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Agricultural Research

Kicking Childhood Obesity,

pp. 2, 4-13

Agricultural Research Service

Solving Problems for the Growing World

FORUM

Childhood Obesity: Researchers Attack a Nationwide Epidemic

Maybe you've heard the old saying, "Tasty is tempting."

If what's tasty and tempting is also rich in fat and calories, this simple truism may help explain why 68 percent of all American adults—and 32 percent of all kids—are overweight or obese. But it is not just our eating habits that are to blame. Lack of adequate physical activity is also a factor. The increase in the amount of time that we spend sitting in front of a computer or watching TV has played a role in making these alarming rates of overweight and obesity three times greater than those of 30 years ago.

Obesity contributes to many health conditions that adversely affect the quality of our lives, including, for example, type 2 diabetes. The incidence of this obesity-linked disease has, not surprisingly, also tripled in recent decades. Some of us will remember when it was known as "adult-onset diabetes." The name was changed when what was once regarded as a disease of grown-ups began frequently showing up in children.

Obesity contributes to other afflictions, as well, including arthritis, gallstones, breathing problems, and high blood pressure. It is also a risk factor in heart disease and cancer—the two leading causes of death in the United States.

USDA's Agricultural Research Service is investigating new approaches to fighting obesity. These studies are a major focus of our national program of human nutrition research. It makes sense that these urgently needed investigations are carried out by a USDA agency, given the Department's major roles in production of healthful, abundant food and development of the *Dietary Guidelines for Americans*.

Obesity-related research is now in progress at all six of our human nutrition research centers (see map, page 13). At two of these centers—the Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas, and the Arkansas Children's Nutrition Center at the University of Arkansas for Medical Sciences in Little Rock—the nutrition needs and concerns of the young, from infancy through adolescence, are the primary emphasis. There, obesity prevention studies may yield new strategies appropriate for these age ranges.

Research areas at the children's nutrition research centers include the roles of food (diet), biology, genetics, epidemiology, and physical activity in weight gain in children.

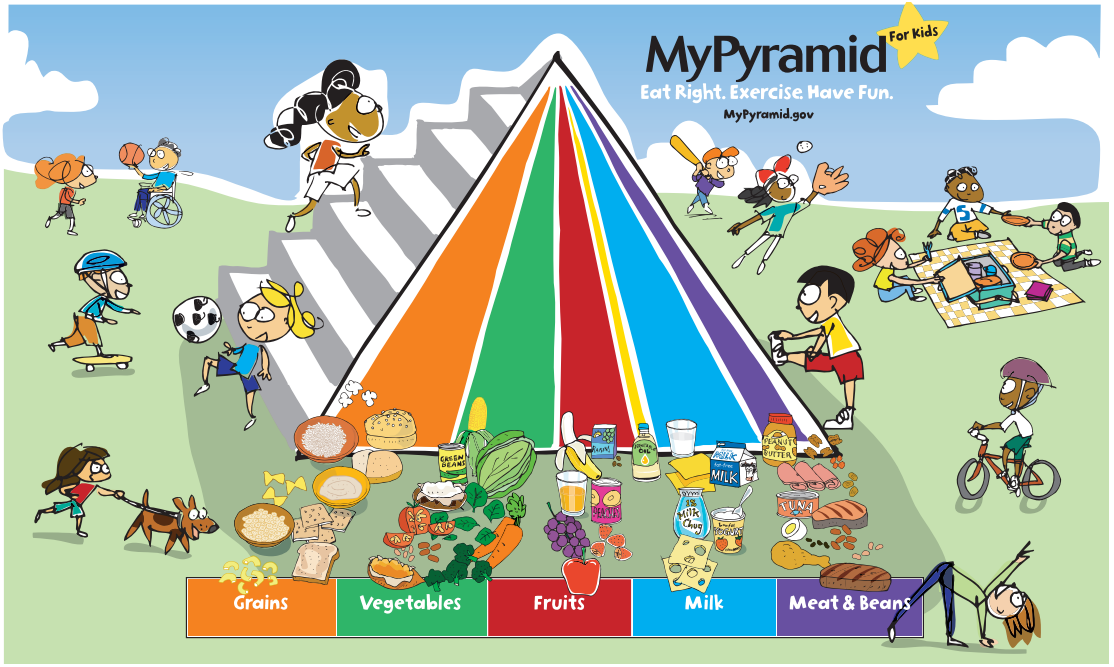
Why look at so many factors?

Because obesity is a multifactorial condition that requires ongoing management to counteract. No single factor or "silver bullet" holds the key to prevention.

This issue of *Agricultural Research* takes a look at some of the ARS research that's designed to better understand—and prevent—childhood obesity. As a scientist, I am excited about the potential of these and other projects to contribute to the health of our nation's children and to stop the trend of unhealthy weight gain.

Some experts predict that—as a result of our nation's huge increase in childhood obesity—the current generation of American kids may be the first to live shorter lives than their parents. We owe it to our children to make sure that this prediction never comes true.

David M. Klurfeld
ARS National Program Leader
Human Nutrition Research
Beltsville, Maryland



MyPyramid.gov For Kids is a website that can be used to help advise kids, their parents, and others on how to eat properly and exercise more.

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Agricultural Research

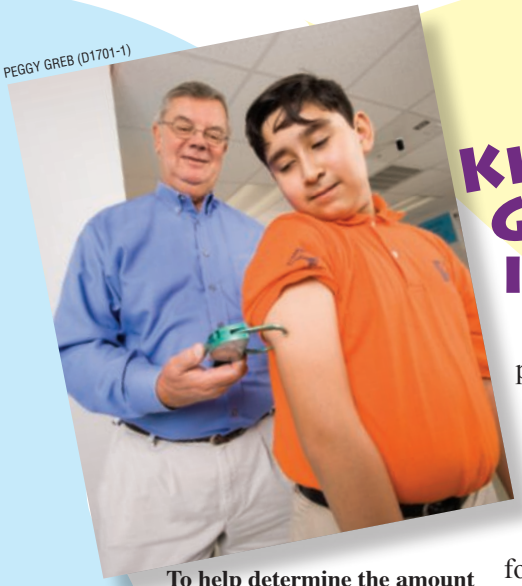
Solving Problems for the Growing World

Cover: Findings from ARS research may help kids enjoy becoming—and staying—physically active, a key to preventing childhood obesity. Photo by Peggy Greb. (D1723-1)

IN THE NEXT ISSUE

100 YEARS OF DISCOVERY—The Beltsville (Maryland) Agricultural Research Center, the world's largest agricultural research complex, turns 100 years old this year. With humble beginnings in a single dairy barn, the center today boasts a long list of advances and achievements in plant science, animal health, human nutrition, environmental health, crop utilization, and much, much more.

PEGGY GREB (D1701-1)



Kids Lose Pounds, Gain Fitness, in Science-Based Regimen

To help determine the amount of body fat, John Foreyt, professor of medicine at Baylor College of Medicine, takes a tricep skinfold measurement of a Houston middle school student participating in a health and nutrition study.

Real-life successes resulted for many Texas middle-schoolers who volunteered for an innovative, ARS-funded study. Kid-oriented strategies helped the children lose weight and gain nutrition savvy—plus physical fitness skills.

Craig Johnston, John Foreyt, Chermaine Tyler, and their co-investigators created the regimens for sixth and seventh graders enrolled in a Houston charter school mainly attended by Hispanic youngsters.

"We targeted young Hispanics, age 10 to 14 years," says Johnston, "because of the high rate of overweight among kids and adults in this minority group."

The research was done at the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, where Johnston and Tyler are instructors in nutrition and Foreyt is a professor of medicine.

Statistics reported for the 6-month study are based on 57 overweight kids who were assigned to either a self-and-parent-taught plan or an intensive, instructor-led program. For example, kids in the self-taught group spent time in study hall, once a week for the first 3 months of the investigation, reading a self-help weight-management textbook for youngsters. Meanwhile, their peers in the instructor-led team spent four class periods a week outdoors, improving their physical fitness, with a fifth session each week—indoors—learning about nutrition, healthy eating, and behavior-change skills essential for living actively and making healthful food choices.

During the final 3 months of the study, kids, parents, and members of their extended families could participate in various follow-up activities, including nutrition and fitness discussions in their homes, conducted in both English and Spanish.

When evaluated at the end of the 6-month venture, kids in the intensive, instructor-led course had significantly greater weight loss as well as greater "physical quality of life"—as measured by their answers to a standard questionnaire—than did the self-taught kids.

Was their success lasting?

To find out, scientists checked back at 1 and 2 years after the start of the study. Kids in the instructor-led team had significantly greater decreases in their body mass index, or BMI (a height-and-weight-based formula that gives an indication of body fatness), at those checkpoints than did the self-taught youngsters.

"More than 79 percent of the kids in the instructor-led cohort *decreased* their BMI in the first year—and 62 percent at 2 years," says Johnston. That was in contrast to the self-help kids: 64 percent *increased* their BMI in the first year and 65 percent *increased* BMI at 2 years.

The statistics from the instructor-led group make the study "one of the few, with Hispanic youngsters, to show sustained success with weight loss and weight management," says Foreyt. "Overall, these preliminary results suggest that a school-based weight-management program might be effective in reaching large numbers of kids. In this instance, we were able to build on the physical education and health education classes already in place. And we had the advantage of working with a school that already had strong ties to the Hispanic community and in which teachers act as extended-family members."

