JANUARY–MARCH 2013 • VOLUME 67 NUMBER 1

California Agriculture

Hands-on learning: *Healthier choices, better lives*

Special issue:
Healthy Families and Communities

E-Edition: Nitrogen use

University of California | Peer-reviewed Research and News in Agricultural, Natural and Human Resources

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COVER: Garden-enhanced nutrition education increases children's fruit and vegetable intakes, helping to address high childhood obesity rates (see page 30). Research indicates that long-lasting improvements are achieved through multiple efforts — offering healthy foods on school campuses; teaching nutritional and environmental science in the context of gardening; and involving communities and regional agriculture (see pages 13, 21). Shown are students tending their vertical garden at Downtown Value School in Los Angeles. The school also has a flower and produce garden that goes around the school grounds, a small greenhouse and a worm compost bin. *Photo by Peter Bennett*

Special issue:
Healthy Families and Communities
Current UC research fosters healthier choices, better lives

Research and review articles

E-Edition

Supplementary material (online only)

News departments

Editor's note: *California Agriculture* gratefully acknowledges the faculty chairs for this special issue, David Campbell and Sheri Zidenberg-Cherr, from the UC Davis Departments of Human Ecology, and Nutrition, respectively.

UC addresses needs of California youth

Karin Higgins

Delaine Eastin

California Superintendent of Public Instruction
1995 to 2003

California is home to a $37 billion agricultural industry, and some of the best public and private universities in the world — yet we are facing a crisis in the health and education of our young people. The challenges include high childhood obesity, rising school dropout rates, and low student achievement, especially in the sciences.

These challenges are persistent, costing the golden state billions of dollars annually, putting future generations at risk and threatening our long-term viability in the global economy. For example, California's economic costs of overweight, obesity and physical inactivity are the highest in the nation at more than $41 billion per year, according to a 2009 study by the nonprofit California Center for Public Health Advocacy.

More than one-third of California school children are overweight or obese, increasing their risk of serious chronic conditions, such as type-2 diabetes and heart disease (according to the Centers for Disease Control). This problem is even more pronounced among the poorest children and ethnic minorities.

We also are grappling with a severe deficit in science literacy, with our students routinely scoring below their peers internationally. Nationwide, our state ranked 47th in science on the 2011 National Assessment of Educational Progress. This bodes ill, not just for those aspiring to science careers, but for all students in today's knowledge-centered society.

The crisis is compounded as we see that youngsters from high-income families outperform those from low-income, even as poverty in California is rising at one of the fastest rates in our nation. Recent U.S. Census Bureau figures indicate nearly one in four California children now live in poverty. And we see white children outperforming African American and Latino children, as well as boys outperforming girls.

Yet as the most populous and diverse state in the union, with bountiful agriculture and a first-rank higher education system, California can bring unique resources to bear upon these problems. UC Agriculture and Natural Resources (ANR) has embarked upon a 5-year program to promote healthy lifestyles, science literacy and positive youth development in an intertwined effort. The Healthy Families and Communities Strategic Initiative addresses all three goals, through projects that integrate research within communities and schools, with the goal of obtaining science-based information about what works best for children.

For instance, research tells us that hunger is related to both low academic achievement and obesity. We also know that given better food choices such as fresh fruit, children will dramatically increase healthy choices (see page 21). By helping schools to offer more nutritious meals — with more fresh fruits and vegetables — while addressing other dietary changes and increasing physical activity, research under this initiative seeks to improve children's health status (see page 13). In the Shaping Healthy Choices Program (see page 30), researchers launch a comprehensive, controlled community study that includes instructional gardens linked with science and nutrition education, improved diet and exercise. As part of their effort, they will help develop school infrastructure to sustain the program beyond the 5-year funding period.

ANR's strategic effort could not come at a more critical time. The questions before us are:

- Can a multifaceted, integrated school and community program, which targets culturally diverse children, promote healthy diets and physical activity?
- Can it promote science literacy, including nutrition understanding, in formal and informal settings?
- Can we use such programs to promote regional, sustainable agriculture?

Peter Bennett

Students water plants in the vertical garden at the Downtown Value School, a charter school in downtown Los Angeles. These pockets are produced by Woolly Pocket Corporation in Los Angeles, and are one part of their school garden program.

