety performance, and timing of swathing.
- **Small grains improvement project.** Several years of devastating wheat and barley losses to scab disease prompted this effort. University researchers are expediting the development of improved small grains, and using molecular technologies to analyze antifungal activity in transgenic tissues and breeding lines.

Details of these projects will appear in *Minnesota Science*, or may be checked at: www.rapidresponse.umn.edu

- Dave Hansen

55% OF SEED CROP REJECTED

Potato Epidemic Threatens Industry

Brunswick and Idaho, the seed crop is managed differently than it is in Minnesota," says entomologist David Ragsdale, who has researched insect-carried pathogens for over 20 years. Seed fields are typically isolated from commercial production and harvested earlier, depending on aphid abundance data obtained by an extensive trapping network.

Ragsdale and plant pathologist Ben Lockhart are testing other areas of the state where seed potato might be increased. Last year only a single grower had clean seed in all lots tested by the Minnesota Seed Certification Program. One way to avoid the many diseases inherent in the primary production areas of the Red River Valley and on the irrigated sands of central Minnesota — from Elk River to Park Rapids — is to locate parts of Minnesota where virus incidence is inherently low.

"We planted clean seed lots at three U of M Agricultural Experiment Stations distant from commercial farms: Morris, Waseca and Lamberton," explains Ragsdale. Our objective is to identify a suitable location for potato growing that is sufficiently isolated from sources of the virus so that seed potatoes generated from tissue culture can be safely increased for one or two years. Such a site may someday be developed as an elite seed farm, if seed potato growers support the idea.

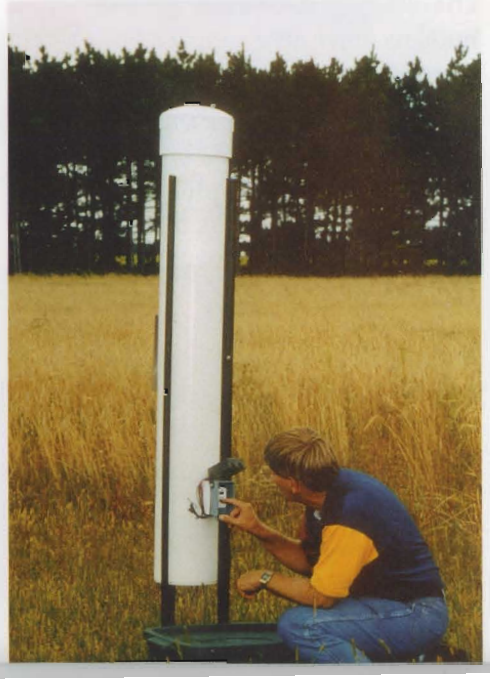
Researchers are also providing growers with options to control the epidemic such as enhanced natural controls; crop borders; timing of vine kill

tic tests that can detect PLRV or PVY in individual aphids. Combined with trapping, this alerted growers when virus-carrying aphids were on the move.

Last year, research results were communicated to growers during the peak season by Aphid Alert, an on-line and printed newsletter produced by integrated pest management specialist Carlyle Holen and Suranyi.

Controlling the Insect

Aphids are also watched by certification inspectors who check seed production fields. They record virus incidence and the proximity of seed fields to commercial potato fields or other crops that harbor aphids. A satellite global positioning system is used to record coordinates of each incident.



by Dave Hansen

Minnesota's seed potato industry faces possible extinction unless researchers and growers curb a five-year epidemic spread by the tiny green peach aphid. University entomologists and plant pathologists have documented severe infections of potato leaf roll virus (PLRV) and potato virus 'Y' (PVY) and are working on many fronts to control the outbreaks. By historic measure, 1994 was a bad year when over two percent of seed potatoes were rejected because of infection. But in 1997, it was 35 percent and last year over half the crop was affected. The financial impact is enormous. Before the epidemic, Minnesota and North Dakota produced nearly 40 percent of the U.S. supply of seed potatoes shipped interstate.