The researchers and their colleagues have reported their findings in the journals *Obesity* and *Pediatrics*.—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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PEGGY GREB (D1702-1)

Craig Johnston, nutrition instructor at Baylor College of Medicine, assesses the blood pressure of a study volunteer.

Through Computer Fun, Girls Improve Fitness and Food Choices

The "Food, Fun, and Fitness Internet Program for Girls" takes a lively, upbeat approach to teach girls about nutrition and fitness. Young African-American girls who worked with the program ate one more serving a day of a fruit, a veggie, or an all-fruit juice—and spent more time in healthful physical activity—than before they began visiting the program's website. That's according to Deborah Thompson, a behavioral science researcher and assistant professor of pediatrics with the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas.

Thompson and colleagues created the program and evaluated how effective it was in motivating 78 volunteers—Internet-savvy African-American girls age 8 to 10—to adopt healthy food and fitness habits. Thompson says those habits "are key to preventing overweight and obesity."

Risk of overweight or obesity among Black girls—age 6 to 11—is higher than that of girls—of the same age range—in some other racial or ethnic groups.

Volunteers for the study used their home computers to log on to the "Food, Fun, and Fitness" website, where they could watch the unfolding drama of six appealing comic-strip characters—young girls very much like themselves. The cartoon personalities struggle with meeting the same food and fitness goals as the volunteers, that is, to eat at least five servings a day of fruit, veggies, and/or 100-percent fruit juice; drink at least five glasses of water; and devote more time to physical activity. Volunteers were paid for their participation.

"Our results showed relatively high log-on rates to the website, low drop-out rates, and statistically significant increases in fruit, 100-percent fruit juice, and vegetable consumption and physical activity over the 8-week study," says Thompson.

For all of its light-hearted moments and drama worthy of a daytime soap opera, the intent of this interactive program is, in fact, deadly serious. Childhood overweight and obesity can lead to onset of life-threatening illnesses, including type 2 diabetes, cardiovascular disease, and certain kinds of cancers.

Thompson and Houston colleagues Tom Baranowski, Karen Cullen, Kathy Watson, and others documented results of this pilot study in the journals *Health Education Research* in 2007 and *Preventive Medicine* in 2008. They are now planning a large-scale study of 400 children and their parents to evaluate the longer-term effects of the program on food choices, physical activity, and obesity risk.

"Food, Fun, and Fitness" was influenced by well-established theories of behavioral science. But it is nevertheless strongly contemporary: The study was conducted entirely over the Internet.

"Our investigation was one of the few—targeted to an at-risk group of young volunteers—to demonstrate that a behavioral-theory-based obesity-prevention program, delivered via the Internet, could change viewers' food choices and physical activity," says Thompson.

Of course, sitting at a computer is often disparaged as sedentary. But time spent interacting enjoyably with the on-screen friends at "Food, Fun, and Fitness" may help young viewers move a step closer to better fitness and food habits for a lifetime.—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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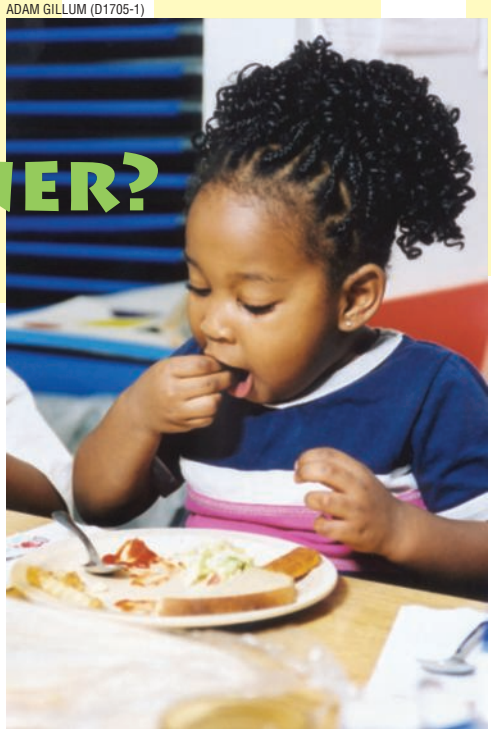
STEPHEN AUSMUS (D446-1)

The "Food, Fun, and Fitness Internet Program for Girls" uses lively, educational comic strips geared toward 8- to 10-year-old African-American girls to promote better food choices and physical activity.

Hey Mom, What's for Dinner?

Parents' Feeding Styles May Affect Kids' Obesity

ADAM GILLUM (D1705-1)



ARS research suggests a link between a youngster's body mass index, or BMI, and the feeding styles of the child's parents and other caregivers.

OK. Admit it.

You all too often find yourself serving your kids or grandkids those deliciously rich, high-calorie foods that they love—at the expense of healthful foods that they don't.

If this describes you, welcome to the club of people who have what nutrition researcher Sheryl O. Hughes and colleagues might classify as an "indulgent" feeding style.

Hughes is based at the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas, where she's an assistant professor of developmental psychology. She is taking a close look at the feeding styles of parents and other caregivers to learn more about how these styles influence a 3- to 5-year-old's attitudes toward food and eating and affect childhood obesity.

"If we know more about the feeding styles in these formative years and their relation to childhood obesity," says Hughes, "then we may be better able to intervene, retrain parents and kids, and help stop the childhood obesity epidemic."

Right now, 32 percent of children and adolescents in the United States are overweight or obese.

Hughes is examining two "permissive" feeding styles—"indulgent" and the nutritionally neglectful "uninvolved"—and two styles that offer more structure—"authoritarian" (a highly controlling approach in which kids are given no choices) and "authoritative" (parents choose what's served, but kids choose what's eaten).

In one early study, Hughes and colleagues worked with data from 718 low-income Black, White, or Hispanic parents of 3- to 5-year-old preschoolers in Texas and Alabama. Parents filled out Hughes's feeding-styles questionnaire. Kids' heights and weights were measured to determine their BMI, or body mass index—an indicator of body fatness.

Among other findings, the team determined that the "indulgent" feeding style was significantly associated with higher child BMI. Hughes, along with Theresa A. Nicklas of the Houston center and other co-investigators, documented the study in a 2008 article in the *Journal of Developmental and Behavioral Pediatrics*.

Hughes also collaborated in another analysis of data from the same volunteers. For that study, led by Michigan State University nutrition researcher Sharon O. Hoerr, scientists scrutinized the relation between feeding styles and how much of a given type of food kids ate—between 3 p.m. and bedtime—on three different days.

In an article published in 2009 in the *International Journal of Behavioral Nutrition and Physical Activity,* the scientists report that kids whose parents' feeding styles were either "indulgent" or "uninvolved" ate the least fruit, 100-percent-fruit juice, vegetables, or dairy foods, as compared to kids whose parents had "authoritarian" feeding styles. Ironically, the least-eaten foods were those that experts agree are the most helpful for weight management, Hughes notes.

While the authoritarian feeding style may not necessarily be the best choice in every parenting situation and for every age group, the scientists point out that some level of parental control—whether from the authoritarian style or the more balanced and nurturing authoritative approach—seems to be needed to help preschoolers eat what's healthful for them and to manage their weight.

The studies are among the most extensive of their kind for this demographic. If heeded, the research may help shape meal-time parenting across America for the better.—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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Kids' Body Fat
What's Healthy? What's Not?

Tell someone they're giving off gamma rays and they may think you've been seeing too many sci-fi flicks.

Actually, it's healthy and natural for humans to emit gamma rays.

Measuring those rays is among the sophisticated tactics that a Houston, Texas-based nutrition researcher is using to figure out how much lean (muscle, bone, and water) and body fat is healthy and normal for America's kids as they develop from infant to tot to teen.

At the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, biophysicist Kenneth J. Ellis's gamma ray device, officially known as a "whole body gamma counter," is one of about a half-dozen complex instruments that he uses, and in some cases improves, for the specialized job of determining body fat and lean, or what's known as "body composition."

These measurements are the foundation for a new generation of "body-comp charts" that may someday be as widely used as the more familiar height-and-weight tables or body mass index (BMI) charts that are a standard feature in pediatricians' offices across the country.

The new body-comp tables would give parents and physicians an updated way to determine how a child's growth pattern compares with that of healthy, fit kids of the child's age, height, weight, gender, and ethnic background. A parent's concern about a child's recent gain of body fat, for example, could be addressed, and perhaps assuaged, by looking at a body-comp chart to see if the youngster's body fat is within the normal range.

Constructing reliable body-comp charts for infants to teens requires finding and fine-tuning the best technologies for acquiring thousands of measurements from healthy young volunteers. Then those measurements must be analyzed to create the charts.

Having accomplished all that, and much more, during the past 15 years, Ellis's team is now within about 2 years of issuing preliminary body-comp tables based on data from normal, fit, Houston-area Black, White, and Hispanic youth.

These body-comp charts will replace and improve on existing tables that don't reflect today's ethnic diversity, are based on data derived from older technologies, and have other major drawbacks.