- Can we strategically deploy researchers, extension advisors and teachers to carry out these programs?

To improve science performance, ANR proposes we build the capacity of formal educators and 4-H volunteers to engage students with inquiry-based discovery and hands-on learning (see page 47 and page 54). Toward this end the UC 4-H Youth Development Program leaders are already recognized for innovative out-of-school models, curricula and professional development. They will analyze the impacts of youth participation in community-based, out-of-classroom programs that build science knowledge and skill; at the same time, they will measure the impact of professional development on educators.

Grounded in positive youth development rather than deficit-based models (see page 38), UCCE 4-H Youth Development is among the high-quality youth programs that are strongly associated with improved school achievement and graduation rates. The extraordinarily high rate of dropouts in California is of grave concern to all who know that education is becoming more, not less, important. Although the official high school dropout rate in California has been between 12% and 24% for several years (based on school reports), we know in fact that 32% of entering high school freshmen fail to graduate in 4 years. Each year, about 100,000 California youth reach graduation age but do not graduate.

At the end of the day, the Healthy Families and Communities Strategic Initiative is about change, scientifically measurable change, yielding concrete evidence of youth improvement due to these efforts. The initiative will draw on existing data and new findings generated by their interventions, on a wide range of indicators, including science test scores for academic improvement, rates of high school graduation, college enrollment and youth employment. This effort will provide a yardstick to measure healthful school and community environments even as we examine equity in outcomes for different racial, ethnic and gender groups.

Once we have this data, we can make the case for public support, and channel resources in the right direction. Educators will evaluate data and identify effective programs, observing impacts on public funding support. We need to make citizens aware of the research that supports efforts to advance health and education among children in their communities.

Healthy families and children are vital to our nation and its prosperous future. It is time that key players in higher education join in a project to promote the general welfare by focusing on measurable, scientific initiatives we can pursue to ensure the blessings of liberty to our posterity. I salute UC ANR for this Healthy Families and Communities Strategic Initiative. I thank you on behalf of our future generations.

Peter Bennett

At the Wonderland Elementary School in Laurel Canyon, Los Angeles, vegetables grow in boxed raised beds. As California Superintendent, Eastin initiated a statewide program to establish a garden in every school.

Peter Bennett

Children tend the planted pockets at the Downtown Value School. Such vertical gardens offer schools, which may have limited space or resources, a cost-effective, easily sustainable option for an instructional garden.

In 1995, California Superintendent of Public Instruction Delaine Eastin launched an initiative to establish school gardens in every school, the first of its kind in the United States. The California Department of Education (CDE) provided curriculum guides on how to teach standards in the garden program. She oversaw the establishment of gardens in more than 3,000 schools, funded by local districts, parents and private gifts. Eastin also enrolled California as the first state to join the USDA's Team Nutrition program to promote healthier lunches under President Clinton. She advocated education about healthy cooking, seed saving and sowing, family farming and sustainable agricultural practices.

Eastin oversaw the creation of teacher guides to demonstrate how "hands-on" learning about the standards could be achieved in gardens and in cooking classes, which she dubbed "living laboratories."

2013 Statewide Conference
UC ANR: California Roots, Global Reach

In 2025, the population of the Earth is projected to be over 8 billion. How can we sustainably feed a population of that size? On April 9, 2013, the University of California, Division of Agriculture and Natural Resources (ANR), will host a Global Food Systems Forum on the challenges faced by food producers and suppliers in a world of growing population, strains on natural ecosystems, shifting geopolitics and other converging forces. The conversation will take place in Ontario, California, as part of a 3-day ANR statewide conference with the theme "California Roots, Global Reach."

"We need a new sustainable paradigm for development based on rights and equity — the one we have has proven itself unsustainable."

Mary Robinson, former president of Ireland
keynote speaker, UC ANR Statewide Conference 2013

The forum will include a keynote address by Mary Robinson, former President of Ireland and founder of the Mary Robinson Foundation — Climate Justice, an organization dedicated to a human-centered approach to development and equitable stewardship of the Earth's resources.