"As with all epidemics, there are several mitigating factors," explains Ted Radcliffe, an entomologist specializing in biological control of pests. One key factor we have identified is that recent changes in fungicide use have contributed to greatly increased green peach aphid pressure. Chemicals are necessary because many other insects and fungi attack the sensitive potato plant. However, the intensive regime of fungicide application, in combination with multiple applications of insecticide, has proven devastatingly disruptive to fungi that control the green peach aphid, which is now a common pest. In 1997, the combination of abundant aphid populations, high levels of virus in the seed crop, a wet spring and a warmer than normal fall resulted in ideal conditions for a viral epidemic.

To implement a large-scale attack on the problem, the 1998 legislature provided special rapid response research funds to curb the epidemic (see sidebar.) Minnesota's potato industry ranks seventh in the country with over 100 million dollars of raw product harvested each year. The processing of fries, chips, soups, stews and fresh-pack products adds well over $500 million to the state's economy.

The epidemic is hitting seed producers especially hard and over 25 percent have gone out of business in the last three years. Seed producers take varieties, some developed by the Experiment Station for local conditions, and reproduce them in commercial quantities for other farmers.

Attacking the Disease

"In key seed producing areas of the world such as Scotland, New Zealand and location of seed fields among others.

Monitoring the Spread

A key to controlling the epidemic is to monitor aphid distribution during the growing season. Entomologist Robert Suranyi, working from the Northwest Experiment Station, Crookston and the Minnesota Certified Seed Department, East Grand Forks, established a network of growers in strategic locations and placed two types of traps near their fields. The hypothesis is that suction traps detect long distance flight of the aphids, whereas conventional pan traps detect local movement. If suction traps are effective, a permanent trapping network could be established to provide a warning of virus spread. In Scotland, such a network exists and is used as a last resort to recommend or mandate killing potato vines in order to stop the aphid spread.

Disease researcher Lockhart developed sensitive and rapid diagnos-

The tiny green peach aphid is only about one millimeter long. The major damage it causes is to spread potato viruses, now reaching epidemic levels in the Red River Valley.

Entomologist David Ragsdale checks a suction trap for evidence of virus-infected green peach aphids. Results were relayed to growers throughout the state via the Aphid Alert newsletter and web site.

Then, using a geographical information system, entomologist Ian MacRae matches lab tests of each seed lot to the field it came from. The digital overlay of the three lines of defense — field inspections, trapping network, and winter testing — may help plot where seed crops can be safely grown. "The goal of this component of the research is to determine the isolation required to maintain virus-free seed when grown in the vicinity of commercial potato growers," says MacRae.

Aphid pressure varies greatly from year to year and location to location, making prediction of outbreaks impossible, Radcliffe explains. Weather and pesticide use are probably the most important factors affecting aphid populations.

"Ultimately, survival of the potato industry is dependent on developing effective management of the aphid and the virus it spreads. There are effective management tactics available, but lack of a biological monitoring network leaves researchers and growers without the information needed to make meaningful management decisions," Radcliffe states. ■

LOVE AT FIRST SMELL

Fish Smells Key to Exotic Species Solution

by Dave Hansen

Fish live in an ocean of chemicals that is often dark and apparently featureless. To find food, avoid predators, and locate each other to reproduce, fish rely on odors rather than on visual cues. How they do this is the focus of fisheries researcher Peter Sorensen.

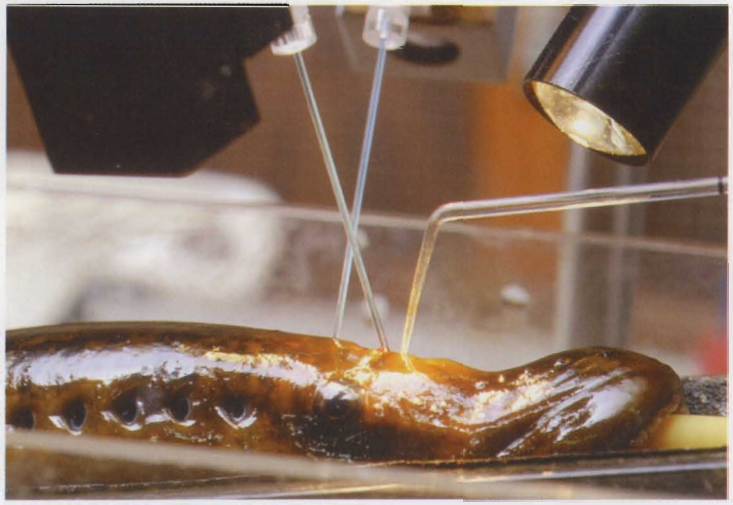
Sorensen investigates vertebrate pheromones and how they function. Pheromones, he explains, are chemicals that stimulate "specific, instinctual, and adaptive behaviors" in others of the same species. They are detected by the olfactory sense, smell, one of the least understood but most conserved senses. The olfactory systems of fish and humans differ little and, at a basic level, resemble those of insects.