The gamma ray machine plays a leading role in this research. It provides inside information about muscle, a "lean" component. Says Ellis, "Gamma rays are emitted from potassium. Most of the body's potassium is in the muscles. So you can use the gamma ray measurements to develop an indirect, but accurate, measure of muscle."

Admittedly, the instruments used in doctors' offices and health clubs today to give a quick estimate of body composition aren't as sensitive as those in Ellis's lab. But that shouldn't create a problem for users of the new body-comp charts. The commonly used devices can simply be calibrated for use with the charts, Ellis points out.

His team is already internationally known for its pioneering work in determining how many calories kids need at various stages of their growth. The new body-comp charts are a much-anticipated sequel that will similarly help parents give their kids a strong start toward a lifetime of good health.—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

Kenneth J. Ellis is with the USDA-ARS Children's Nutrition Research Center at Baylor College of Medicine, 1100 Bates St., Houston, TX 77030; (713) 798-7131, kellis@bcm.edu. ✷

PEGGY GREB (D1687-1)

New body-composition charts would give parents and physicians an updated way to assess kids' growth patterns.

PEGGY GREB (D1689-1)

At the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas, research assistant Maryse Laurent prepares to place a sleeping infant into the measurement chamber of the PEA POD, a specialized instrument for accurately measuring infant body fat.

PEGGY GREB (K9831-1)

Baby's Weight: Is Epigenetics To Blame?

Findings by ARS scientists may underscore the need for aspiring moms to achieve a healthy weight before becoming pregnant and to gain only the recommended amount of weight during pregnancy.

No one is surprised when the child of an overweight mother becomes overweight or even obese. But scientists at two ARS-funded nutrition research centers are taking a new and closer look at how influences occurring in the womb and perhaps during the first few months of life might affect development of the child's ability to regulate his or her weight. The child's body-weight-regulating mechanisms might in fact be harmed during those times by the mother's own overweight.

Such maternal programming of the unborn child and the developing newborn could increase the risk that the child would become an overweight or obese adult. In turn, that adult would have a higher risk of obesity-related afflictions such as type 2 diabetes or cardiovascular disease.

Understanding more about little-known heritable maternal influences may lead to new ways to help at-risk youngsters keep excess pounds at bay.

Kartik Shankar, an investigator with the ARS Arkansas Children's Nutrition Center in Little Rock and an assistant professor of pediatrics at the University of Arkansas for Medical Sciences, looked at weight gains among rat pups whose mothers, called "dams," were either lean or overweight (from overfeeding) at the time of conception and during pregnancy.

For this research, Shankar and colleagues mated the lean or overweight female rats with lean males. The pups were nursed only by normal-weight dams "to make sure that the pups' exposure to their mother's obesity occurred only in the womb," Shankar says.

All pups were of normal weight at birth and at weaning. However, when the weaned offspring were given free access to an unlimited amount of high-fat rations, the offspring of overweight dams gained significantly more weight, and more of that weight as fat, than did the offspring of lean dams.

"This occurred despite the fact that the offspring of overweight dams ate the same amount of high-fat food as the offspring of lean dams," Shankar points out.

"Our study strongly suggests that exposure to the mother's obesity—while in the womb—results in programming of the offspring's body-weight-control mechanisms," he says. "The dams' obesity alone was sufficient to significantly increase the pups' susceptibility to obesity."

PEGGY GREB (D1694-1)

Kartik Shankar, an investigator at the ARS Arkansas Children's Nutrition Center in Little Rock, analyzes rat fat cells. The size of fat cells in offspring is influenced by maternal obesity.

Since Shankar's group used only rats that were genetically similar, the scientists essentially ruled out the possibility that any important genetic differences among the dams could contribute to the remarkable difference in pups' sensitivity to the high-fat rations.

If proven true for humans, the findings would underscore the need for aspiring mothers to achieve a healthy weight before becoming pregnant and to gain only the recommended amount of weight during their pregnancy. Right now, the incidence of overweight or obesity among pregnant women in America continues to increase, according to Shankar.

His team documented this study in a 2008 article in the *American Journal of Physiology–Regulatory, Integrative and Comparative Physiology.*

Maternal obesity may alter pups' body-weight-controlling mechanisms in a way not described by traditional Mendelian genetics. Instead, this programming may result from what's known as an "epigenetic mechanism."

Literally translated, epigenetics means "on or above genetics." When an epigenetic mechanism is in play, genes themselves aren't altered. But the way the genes function, or are "expressed" (turned on or tuned off), during early growth is indeed changed.

Once highly controversial, epigenetics has at least won some acceptance as having a role in human disease, in part because of increasing evidence of epigenetic linkages to cancer.

Epigenetics may provide the explanation for an obesity phenomenon described in a 2008 study led by Robert A. Waterland. He's conducting follow-up research in his laboratory at the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas, where he is an assistant professor of pediatrics.

Waterland did the research with a population of genetically similar laboratory mice known for their genetic tendency toward obesity. He says the findings suggest that "an epigenetic mechanism may act to increase the severity of obesity from one generation to the next."

This "transgenerational amplification of obesity" occurred in three successive generations of mice that Waterland and coinvestigators studied. Specifically, overweight dams gave birth to even-more-overweight offspring, the females of which gave birth to even heavier pups, and so on, through generation three.

Reported in the *International Journal of Obesity,* the study showed that the mothers' obesity apparently induced changes in the expression of genes that control the formation of the pups' body-weight-regulating mechanisms. That likely took place in the womb and perhaps in the weeks thereafter, setting the pups on the path to obesity.

Scientists elsewhere have shown that effects resulting from an epigenetic mechanism might be reversed in lab animals by feeding them rations that boost an epigenetic process known as "DNA methylation." That appears to be what happened when Waterland and colleagues provided dams with methylation-enhancing chow. That's a research procedure, not a cure for obesity, Waterland cautions.

Right now, these leading-edge investigations into mother's overweight and baby's epigenetically controlled predisposition to obesity perhaps raise more questions than they answer. But the studies provide a strong foundation for new research that might help to unburden tomorrow's generations from a lifelong struggle with obesity.—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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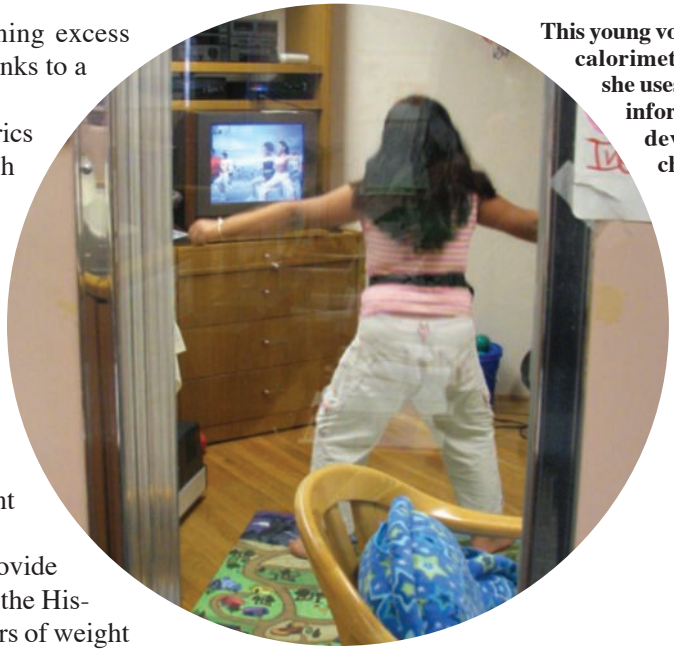
Weight Gains in U.S. Hispanic Children

Study Identifies Significant Predictors

ADAM GILLUM (D1706-1)



This young volunteer is in a room-size calorimeter, where the calories she uses can be monitored. The information can be used in developing predictors of childhood obesity.

Kids who have the highest risk of gaining excess weight might be identified reliably, thanks to a set of scientifically sound predictors.

Nancy F. Butte, a professor of pediatrics at the ARS Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas, led a team that found statistically significant associations between weight gains and several measurable factors. The team worked with volunteers—879 Hispanic kids, preteens, and teens, age 4 to 19, from the greater Houston area. They were participants in Viva La Familia, an ambitious investigation of what's causing obesity among America's Hispanic kids and what might be done to prevent or treat it.

The weight-gains study was "the first to provide definitive predictors of excess weight gains for the Hispanic population," Butte says. Positive predictors of weight gain, as reported by Butte and co-investigators in the *American Journal of Clinical Nutrition,* are:

- **child's BMI, or body mass index.** The heavier the child, the more likely a gain.
- **mother's BMI.** Gains are more likely with heavier mothers.
- **levels of the hormones insulin, ghrelin, leptin, or thyroid,** measured in a fasting blood sample. Higher values are associated with higher gains.

- **calories burned in a day.** Perhaps surprisingly, the *higher* the energy expended, measured while asleep or awake, the *higher* the gain.

Butte collaborated in the research with Kenneth J. Ellis and Theresa A. Wilson at the Houston center; Jennifer O. Fisher, Temple University, Philadelphia, Pennsylvania; Issa F. Zakeri, Drexel University, also in Philadelphia; Guowen Cai, SAS Institute, Inc., Cary, North Carolina; and Shelley A. Cole and Anthony G. Comuzzie of the Southwest Foundation for Biomedical Research, San Antonio, Texas.