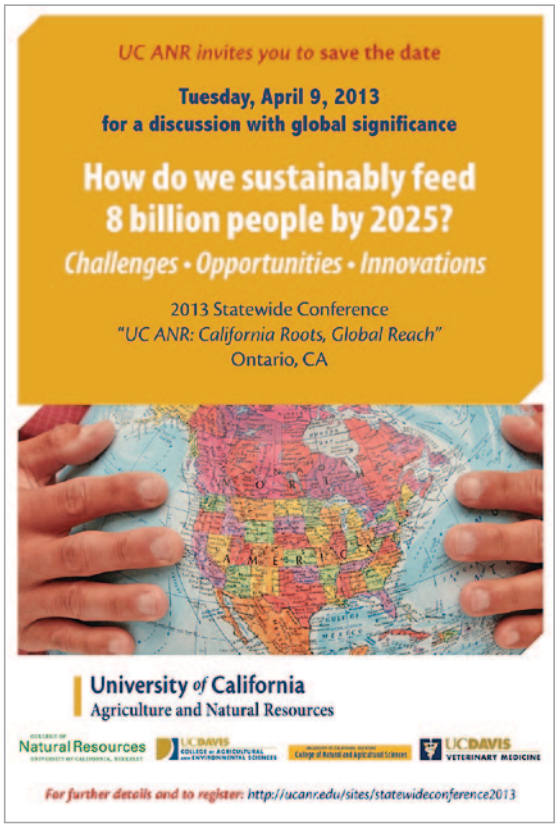
The program will consist of three panels, two with a global focus and the third with a California emphasis. The first panel will address the geopolitical, ethical, economic and technical challenges facing food systems worldwide. Panel two will discuss whether we can meet these challenges without depleting natural resources, and the third panel will question the implications, responsibilities and opportunities from a California perspective. The panels will offer a lively interchange of ideas moderated by two award-wining authors and journalists, Michael Specter and Mark Arax.

As William Lesher, former chief economist for the USDA, recently stated: "We're going to have to produce more food in the next 40 years than we have in the last 10,000. Some people say we'll just add more land or more water. But we're not going to do much of either."

UC will continue to play a leadership role in convening these kinds of dialogues, which will help guide the preparation of the next generation of students for careers in sustainable food production, as well as focus innovative research on finding solutions to these worldwide challenges.

As someone interested in California and global agriculture, please join us in this important discussion. You can follow us on twitter @ucanr #Food2025 for updates, and more information on the forum will be available on our website at http://ucanr.edu.

Barbara Allen-Diaz
Vice President
UC Division of Agriculture and Natural Resources



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University of California
Agriculture and Natural Resources

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Mission and audience. *California Agriculture* publishes refereed original research in a form accessible to a well-educated audience. In the last readership survey, 33% worked in agriculture, 31% were university faculty or research scientists, and 19% worked in government agencies or were elected office holders.

Electronic version of record. In July 2011, the electronic journal became the version of record; it includes printed and electronic-only articles. When citing or indexing articles, use the electronic publication date.

Indexing. The journal is indexed by AGRICOLA, Current Contents (Thomson ISI's Agriculture, Biology and Environmental Sciences and the SCIE databases), Commonwealth Agricultural Bureau (CAB), EBSCO (Academic Search Complete), Gale (Academic OneFile), Proquest and others, including open-access databases. It has high visibility on Google and Google Scholar searches. All peer-reviewed articles are posted to the ANR and California Digital Library eScholarship repositories.

Authors and reviewers. Authors are primarily but not exclusively from ANR; in 2010 and 2011, 23% were based at other UC campuses, or other universities and research institutions. In 2010 and 2011, 33% and 40% (respectively) of reviewers came from universities, research institutions or agencies outside ANR.

Rejection rate. The rejection rate has averaged 34% in the last 3 years. In addition, associate editors and staff may send back manuscripts for revision prior to peer review.

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California Agriculture

Peer-reviewed research and news published by
University of California Agriculture and Natural Resources

VOLUME 67, NUMBER 1

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California Agriculture (ISSN 0008-0845, print, linking; ISSN 2160-8091, online) is published quarterly and mailed at periodicals postage paid at Richmond, CA, and additional mailing offices. Postmaster: Send change of address "Form 3579" to *California Agriculture* at the address above.

Early findings: Food insecurity, obesity high in low-income Latino families

New findings indicate the prevalence of food insecurity may be as high as 37% among low-income, Mexican-origin farmworker families in California, say researchers analyzing early data in a 5-year UC study in Fresno County.