Given the conditions in which fish often live, pheromones appear essential to their survival. "Fish, particularly those in temperate waters, have a very important is the sense of smell to many fishes that if it is somehow damaged, for example, by pollutants, they suffer close to complete reproductive failure.

This kind of insight into animal biology has practical applications. As with insect pheromones, fish pheromones show great promise in the control of nuisance or exotic species, for which few options currently exist. As with insects, fish abundance may one day be monitored by measuring pheromones in the water or by using pheromone traps, suggests Sorensen.

Unwanted species could also be trapped or their behavior disrupted by adding pheromones to the water. "Pheromones are highly specific, potent, environmentally friendly, and easy to apply. They offer great promise," Sorensen notes.

In Sorensen's lab, he and a team of research assistants investigate all



Probes in the olfactory opening of sea lamprey monitor what pheromone blends they react to. The probes measure voltage changes when the lamprey detects an odor it is genetically programmed to respond to.

cial and sport fishing combined."

Although not a big problem in frigid Lake Superior, the lamprey has decimated the other lakes. This ancient eel-like fish, which has a nose larger than its brain, is presently held in check with chemicals put into streams to kill larvae. However, not all streams can be effectively treated. Sorensen and his colleagues have discovered that adult lamprey recognize and locate spawning streams by the odor of unique bile acids released by larval lamprey found in the streams.

Sorensen is currently seeking pheromone alternatives that will lure lamprey away from spawning areas, perhaps into traps or to unsuitable habitat where their eggs will be left high and dry. Large-scale treatment means producing commercial quantities of pheromones. Sorenson and others are working on this. The results will mean earth-friendly control of exotic fishes plaguing Minnesota's lakes and streams, such as common carp, ruffe, and round-nosed goby.

At present, scientists don't know how big the fish pheromone puzzle is. Sorensen and others have identified specific pheromones for only a handful of species. They have also shown, but not proven, that pheromones are released in strategic pulses, and as with insects, comprised of message-holding pheromonal blends. ■

(CU) Sea Lamprey have an opening on their underside that attaches to host fish and chews its way inside. Pheromone research is leading to biological con-

TOLERANT AND TASTY

New Strawberry Needs Few Inputs

by Sam Brungardt

trol of this Great Lakes nuisance species.

short reproductive season because of temperature and substrate requirements," Sorensen explains. "Further, because they're external fertilizers, individual females sometimes only have a few hours to spawn."

As a result, fish have developed pheromone systems and an acute olfactory sense to find their way to spawning grounds and locate each other. So aspects of fish pheromones. This includes their chemistry, neural sensitivity, and behavioral responsiveness. An applied project is deciphering how the sea lamprey, an exotic species that invaded the Great Lakes at the turn of the century, uses pheromones. Sorensen explains that, "The lamprey is the number one problem in the Great Lakes fishery, consuming more fish than commer-

HELLO DOLLY!

Biotechnology Primer Essential Reading

By Larry A. Etkin

A primer on the tools of modern biotechnology, *Animals By Design*, has been published by the Minnesota Agricultural Experiment Station. The 28-page publication is authored by molecular geneticist Lawrence Schook. The book includes color panels, photos, charts and illustrations to explain genetic advances in animal breeding.

"Decisions about the applications of biotechnology within our food systems and our society are being made daily in university laboratories and private commercial firms around the world," says Schook. "It's important for current and future leaders to understand both the issues and the potential surrounding the technologies of genetic mapping and manipulation."