The weight-gain predictors are "meant to shed light on the causes of childhood obesity and to help identify those children who are at increased risk for excess weight gain," says Butte. "Mindful weight management may help at-risk kids reduce their chances of developing obesity-related illness, including type 2 diabetes and cardiovascular disease, later in life."—By **Marcia Wood,** ARS.

This research is part of Human Nutrition, an ARS national program (#107) described at www.nps.ars.usda.gov.

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CUTTING THE FAT

and Calories in a Childhood Favorite

STEPHEN AUSMUS (D1699-4)

The FANTESK that food technologist Mukti Singh (foreground) examines as it comes off a drum dryer was prepared by plant physiologist Frederick Felker (background, left) and chemist George Fanta (background, right) using a steam jet cooker. Singh uses FANTESK to cut the fat and calories in cake and frosting.

Children's birthday celebrations might soon be even happier, thanks to research that's trimming the fat and calories from a traditional favorite—cake and frosting. Any subtracting of fat, and its calories, from foods that kids crave is a plus, in light of the nation's epidemic of childhood obesity.

At the ARS National Center for Agricultural Utilization Research in Peoria, Illinois, food technologist Mukti Singh is working to slim down the fat and calories of cake mixes. She's doing that by formulating the mixes with FANTESK—microdroplets of trans-fat-free cooking oil, encapsulated in cornstarch or wheat flour.

In experiments at her laboratory, Singh has found that low-fat cake mixes made with FANTESK don't need added oil. The mixes yield cakes that have better texture and a higher volume—improvements that even the most undiscerning young palates can readily appreciate.

What's more, the lower fat frostings that she and Peoria chemical engineer Jeffrey Byars are creating with FANTESK have the smooth texture and spreadability of buttercream favorites, yet contain up to 50 percent less fat.

Meanwhile, fruit is the focus of two healthful snacks from scientists based in California—the state that grows more fresh produce than any other.

The all-natural, junior-size fruit bars that ARS food technologist Tara H. McHugh, at the ARS Western Regional Research Center in Albany, near San Francisco, and retired colleague Charles Huxsoll have developed fit perfectly in a child's lunch sack or backpack. The chewy bars each provide the equivalent of about one serving of fruit and are available in an array of appetizing flavors, including apple, pear, pear-cranberry, and more.

Another orchard-fresh option: The prepackaged apple slices that you may have seen at food stores or perhaps on the menu of fast-food restaurants near you. Kids whose wiggly teeth don't yet have the power to bite into a big, round apple may find these slices more manageable. The crunch, color, and flavor of the slices are protected by a vitamin-and-mineral-based coating. Invented and patented by Albany chemist Dominic Wong and his ARS and corporate colleagues, the invisible coating helps keep refrigerated slices from becoming brown and mushy, yet doesn't alter the taste of this ready-to-enjoy snack.—By **Marcia Wood,** ARS.

Lower-fat confections, all-natural fruit bars, and crunchy fruit slices—all from ARS research.

This research is part of Quality and Utilization of Agricultural Products, an ARS national program (#306) described at www.nps.ars.usda.gov.

To reach the scientists mentioned in this story, contact Marcia Wood, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; (301) 504-1662, marcia.wood@ars.usda.gov. ✸

Helping Kids Fight Obesity

Best Online Info Sources

Need trustworthy, up-to-date information on how to help your kids —or grandkids—avoid obesity? If so, you'll want to take a look at the top-notch sources shown below. Sara Wilson, a registered dietitian and nutrition information specialist with the Food and Nutrition Information Center at ARS's National Agricultural Library, in Beltsville, Maryland, selected these highly reliable sources as among the best.

empowerME

empowerme2b.org

This kid-friendly venue helps youngsters motivate each other to be healthier by participating in polls, joining in conversations with peers about the challenges of—and solutions to—obesity and, perhaps best of all, sharing their own success stories. This site was created by the Alliance for a Healthier Generation, which, at its own web pages (healthiergeneration.org), offers practical tips—like how parents can talk to their kids about obesity—and much more.

Nourish Interactive

nourishinteractive.com

and in Spanish at: nourishinteractive.com/languages/es

Vetted by nurses and registered dietitians, this energetic site teems with online games for kids, plus blogs, newsletters, health-hint calendars, lesson plans, and worksheets for parents and educators—all instantly accessible via a free log-in.

SmallStep Kids

smallstep.gov/kids/flash/index.html

Kids visiting this U.S. Department of Health and Human Services site can take small steps to better health with fun games, quizzes, and TV public-service ads designed to entertain while encouraging healthy eating and physical activity.

Kidnetic.com

kidnetic.com

Find yet more games here, plus recipes and other content offered by the International Food Information Council to help kids move more and eat better.

Kidshealth.org

kidshealth.org

Health and medical experts share kid-focused information on all facets of health—including overweight and obesity—for this graphics-rich, easy-to-navigate Nemours Foundation site.

Girlshealth.gov

tinyurl.com/GirlsHealth

Find smart choices for ordering fast food, or advice on how to achieve a healthy weight, at this award-winning, U.S. Department of Health and Human Services site for girls ages 10 to 16.

Weight Management and Obesity Resource List (2009)

nal.usda.gov/fnic/weight.pdf

Concerned about your child's weight? You may want to go directly to page 24 of this comprehensive, helpful collection. Later, peruse the rest: more than 150 books, brochures, and articles on weight management and obesity, all carefully selected by the National Agricultural Library's Food and Nutrition Information Center.

Weight Management for Youth

www.nutrition.gov/youthweight

More than a dozen links to weight-management-oriented websites specifically for kids, teens, and parents are offered here.

We Can!

nhlbi.nih.gov/health/public/heart/obesity/wecan

Online training and other aids featured at this National Institutes of Health site may help parents get their kids to make better food choices, be more active, and spend less time watching TV.

MyPyramid.gov

mypyramid.gov

The Pyramid helps users achieve and maintain a healthy weight by explaining what—and how much—to eat from each of the food groups and by providing handy tools, such as menu planners, for creating healthy meals.

Healthy Youth! Childhood Obesity

cdc.gov/healthyyouth/obesity

The Centers for Disease Control and Prevention provides links to sites with science-based strategies that schools and communities can use to tackle the obesity epidemic; see also this site's statistics on the prevalence of childhood obesity.

Robert Wood Johnson Foundation Center To Prevent Childhood Obesity

reversechildhoodobesity.org

Get inspired by this organization's array of strategies to reverse the childhood obesity epidemic by the year 2015. Use the "Reversing the Epidemic" tab to find the "What Individuals and Families Can Do" link, offering practical suggestions that might work in your community.

ARS Research Program on Children's Nutrition—and Obesity Prevention

The Agricultural Research Service conducts one of the most important research programs on children's nutrition—and childhood obesity prevention—in the world. The agency's obesity research program rises from an interlocking tripod of research areas: learning what people eat, what the body needs, and how to modify what we eat to be more beneficial—whether the changes are made while the food is being grown, processed, or eaten. Research from each of these areas influences research in the others.

One focus is relatively new in the history of ARS nutrition research, but it is of particular importance when it comes to preventing obesity in children: studying how and why children make food choices and what intervention strategies can move those choices in directions that will lessen obesity.

ARS's Obesity Prevention Initiative focuses on determining barriers—as well as motivators—to following the *Dietary Guidelines for Americans*. For example, ARS reported the first long-term study of food choices in school. When middle school students had access to foods not in USDA-approved lunch programs, not surprisingly their diets suffered. The finding has contributed to the revamping of school system food policies on the sale of snack foods and soft drinks in schools.

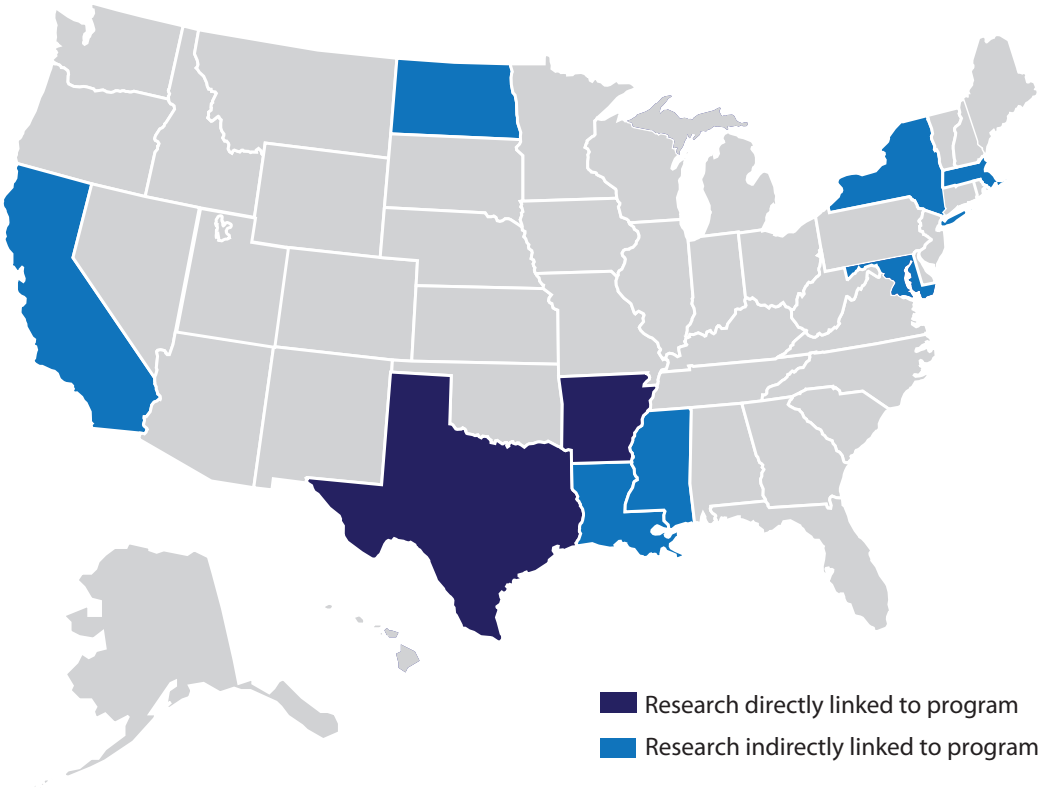
Another priority for the children's nutrition and obesity prevention program is to establish a children's growth standard based on body composition during growth rather than the current standard based only on body weight/height gain.