Data gathered in the first year of Niños Sanos, Familia Sana (Healthy Children, Healthy Family) form the baseline for a project under way in the Central Valley towns of Firebaugh and San Joaquin. The study is designed to reveal how best to prevent overweight and obesity in Mexican-origin children aged 3 to 7 years.

"Our data also show that 49% of the 3- to 7-year-olds in this group are overweight or obese," says Lucia Kaiser, UC Cooperative Extension specialist in the UC Davis Nutrition Department and a co-investigator. "Several studies have reported a positive correlation between obesity and food insecurity in adults. These new findings underscore the urgency of addressing socioeconomic determinants in designing obesity prevention interventions for this population."

Funded by a $4.8 million grant from USDA National Institute of Food and Agriculture, the project involves a multidisciplinary team of UC Davis and Cooperative Extension (UCCE) investigators.

Previous economic research has shown that hunger rose sharply during the 2007-2008 recession. Although the recession officially ended in summer 2009, the number of households reporting food insecurity, both state- and nationwide, has changed little since then.

Albert Aguilera

UC Davis student Ezequiel Valenga measures the height of a child during one of the data collection events in Firebaugh.

In September 2012, the U.S. Department of Agriculture's Economic Research Service (ERS) reported that California's overall rate of food insecurity is 16.2%, significantly higher than the national average of 14.9%. (ERS figures are based on 2011 data from a nationally representative sample.)

Households with very low food security constitute about 6% of the total, both state- and nationwide. That rate more than doubles among participants in the Niños Sanos, Familia Sana study. In the latter sample of 258 households, 13% reported very low levels of food security. (Very low food security refers to households reporting severe or child hunger; low food security refers to households reporting moderate or adult hunger.)

The UC Davis project is headed by Adela de la Torre, interim vice chancellor for student affairs. She is also an agricultural economist and faculty member of the UC Davis Department of Chicana/o Studies.

"More than four in every 10 children born to parents of Mexican heritage are overweight or obese and therefore at greater risk of early diabetes, high blood pressure and heart disease," said de la Torre. "We are fortunate that we have received unprecedented support to tackle this issue from community members, so that we can build a healthier environment in Firebaugh and San Joaquin."

Courtesy of UC Davis

Kids and parents enjoy watermelon during a health fair in San Joaquin last summer. Researchers explained the project to members of the community and took measurements of children's height and weight.

For coverage of Niños Sanos, Familia Sana
and related stories in Spanish, go to
La inseguridad alimentaria y sus consecuencias para la salud
http://ucanr.edu/u.cfm?id=60

Niños Sanos, Familia Sana has a quasi-experimental design, Kaiser explained: one community, Firebaugh, was randomly assigned to receive the nutrition and economic incentive intervention and a comparison community, San Joaquin, to receive an educational program geared toward promoting academic success of Latino children.

The multidisciplinary UC team guiding this project includes 20 social scientists and other professionals, all working in partnership with parents and community members of Firebaugh and San Joaquin.

The Firebaugh program activities include:

- $25 monthly in vouchers that can be used to buy fruits and vegetables at participating markets.
- Family nights that include parent education about children's nutrition needs and physical activity.
- Classroom instruction for children on nutrition and physical activity.
- Two health screenings yearly to monitor body mass index, skinfold thickness and waist circumference.
- A community art project with murals and posters promoting healthy eating and active living.

Concurrently, in San Joaquin, a similar number of children will receive the health screenings. In addition, their parents will be provided workshops on topics such as "How to support your children in school" and "Strategies to help your child prepare for college."


Gilda Posada

The Niños Sanos, Familia Sana mural in San Joaquin was painted by community members, and UC Davis faculty and students.


Banafsheh Sadeghi

Graduate student Albert Aguilera and undergraduate Anahi Nunez complete measurements during data collection at Bailey Elementary in Firebaugh.

However, the San Joaquin group will not receive the more-intensive nutrition intervention. (After both towns had agreed to take part in the study, a random card draw determined that Firebaugh would be the intervention group and San Joaquin would be the control group.) At the study's end, UC Davis researchers will analyze the results to see which strategies worked best.

"This intervention study will be one of the first of its kind in the nation for Latino children between the ages of 3 and 8 and, hopefully, will help us target what really works in sustaining healthy eating and exercise for Latino families with young children," said de la Torre.