Animals By Design tackles this tough, jargon-filled area of science. It translates and defines the field's terms and concepts with language suited to the educated non-scientist and the interested general public. "My goal in writing the primer was to make biotechnology understandable so people will be able to make informed decisions, particularly about policies related to biotechnology," Schook says.

A sampler of *Animals by Design* can be viewed at: www.extension.umn.edu/Documents/D/I/DI7220.html . Single copies of the publication cost $8.

Call 612-624-4900 (Twin Cities) or 800-876-8636. Ask for publication MR-7220-MS. ■

Two strawberry cultivars, Winona™ and Mésabi™, are available to growers courtesy of the Minnesota Agricultural Experiment Station and the USDA Agricultural Research Service.

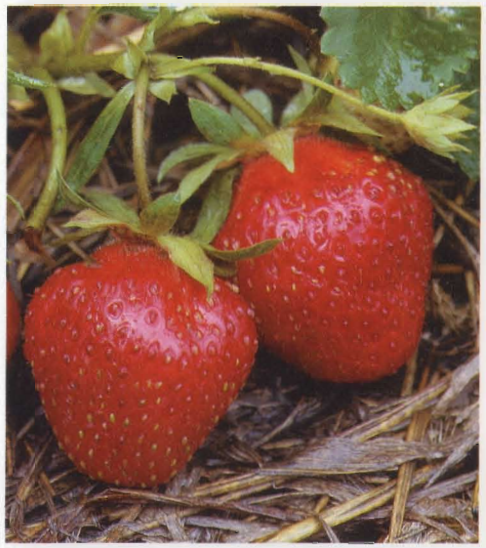
University of Minnesota horticultural scientist Jim Luby, who heads the fruit breeding project, says Winona was developed over a 15-year period. The cooperative effort sought to produce a strawberry adapted to the north-central region that fits into integrated pest management (IPM) programs. IPM promotes minimal use of chemicals to control diseases and other pests.

Winona, first available two years ago, has the needed winter hardiness. And, it fits into IPM programs because it is resistant to, or tolerant of, many diseases. It is resistant to five races of red stele and has good tolerance to black root rot. In U of M trials, Winona's foliage was unaffected by leaf spot, leaf scorch, leaf blight and powdery mildew, diseases that growers must otherwise control with fungicidal sprays.

Luby says Winona also does not exhibit June yellows, a physiological disorder that is most apparent in cold spring weather. "Strawberry cultivars differ in how they display June yellows," he says. "We expect Winona to replace Blomidon, a late-season cultivar that has become very popular with Minnesota growers, who like its very attractive fruit and productivity but began exhibiting June yellows in the early 1990s."

The fruit of Winona is a bright orange-red with a conical shape. Its flesh is smooth and creamy in texture. The flavor is moderately intense, with classic strawberry flavors and, sometimes, a hint of peach. The flesh is very firm, and the skin is tough enough except during very wet and humid seasons.

Mesabi™, another new highly productive cultivar from the same breeding program, has shown special tolerance to cold winter and warm summer temperatures during testing. Plants of Mesabi will be available from a few nurseries for planting in 1999. For a list of nurseries contact Jim Luby at: lubyx001@maroon.tc.umn.edu/. ■



Two recent University of MInnesota strawberries are available to north-central U.S. growers. Pictured is Winona, released in 1996 and becoming popular with U-pick operators in the region. Mesabi, an even hardier introduction, is available on a limited basis in spring, 1999.

STUDY PROMPTS LOOK AT BUILDING PRACTICES

Does Your House Make You Sick?

by Dave Hansen

Ice dams, wet basements, musty odors or mold can be found in many Minnesota homes and yet most homeowners are satisfied with their dwelling. A survey of 200 Twin City homes and interviews with their owners by housing researcher Marilou Cheple documented many issues facing owners, builders and overseeing agencies.

- 35% do not have gutters
- 20% never use bath vent fan
- only 45% have kitchen exhaust (50% never use it)
- 45% line dry clothes inside
- 80% never open windows in winter

Housing researchers inspected 200 newly built Twin City homes and surveyed their owners to determine the extent of moisture problems. The red "blower door" is a tool used to pressurize the house and measure air leakage.