ARS has two primary locations for children's nutrition research: the Arkansas Children's Nutrition Center in Little Rock and the Children's Nutrition Research Center at Baylor College of Medicine in Houston, Texas. The Houston center is the largest federally funded children's nutrition research center in the country.

But all of ARS's nutrition research centers play a vital role in increasing our understanding of what all groups of people, including children, need in an optimum diet.

The need to reduce the growing epidemic of childhood obesity has been recognized as a priority by the White House and the U.S. Secretary of Agriculture. Research that expands our understanding of dietary factors, such as eating habits and nutrition, and lifestyle factors, such as physical activity, is a national priority for ARS. ✸

States Where ARS Does Children's Nutrition and Obesity Prevention Research



Line 1 Hereford Cattle

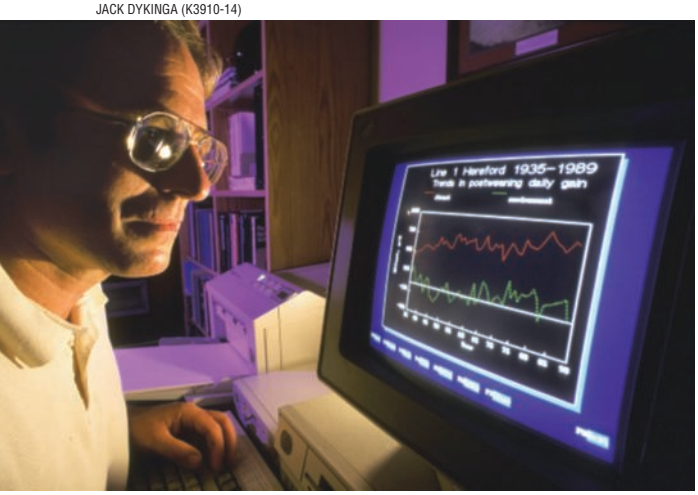
More Than 75 Years of Research

The term "genetics" is everywhere these days—in human medicine, animal and plant health, and basic research. But long-term studies on genetic selection and linebreeding of cattle have been ongoing at ARS's Fort Keogh Livestock and Range Research Laboratory (LRRL) in Miles City, Montana, since 1934.

The year 2009 marked the 75th anniversary of the founding of Line 1 Hereford cattle. Today, Line 1 has been closed to the introduction of other germplasm longer than any other identified line of beef cattle.

Line 1 Hereford cattle have been at the forefront of beef cattle breeding research. During the 1930s, success with hybrid corn sparked the development of many inbred lines of livestock across the United States. "Line 1 was created as a way for cattlemen to capture heterosis—or hybrid vigor—and produce a consistent product by crossing inbred lines," says LRRL geneticist Michael MacNeil. "But this vision was never fulfilled and has since been largely supplanted by crossbreeding. Today, the Hereford-Angus cross female is widely viewed as one of the best females available for commercial beef production." In large part, because of heterosis, these crossbred cattle have high fertility, are long-lived, and thrive in temperate regions.

JACK DYKINGA (K3910-14)



Geneticist Mike MacNeil reviews Line 1 Hereford breeding data collected since 1934.

The Beginning of the Line

Line 1 was founded in 1934 from two sons of Advance Domino 13. These bulls, Advance Domino 20 and Advance Domino 54, were purchased from Fred C. DeBerard of Kremmling, Colorado, and bred to 50 cows purchased from George M. Miles of Miles City, Montana. Then, daughters of Advance Domino 20 were bred to his paternal half-sibling, Advance Domino 54, and vice versa. Ever since, Line 1 Hereford cattle maintained by USDA at Miles City descend solely from this foundation.

The increase in inbreeding per generation has been kept low as matings between close relatives have been avoided. Line 1 illustrates a successful linebreeding program in which a high degree of relationship (39 percent) to the founding sire has been maintained for 18 generations. Without linebreeding, the relationship to an ancestor 18 generations ago would be less than one one-thousandth of a percent. Nearly all academic and commercial tests that assess production characteristics of individual bulls can be traced to original research with Line 1. Such practical things as the length of feeding period and number of animals required to measure economy of gain in progeny testing were pioneered in developing Line 1 and are now codified in the Beef Improvement Federation Guidelines for Uniform Beef Improvement Programs. Data from Line 1 also contributed to the first estimates of heritability and genetic correlation for beef cattle.

Work with Line 1 has also contributed greatly to the understanding of maternal genetic effects in beef cattle. The influence of a cow's milk production on the growth of her calf is one well-recognized example.

Early on, it was established that inbreeding could have detrimental effects on production efficiency. Crossing Line 1 with other inbred lines of Hereford cattle provided some of the first estimates of heterosis for beef cattle. These early results were complemented by the later observation that heterosis fully offset negative effects of inbreeding.

After exchanges of germplasm with the Northern Montana Agricultural Experiment Station at Havre and the USDA-ARS Brooksville Beef Cattle Research Station in Florida, pioneering comprehensive evaluations of genotype-environment interaction were conducted. Calves sired by bulls with parents and grandparents from Montana were found to perform better in Montana than their contemporaries sired by bulls with parents and grandparents from Florida. Conversely, calves sired by bulls from Florida stock were found to perform better in Florida than calves sired from bulls from Montana stock. Today, many cattle producers use results of these studies when they decide where they will obtain breeding stock.

Line 1 has had a profound influence on the Hereford breed. For more than 60 years, Hereford breeders and commercial beef producers have purchased Line 1 cattle for use in their herds. Today, direct descendants of the Line 1 Hereford cattle bred at Fort Keogh are recorded in almost every state and in several foreign countries. More than half of all Herefords recorded in the United States trace part of their ancestry to Line 1.

"Hereford cattle are appealing because they provide a fertile and highly adaptable maternal germplasm," says MacNeil. "And mating close relatives, as we do at Miles City, provides us with a continuous test for the presence of harmful recessive genes." Thus, ARS has provided a secure source of germplasm when the Hereford breed has run into problems with genetic defects, for instance dwarfism and more recently epilepsy.

LRRL (D1695-1)

Advance Domino 20 (left) and Advance Domino 54 (right), sons of Advance Domino 13, from whom all Line 1 Hereford cattle descend.

LRRL (D1696-1)

Breeding practices implemented by ARS researchers at Miles City make Line 1 the longest-running selection experiment using beef cattle worldwide. The resulting database provides an exceptional resource for prototyping procedures for national cattle evaluation. Results of this research have found their way into many modern-day genetic evaluation programs worldwide.

Back to the Future for Line 1

Research is always moving forward—in this case, in genomics. Increased genetic uniformity resulting from long-term linebreeding makes genome sequences easier to assemble and has uniquely positioned Line 1 Hereford cattle for contributions in future research. A Line 1 bull was selected to make a widely used genomic library, and DNA from a Line 1 cow was the foundation of the recently completed bovine genome sequence.

"Today we are looking for areas in the genome where heterozygosity has remained in spite of inbreeding," says MacNeil. Heterozygosity is the state of possessing two different forms of a particular gene, one inherited from each parent. "We know that genetic fitness increases with increased heterozygosity, so it stands to reason that certain areas (called loci) on some chromosomes would remain heterozygous if they have important effects on fitness. We don't know where these regions are, but if we can locate them then we may find out why animals are more or less fit."

Research with Line 1 Hereford cattle has yielded important animal-improvement information, making beef production more efficient. ARS's research has also generated useful germplasm that will allow cattle producers to use new technologies to improve their herds for decades to come.—By **Sharon Durham,** ARS.

This research is part of Food Animal Production, an ARS national program (#101) described at www.nps.ars.usda.gov.

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MIKE MACNEIL (D1698-1)

This Line 1 Hereford bull (99375) is the sire of the cow upon whose DNA the bovine genome sequence is based.

BRIAN PRECHTEL (K9032-1)

Biocontrol Bacteria Hold Their Own—to the Benefit of Apples

Plant pathologist Mark Mazzola prepares to evaluate the root system of young apple trees in a wheat rotation plot. The roots will be examined to determine whether the rotation crop effectively suppressed root infection by the fungal complex that causes replant disease.

To hear Mark Mazzola describe his latest discovery in the weird, wild world of microorganisms, you'd think the amoebae he's been studying—and the bacteria they stalk in the soil—were lion and wildebeest locked in an epic battle for survival on the plains of the Serengeti in East Africa.

Mazzola, a plant pathologist with the Agricultural Research Service in Wenatchee, Washington, is keen on understanding such microbial strife as part of a broader effort to devise new, integrated approaches to managing apple replant. It's an apple tree disease that can cost Pacific Northwest growers as much as $40,000 per acre in diminished returns over 10 years, an orchard's average productive life. Apple replant has been controlled with chemical fumigants, like methyl bromide, but using them is costly and environmentally worrisome.

Of particular interest to Mazzola is the role that resident populations of *Pseudomonas* bacteria could play in naturally protecting the trees' roots from infection by the pathogens that together cause apple replant disease. Among them are *Rhizoctonia* fungi, *Pythium* oomycetes, and the parasitic nematode *Pratylenchus penetrans*.

BRIAN PRECHTEL (K9031-12)

Mark Mazzola measures shoot length and trunk diameter as an indicator of growth rate in trees from wheat rotations.

Subterranean Slugfest

In studying how best to use *Pseudomonas* bacteria to control apple replant, Mazzola and colleagues made an interesting observation. When threatened by single-celled predators called "amoeba flagellates," the rod-shaped bacteria band together and secrete surfactant-like proteins called "cyclic lipopeptides" (CLPs), forming a kind of biochemical picket line. Mazzola, who's with ARS's Tree Fruit Research Laboratory, gives the play-by-play:

"The amoebae follow their prey and then ingest it by forming cytoplasmic extensions"—otherwise known as "false feet"—which engulf and funnel the hapless captives into food vacuoles for digestion. But the *Pseudomonas* bacteria can sense the predators' advance and respond by producing more CLPs as protectants.

The result for the amoebae is catastrophic. Upon contact with the CLPs, "the amoebae blow up, sometimes instantaneously," says Mazzola, who's captured the action on video. But without the CLPs to protect themselves, the bacteria become easy pickings for the amoebae.

The Haves and Have Nots

"We found that if you mutate the bacteria so that they can't produce CLPs, their ability to survive predation declines significantly," says Mazzola. He performed the research in collaboration with Jos M. Raaijmakers at Wageningen University, The Netherlands.

The team's observations are drawn from petri dish, soil tube, and plant-root experiments in which two CLP-producing *Pseudomonas fluorescens* strains—SBW25 and SS101—and two nonproducing mutant strains—17A8 and 10.24—were exposed to the predatory amoeba *Naegleria americana*.

In the petri dish experiments, *N. americana* avoided areas inhabited either by SBW25 or SS101, but overran—and feasted on—the mutant strains. A similar fate befell the mutant bacteria in soil tests, while the CLP-producing strains persisted.

In related work, the team found that the CLP-gene-expression levels in strains SBW25 or SS101 increased by fourfold when the amoebae approached to within 1 centimeter of the bacteria.

"Collectively, these results show, for the first time, that CLPs produced by *Pseudomonas* contribute to their survival in soil and are potent defenses against amoeba predation," Mazzola says.

The CLPs also serve other important functions, including enabling the *Pseudomonas* to move about and form protective biofilms—both of which may contribute to the bacteria's usefulness as biological control agents against pathogens that cause apple replant disease.

Ousting Apple Replant from Orchards

In studies at Wenatchee since 2000, Mazzola and colleagues have sought to either replace or diminish the use of synthetic pesticides with a combination of strategies. One approach calls for planting wheat cover crops around newly planted apple trees. Nutrients leaking from the wheat's roots can bolster populations of beneficial bacteria that help keep apple replant pathogens at bay.

BRIAN PRECHTEL (K9032-16)

A wheat cover crop (foreground) planted around young apple trees (background). Nutrients leaking from wheat roots can bolster populations of beneficial bacteria that help keep apple replant pathogens at bay.

Another strategy calls for treating the soils around trees with ground seed meal from canola and *Brassica* species, such as mustard. As they decompose, some seed meals increase bacteria that suppress *Rhizoctonia* fungi, while others release compounds called "isothiocyanates." In both instances, the soil environment is changed such that it becomes hostile territory for *Rhizoctonia* fungi, diminishing their contribution to apple replant disease. Though the approach showed promise in field trials, use of canola seed meal unexpectedly increased populations of *Pythium,* necessitating use of the fungicide mefenoxam.

While mefenoxam use could fit in with an integrated approach to managing *Pythium* in conventionally grown orchards, it would not be a viable alternative for organic growers. Instead, they may be able to call on the soil's contingent of CLP-producing *Pseudomonas* bacteria to dispatch *Pythium*.

Not all strains of *Pseudomonas* that suppress pathogens produce CLPs. But those that do, like SBW25 and SS101, stand a better chance of getting the job done in soils where predatory amoebae lurk.

Mazzola cautions against vilifying amoebae outright, though. Some species contribute to nitrogen recycling, which promotes soil health. Recognizing such nuances is at the heart of his team's approach, which is to make the best of what nature already has to offer in place of chemical solutions synthesized in the factory.—By **Jan Suszkiw,** ARS.

This research is part of Methyl Bromide Alternatives, an ARS national program (#308) described at www.nps.ars.usda.gov.

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Geraniums and Begonias

New Research on Old Garden Favorites

Some insect pests are very specialized—usually feasting on one crop. Many are named after that one particular crop that they ingest most—like pickleworms, melonworms, and sweetpotato weevils. Unfortunately for growers of ornamentals, soybean, maize, fruit, and vegetables, the Japanese beetle is not a picky eater. It feeds on nearly 300 plant species in almost 80 plant families.

The beetle, *Popillia japonica,* is by far the most destructive pest of ornamental and turf plants in the eastern United States, with more than $450 million spent each year to control it and replace damaged plants.

But there is hope, since there is one plant that the hungry little critter may want to avoid—the geranium, *Pelargonium zonale*. Though its lovely, colorful flowers are very attractive for all and profitable for growers, the flowers are deadly to the beetles. Within 30 minutes of consuming the petals, the beetle rolls over on its back, its legs and antennae slowly twitch, and it remains paralyzed for several hours. When paralyzed under laboratory conditions, the beetles typically recover within 24 hours, but they often die under field conditions because predators spot and devour them.

The poisoning effect of geranium flowers on beetles is not a new discovery; it has been reported in scientific papers dating back to the 1920s. But the phenomenon has not been studied in depth—how or why it happens—until recently, when Agricultural Research Service scientists in Ohio picked up where scientists left off more than half a century ago.

Currently, Chris Ranger, an entomologist in the ARS Application Technology Research Unit in Wooster, is working on a natural, botanical formulation for controlling the beetles based on paralytic compounds isolated from geraniums. Patent rights are being pursued. Ranger is collaborating with Ajay Singh, a natural products chemist from Rutgers, The State University of New Jersey.

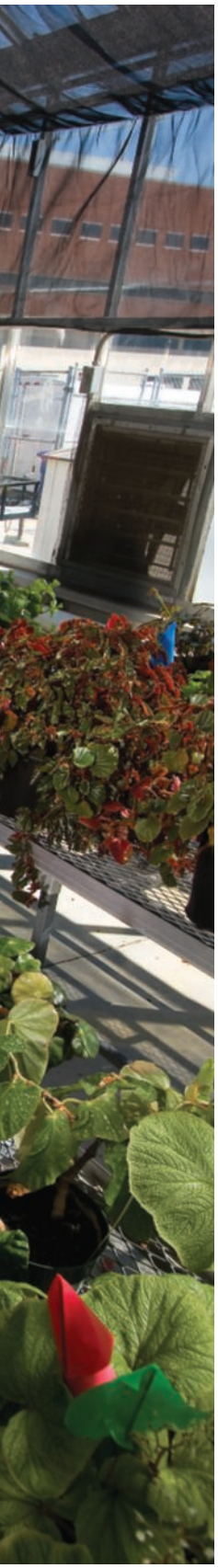
Also at Wooster, agricultural engineer Heping Zhu is working on pesticidal droplet reactions on hairy and glassy (waxy)

STEPHEN AUSMUS (D1585-4)

Technicians Gerald Hammel (left) and Alane Robinson prepare geranium leaves for grinding, extracting, and filtering, while entomologist Christopher Ranger (background) separates and purifies the active phytochemicals.

STEPHEN AUSMUS (D1681-3)

ARS horticulturist Jonathan Frantz (left) and Ohio State horticulturist Susan Stieve evaluate begonia plants for tolerance to cold and flowering characteristics in a greenhouse at the Ornamental Plant Germplasm Center at Ohio State University.



geranium species that could help leaves retain and hold on to the pesticides that are sprayed on them—which, in turn, could help reduce pesticide use.

Meanwhile, at ARS in Toledo, horticulturist Jonathan Frantz is collaborating with Susan Stieve, curator of Ohio State University's Ornamental Plant Germplasm Center in Columbus, in studies of begonias.