Cheple looked only at newer homes, built in the 1990s, so her review would be relevant to current building practices. Before academic work

"In Sweden, for example, it is tradition to open windows and air out the house every day to let in fresh air and expel dust, moisture, and stale air," not have the awareness, knowledge, tradition, or perhaps time to maintain their home air quality. "When building a new home, owners need to help choose materials, and spend extra for a better heating and ventilating system instead of a hot tub," she says. She adds that homeowners need to educate themselves about sources of moisture and pollutants. Don't store pesticides, and don't bring in green wood; it contains a lot of moisture in addition to insects.

"For those worried about the status of their home, the most obvious warning sign of a moisture problem is condensation on windows, more serious is mold or mildew," Cheple states. If eye irritation or chronic fatique go away when you're not at home, your house may be the cause of such health problems.

Changes are coming with a statewide energy code that takes effect in July of 1999. The code which Cheple's work has helped bring about, requires mechanical ventilation to supply fresh air.

"Your home is typically your largest single investment," Cheple concludes. "It is where we feel most secure, and we expect it to keep us healthy, not make us sick."

Cheples' research was completed while she was a graduate student in the Department of Design, Housing and Apparel. She worked closely with housing researcher Rebecca Yust, who studies energy consumption and residential technology. Cheple is now in the Department of Wood and Paper Science, and works with builders and

ENVIRONMENT FRIENDLY

Preserving Log Furniture

by Martin Moen

Bark-covered wood has long been a popular material from which to build rustic furniture used in lodges and homes. As popularity of such products increases, so does interest in protecting the typically high-moisture wood from insect damage. Methyl bromide, a compound used in the past for this purpose, is less than ideal because it does not prevent reinfestation after manufacture. Its use will soon be restricted because it contributes to the destruction of the ozone layer.

Wood products researcher Elmer Schmidt, along with a Purdue University colleague, has discovered a promising new approach to prevent insect infestation in bark-covered wood. The researchers treated bitternut hickory samples with borate, a preservative that penetrates green wood better than other preservatives and has very low human toxicity.

The samples were tested for two summers. For a portion of that time, the samples were mixed into a stack of firewood. The result was that approximately 28 untreated control samples were infested with insects, while none of the borate-treated logs showed damage. An additional indoor storage period produced insect damage in the remainder of the controls, but in only

,Cheple was a builder herself, worked for other builders and did home design. She pursued her investigation, because builders weren't recognizing moisture problems. Contractors would tell concerned homeowners that everyone in Minnesota has a damp basement.

"Moisture is a concern in residences because of asthma and other respiratory illness; infections; fungal illness; increased bacterial counts and hypersenitivities," Cheple explains. Also, moisture trapped in walls leads to decay of wood members and durability problems.

The homeowner survey reports problems including:

- ice dams - 26%
- water on basement floor - 15%
- water standing in sump - 25%
- interior paint peeling - 15%
- frost on window frames - 45%
- mold on sills - 23%

Moisture problems have increased over the last two decades as tighter, energy efficient homes were built. With less fresh air coming in, moisture and pollutant — carbon dioxide, dander, dirt, and pollutants from carpets, glues, cleaning products and pestcides — are trapped inside. U.S. homes built through the 1970s were leaky enough that air exchange took place inadvertently. But owners of a newer home need to know how and when to manage their indoor environment because building codes and practices rely on owner decision-making.

Despite experiencing significant moisture problems, the study found that homeowners do not manage their Cheple notes. Homeowners here do

housing inspectors. ■

one treated sample. ■

GOOD BREEDING

Clean Bees May Save Hives

by Anne Gillespie Lewis

Good housekeeping usually is not a life-or-death matter, but breeding a "hygienic" behavior trait into honeybees may be crucial to their survival, according to Minnesota Experiment Station entomologist Marla Spivak.

Hygienic behavior is a trait that causes certain honeybees to quickly get rid of infested pupae (immature bees) that threaten the colony. Spivak has successfully bred honeybees that are better equipped to fight off pests and diseases. This breeding involves selection for a recessive "hygienic" behavior trait and artificial insemination of hygienic queen bees with semen from males from hygienic hives.