Begonias are considered to be sensitive to high light and perform best under low-light conditions found in shade gardens or along the north side of houses. If varieties are found that grow equally well in high light, they could be used in breeding programs or grown commercially. This fits commercial growers' systems well because they have gone to great effort to maximize the light inside greenhouses.

The team found that two varieties—*Begonia cubensis* and *B. echinosepala* var. *elongatifolia*—performed well in either light environment.

"Their leaf area, plant weight, and flower development did not appear to be negatively affected by the higher light levels," says Frantz. "Lower light environments still result in less bleaching in other begonia species, but all species we tested had similar sizes and developmental rates in either light level."

Frantz and Stieve are also studying whether a specialized breed of begonia can tolerate colder temperatures.

Ohio and neighboring Michigan are some of the largest producers of horticultural plants, most of them grown in greenhouses. The scientists are screening the begonias at two production temperatures—5°F colder than normal and 10°F colder than normal. Begonias are found naturally in a wide variety of climates and altitudes—ecological clues that can be used to identify promising germplasm.

"For every one degree cooler, growers can reduce heating bills by 3 percent in northern climates," said Frantz. "And with the way energy costs are rising, that can make a huge difference in operating expenses. But the tradeoff is that cooler temperatures can greatly delay flower development." The trick is to find varieties or species with acceptable growth and with flowers that are not delayed significantly by cooler temperatures.—By **Alfredo Flores,** ARS.

This research is part of Crop Protection and Quarantine, an ARS national program (#304) described at www.nps.ars.usda.gov.

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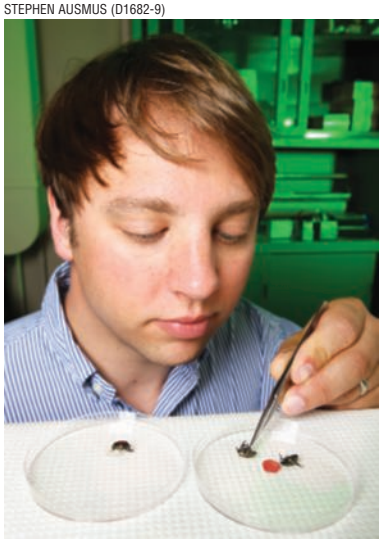
STEPHEN AUSMUS (D1586-5)

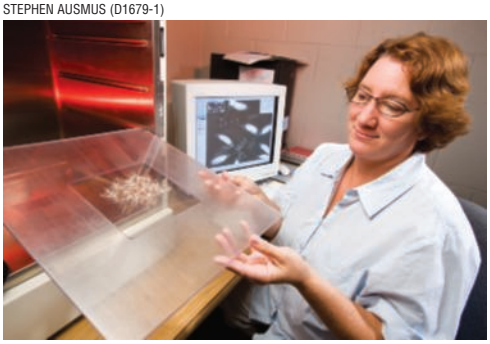
Using high-performance liquid chromatography, entomologists Michael Reding (left) and Christopher Ranger analyze geranium extracts with paralytic activity against Japanese beetles to identify the active phytochemicals.

STEPHEN AUSMUS (D1682-9)



Christopher Ranger observes healthy (left petri dish) and paralyzed (right petri dish) Japanese beetles after the beetles on the right consumed extracts isolated from geranium flowers.

STEPHEN AUSMUS (D1679-1)



Susan Stieve uses X-ray technology to assess seed quality of geranium (*Pelargonium* sp.).

Helping Cattle Keep Their Cool

Cattle may not worry about job security or credit history, but that doesn't mean their lives are stress free. For some cattle, rising stress levels correspond with rising temperatures. This can be a problem for the many cattle raised in the Central Plains, a region subject to long periods of extreme heat in the summer.

Heat stress can have serious consequences. While some cattle exhibit little or no response to it, others may experience diminished appetite and feed intake, reduced growth rate, compromised disease resistance, and—in extreme cases—death.

What causes heat stress? The simplest answer is that extremely high temperatures overwhelm an animal's natural ability to regulate its body temperature. But other factors are involved, and understanding them is essential for predicting, preventing, and responding to potential heat-stress scenarios.

Agricultural Research Service scientists at the Roman L. Hruska U.S. Meat Animal Research Center (USMARC) in Clay Center, Nebraska, are working together with scientists at several universities around the world to identify causes of and responses to heat stress in cattle. They are also developing risk-assessment tools and management strategies for producers. This work has three main components: analyzing animal susceptibility, identifying contributing environmental factors, and evaluating management techniques.

Hot or Not? Predicting Animal Susceptibility

Every animal responds to heat stress differently, so USMARC agricultural engineer Tami Brown-Brandl and her colleagues conducted several studies to identify factors that contribute to animal susceptibility. They identified 11 influential factors, including coat color, health history, and temperament.

One study analyzed several factors that influence sweating rate in different breeds of cattle. This is significant because cattle, like humans, sweat to stay cool. Results showed that coat color, wind speed, access to shade, and breed could influence an animal's physical response to heat. For example, scientists observed that Angus cattle adapted to conditions in Kansas had higher body temperatures than those adapted to conditions in Florida. Though genetically similar, the Kansas cattle also had a more erratic sweating rate, suggesting that the Florida cattle are better suited to warmer climates.

Understanding differences like this can help producers anticipate the reaction of individual animals within their herds and respond accordingly. But individual assessments can be complicated and time-consuming. To help, Brown-Brandl worked with University of Nebraska-Lincoln engineer David Jones to develop a model that evaluates the characteristics of individual animals and produces an index value that reflects the susceptibility of each one.

"This value could then be used by producers to sort cattle into different groups so that management schemes could be developed to fit the risk category of each group," Brown-Brandl says.

Such a system would enable more targeted management. And enabling producers to isolate the most susceptible animals for special treatments could reduce casualties.

Hot Models: Mapping Environmental Influences

Identifying other sources of environmental stress is also

JOHN GAUGHAN, QUEENSLAND, AUSTRALIA (D1597-1)

ARS scientists at the Roman L. Hruska U.S. Meat Animal Research Center in Clay Center, Nebraska, are comparing several types of shading material and structures that help alleviate heat stress in cattle raised in outdoor pens. One such method, shown here in Queensland, Australia, uses large openings to help reduce snow and wind loads.

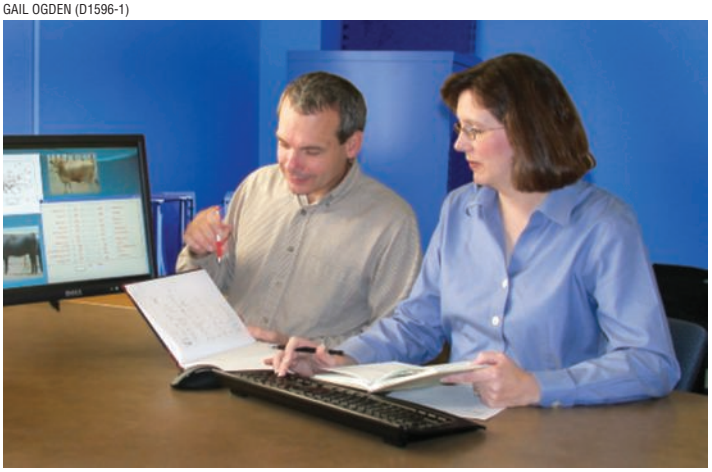
essential for anticipating heat stress and taking action to reduce the consequences. For years, cattle producers turned to the National Weather Service and university websites for livestock weather warnings based on temperature and humidity predictions.

"Temperature and humidity are two key factors contributing to heat stress, but there are factors not reflected in those models that are significant in the stress relationship," says USMARC engineer Roger Eigenberg. "A model that takes those other factors into account could provide more accurate predictions."

To create a more accurate model, Eigenberg and Brown-Brandl worked with USMARC engineer John Nienaber to analyze weather data from significant heat waves and identify environmental factors that contributed to higher incidences of cattle stress.

The result was a heat stress model that incorporates predictions of temperature, humidity, sun intensity, and wind speed. The model predicts when environmental conditions are particularly suited for heat stress, and presents the information in an easy-to-read, color-coded map that includes South Dakota, Nebraska, Iowa, western Colorado, Kansas, Missouri, Oklahoma, and northern Texas. It can be viewed online at www.tinyurl.com/HeatStressModel.

GAIL OGDEN (D1596-1)



University of Nebraska-Lincoln engineer David Jones (left) and ARS agricultural engineer Tami Brown-Brandl developed a model that evaluates the characteristics of individual animals and produces an index value that reflects each one's susceptibility to heat stress.

Action Figures: Assessing Management Decisions

Models can help producers identify potentially troublesome cattle and conditions, but the information models provide can only reduce heat stress if managers respond to it.

When weather conditions threaten the health of their herds, producers have several options for fighting back. To allay heat stress, they may erect shades, alter the animals' diets, change feeding times, remove wind breaks, or use sprinklers to cool the animals or the ground.

"The problem is that there are costs and drawbacks associated with each of the methods," Brown-Brandl says. "For example, a producer considering sprinkler cooling needs to assess the cost of the equipment, maintenance, and water—as well as the potential for wet soil to generate odors."

Having more information about the potential benefits and disadvantages of stress-alleviation methods can help managers decide how to respond to dangerous heat situations, so the USMARC scientists have evaluated one of the more common management options.

Eigenberg, Nienaber, and Brown-Brandl compared the effects of four commercially available shade materials on cattle raised in outdoor pens. Three of the shades were constructed of solar radiation-blocking polyethylene cloth. The fourth used a porous snow fence that provided some shade, but allowed sunlight to filter through.

The scientists found that all the materials reduced cattle stress. The higher the percentage of solar radiation blocked by the shades, the more effective they were at reducing stress. But all the shades offered some protection that could result in slower respiration rates and lower body temperatures—even the snow fence, which is less expensive than the other shades and offers comparatively less protection.

"Based on these results, we can conclude that erecting shades is indeed an effective method to reduce stress-related losses," Brown-Brandl says.

Research efforts like these have been essential for developing tools and management practices to help cattle producers beat the heat. And that's a relief not just for the cattle, but for the people who work with them as well.—By **Laura McGinnis,** formerly with ARS.

This research is part of Food Animal Production, an ARS national program (#101) described at www.nps.ars.usda.gov.

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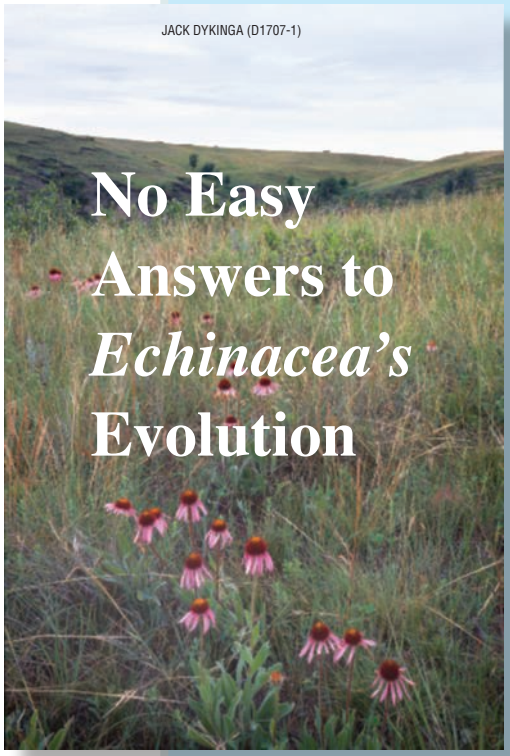
No Easy Answers to *Echinacea's* Evolution



Purple coneflower *(Echinacea).*

Every summer, gardens across the United States are visited by goldfinches feasting on seeds produced by the popular perennial *Echinacea*. But birds aren't the only ones that profit from these pretty coneflowers. According to estimates by Nutrition Business Journal, U.S. consumers looking for botanical remedies spent $126 million on *Echinacea* products in 2007. These products may modulate the human immune system, but they are also being studied for related effects on infections, inflammation, and pain receptors.

Only a few *Echinacea* species—*E. purpurea, E. angustifolia,* and *E. pallida*—are currently cultivated as remedies, and plant breeders would like to know whether other types also possess commercially useful traits. But first they need to know how many distinct *Echinacea* species there are. Previous studies have put the number between four and nine species, depending on classification criteria.

Mark Widrlechner, a horticulturist at the ARS North Central Regional Plant Introduction Station (NCRPIS) in Ames, Iowa, has joined an effort to solve this puzzle. Working with a team in Jonathan Wendel's lab at Iowa State University, Widrlechner selected 40 diverse *Echinacea* populations for DNA analysis from the many populations conserved at the NCRPIS.

Most of these *Echinacea* populations were found to have a remarkable range of genetic diversity. This complicated efforts to explain how so much diversity among different species could have evolved from a common ancestor.

"What we had was really, really hard to sort out," Widrlechner admits.

But the team has been able to make some sense out of the genetic jumble. For instance, DNA analysis suggested that when much of North America was covered with glaciers, *Echinacea* found southern refuges on both sides of the Mississippi River. But when the glaciers receded after thousands of years, the groups came together as they moved northward and began to hybridize, which might have blurred previous genetic distinctions.

Since DNA analysis did not provide conclusive results, Lankun Wu, from Eve Syrkin Wurtele's lab at Iowa State, focused on analyzing the same populations for chemical differences in root metabolites. These metabolites, which are often essential for survival and propagation, can vary widely among species and may play roles in human-health effects.

Using this approach, researchers were able to identify clear distinctions among all 40 populations. These distinctions were organized into three composite profiles that accounted for almost 95 percent of the metabolite variation among the populations.

Additional analysis indicated that the populations grouped together in ways that aligned well with earlier *Echinacea* species assignments that were based on plant morphology, supporting nine rather than only four distinct species. But Widrlechner says the research isn't close to a payoff for commercial producers—yet.

"Even though the metabolite study has given us some good species definitions, we still need to follow up with more genetic studies," Widrlechner says. "It's important to find the traits that may be medicinally beneficial."—By **Ann Perry,** ARS.

This research is part of Plant Genetic Resources, Genomics, and Genetic Improvement, an ARS national program (#301) described at www.nps.ars.usda.gov.

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Science Update

Reaping More Rewards from Crop Residues

A 2-year study indicates that wheat and barley producers in Washington State's Palouse region have another potential tool to refine crop residue management to build soil organic matter, curb soil erosion, retain soil moisture, and maximize crop yields. Researchers tracked postharvest crop residues from 17 cultivars of winter wheat, 16 cultivars of spring wheat, and 9 cultivars of spring barley grown in 4 different locations in southeastern Washington to identify links between decomposition processes and fiber and nutrient characteristics of the straw.

The straw from the different cultivars had notable differences in fiber composition and carbon/nitrogen ratios. These characteristics also varied significantly by location. Fourteen percent of the cultivars had characteristics for slow residue decomposition and 14 percent had characteristics indicating a potential for rapid decomposition.

Crop residues decompose into soil organic matter, which provides nutrients to crops, limits erosion, and helps retain soil moisture. Rapidly decomposing cultivars are less likely to impede no-till seeding in higher rainfall areas where more straw is produced. *Ann Kennedy, USDA-ARS Land Management and Water Conservation Research Unit, Pullman, WA 99164-6421; (509) 335-1554, ann.kennedy@ars.usda.gov.*

Experimental Chickpeas Fend Off Caterpillar Pest

Chickpeas are high in protein, fiber, and other nutrients and are important legume crops the world over. Now new lines of pest-resistant chickpeas could put a halt to the damage from beet armyworm moth larvae, which like to eat the crop's leaves. The new chickpeas were conventionally bred from a cross between wild types with a broad range of insect resistance and cultivated types that have other good agronomic traits. In greenhouse trials conducted in 2006 and 2007, 28 to 62 percent of beet armyworms that fed on the leaves of the new chickpea cultivars died within a few days of hatching from eggs.

The worms that did survive were smaller and shorter than usual. The new chickpea lines were also more resistant to pests than the commercial cultivars currently grown by producers. Further testing is needed to assess how well the experimental chickpeas will fare in field production. *Stephen L. Clement, USDA-ARS Plant Germplasm Introduction and Testing Research Unit, Pullman, WA 99164; (509) 335-3572, stephen.clement@ars.usda.gov.*

ARS Scientists Help Sequence Genome of Potato Late Blight Pathogen

Researchers have sequenced the complete genome of *Phytophthora infestans*, the pathogen that caused the infamous Irish potato famine and the recent loss of potato and tomato crops in the eastern United States. A scientific team examined and annotated the genes in the pathogen that produce enzymes to degrade a plant's cell wall and found several groups of enzymes located in close proximity to each other.

When these enzymes attack the surface of a plant, they create an entry point where the pathogen can gain access to the plant's nutrients. Some evidence suggests that two enzyme groups may be active at the initial stage of the infection. The research team also provided the first report on a unique pattern of gene segments in the pathogen's genome that are called "introns." These genetic segments prompt production of different proteins from the same gene that attack different compounds within the plant cell wall. *Richard W. Jones, USDA-ARS Genetic Improvement of Fruits and Vegetables Research Unit, Beltsville, MD 20705; (301) 504-8395, richard.jones@ars.usda.gov.*

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Potato infected with late blight.

Reflective Particle Films Improve Apple Quality

Spraying apple trees with films that contain microscopic mineral particles may improve the color of the fruit and increase its weight. Researchers conducted a multi-year study in which sprayable particle films were applied strategically in an orchard of Empire apple trees.

The particle film's microscopic layer of mineral particles allows water and carbon dioxide to pass through the film. With some trees, an aluminized plastic film (ALF) was applied to the grass strip between the apple rows. With other trees, a sprayable particle-based reflective film (PF) was applied to the trees as well as the grass between the tree rows.

A third group of trees received no treatment. The ALF consistently improved apple color, while the PF increased red color in apples in 2 of the 3 years of the study. When PF was applied to the grass between tree rows, the average fruit weight was increased in all years of the study, compared to the untreated trees and those that received the ALF treatment.

The mechanism responsible for the increased fruit weight with the PF may be the altered light quality. This reflected light has enhanced far-red radiation that may have beneficial effects on both fruit color and fruit weight. *Michael Glenn, USDA-ARS Appalachian Fruit Research Station, Kearneysville, WV 25430; phone (304) 725-3451 ext. 321, e-mail michael.glenn@ars.usda.gov.*

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