"Honeybees' poor housekeeping or 'unhygienic' behavior," Spivak explains, "may have been one factor responsible for last year's honeybee disaster." Approximately half of Minnesota's 150,000 honeybee colonies died and nearly all the wild honeybees were wiped out. "The wild population, important for pollinating orchards and gardens, may need years to recover," Spivak adds.

The "hygienic" bees, Spivak found through experiments, uncap the wax cells containing infested pupae and dispose of them quickly, while non-hygienic bees take much longer, giving mites time to infest other bees, weakening them and eventually causing the colony to collapse. Hygienic bees also clear out pupae infected by two diseases, American Foulbrood and Chalkbrood. "The neat thing about this trait is that it makes the bees healthier," Spivak notes.

Entomologist Marla Spivak - without gloves - has little fear as she works with honey bees in her effort to develop "hygenic" bees that clean their hives of deadly mites.

Since Minnesota is the fifth-ranking producer of honey among the states, loss of bees means loss of honey, which means a big income loss for state beekeepers. Spivak estimates that using queen bees bred for hygienic behavior could mean an increase in honey production by as much as 20 pounds per colony, a hefty increase for some commercial apiaries that may have a couple of thousand colonies.

"The key to healthier colonies," Spivak says, "lies in teaching beekeepers how to produce hygienic bees." Now, some beekeepers apply pesticides twice yearly for mite control. Breeding for hygienic queens would be safer, Spivak says, as well as cheaper. "They can use pesticides, which are very expensive, or they can put some money into breeding," she states.

Spivak is giving hygienic breeder stock to commercial beekeepers for a two-year period. She says genetic diversity in bees, now low due to widespread mite kill-off, can be maintained if many bee breeders select for hygienic bees. Work is also underway to determine whether neurological differences are involved in individual bees' hygienic behavior. ■

POULTRY *from cover*

four days a week, according to Doug Jensen, director of veterinary services for the operation. Each bird gets vaccinated four times — sometimes via food or water, sometimes by injection. The life of a layer hen includes 12 vaccinations. "It's a pretty elaborate program," says Jensen, "but Newcastle is always a problem, and IBD is critical." Because of in-ovo vaccination, Marek's is not an issue.

Machines can inoculate up to 50,000 eggs per hour and are way ahead of the in-ovo vaccines. "Existing IBD and Newcastle vaccines have been modified for in-ovo vaccination," explains Sharma, "but only the Marek's vaccine is in use, and no one sells an in-ovo vaccine for multiple diseases."

While Sharma has a 3-way vaccine ready, his goal is "multivalent vaccines that will, by a single injection, protect chickens and turkeys against all or most of the commonly occurring diseases." His targets are all three common strains of Marek's disease, IBD, Newcastle disease, and reovirus in chickens; and Newcastle and hemmorrhagic enteritis in turkeys.

Jagdev Sharma checks a bird in one of 42 isolation chambers used to monitor immune system responses to in-ovo vaccines.

Sharma's lab is the world leader in disease control in poultry. He now uses combinations of whole, attenuated viruses. "Combinations of multiple-live vaccines have been used in people and domestic animals for a long time, but they'd never been tried in chicken embryos," says Sharma. "You can't simply mix two syringe-fulls of existing vaccine; that's dangerous. They can become more virulent, or less effective. The trick is to learn how much virus the embryo can tolerate, yet still produce a protective immune response."

Sharma's poultry vaccine work is supported by the University's Agricultural Experiment Station and the Sota Tec Fund which helps researchers create new businesses for Minnesota. Funding also comes from the biologic and poultry industries, including the Minnesota Turkey Growers Association. ■

RESEARCH CONNECTIONS

Research of the Minnesota Agricultural Experiment Station is conducted throughout Minnesota by investigators in five colleges of the University of Minnesota. For more information explore the following Internet sites:

- *College of Agricultural, Food and Environmental Sciences,* www.coafes.umn.edu/
- *College of Biological Sciences,* www.cbs.umn.edu/
- *College of Human Ecology,* www.che.umn.edu/
- *College of Natural Resources,* www.cnr.umn.edu/
- *College of Veterinary Medicine,* www.cvm.umn.edu/
- *Minnesota Agricultural Experiment Station,* www.mes.umn.edu/~maes/
- *University of Minnesota Extension Service,* www.extension.umn.edu/

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