The programs will run for 3 years in these two Fresno County communities (with 2 additional years for baseline and followup data collection). UC nutrition specialist Kaiser noted that other goals of the project include 1) cultural adaptation of UCCE materials to prevent childhood obesity in Mexican-origin populations and 2) training of graduate and undergraduate students to increase cultural competency and ability to conduct community-based participatory research.

The Niños Sanos, Familia Sana team includes UC scientists, UC Cooperative Extension specialists and advisors, UC CalFresh in Fresno County, as well as other faculty and staff from the UC Davis Chicana/o Studies, Nutrition, and Agricultural and Resource Economics departments, the School of Education, and the Medical and Nursing schools in Sacramento.

Throughout the study, a community advisory committee consisting of school, community and parent representatives will meet regularly to provide feedback on program strategies, approaches, concerns and solutions to barriers. — *Janet White*

Initiative promotes youth development, healthy living, science literacy

California's youth are in trouble, facing challenges from alarmingly high obesity and school dropout rates to alarmingly low science literacy rankings. While these trends have been easy to spot, reversing them has been difficult. To help identify — and implement — effective solutions to these urgent problems, UC Cooperative Extension (UCCE) is partnering with communities statewide via a new UC ANR strategic initiative aimed at helping youth in California.

One in six youths aged 16 to 24 years is out of school and out of work.

"We're bringing a lot of people together across many disciplines," says UCCE Community Development Specialist Dave Campbell, who leads the new youth-focused initiative. "If our work is going to be relevant to the real world, we need to reflect its complexity."

Healthy Families and Communities

Called Healthy Families and Communities, the initiative includes three interwoven strands: encouraging healthy lifestyles, boosting science literacy, and fostering positive youth development. The need is great. A third of school-aged children in California are overweight or obese, and at current rates nearly half of the state's adults could be obese by 2030, according to a 2012 report called *F as in Fat: How Obesity Threatens America's Future* by the nonprofit Trust for America's Health. Obesity is linked to chronic illnesses, including type 2 diabetes, heart disease and high blood pressure. In 2009, the California Center for Public Health Advocacy estimated the cost to the state of overweight, obesity and physical inactivity was more than $41 billion per year, the highest nationwide.

Peter Bennett

Students, parents and teachers work on the garden at the 24th Street School garden in Los Angeles on Big Sunday, the nation's largest annual citywide community service event. This prototype garden classroom spans more than one acre and includes an orchard with 55 fruit trees.

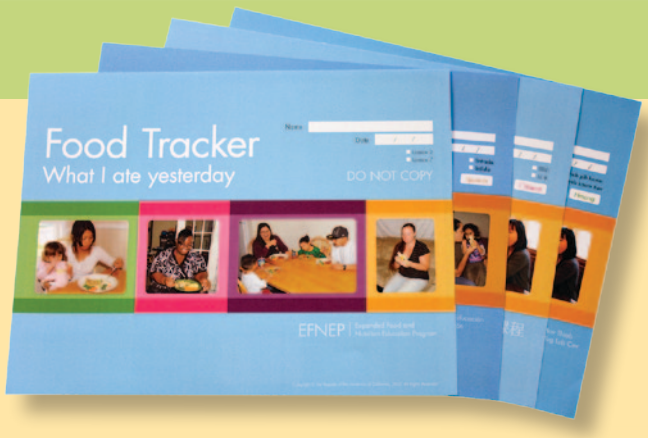
California's science literacy is also abysmal, with only the District of Columbia scoring worse in eighth-grade science in the National Assessment of Educational Progress's 2011 State Snapshot Report. A workforce with the knowledge and skills for scientific careers is critical to the state's economy, and understanding science is key to participating fully in today's technological society. "It's very important to be able to reason and think critically," Campbell says. "We need an informed citizenry." Equally dismal are the state's high youth dropout rates. One in six youths aged 16 to 24 years is out of school and out of work. Besides having high social costs, this is a missed opportunity for training skilled workers to replace those close to retirement.

Because the challenges facing California's youth are multifaceted, solving them will require a multipronged approach. "We shouldn't think of these issues as discrete — they're interconnected," Campbell says. He cites the school gardening movement as an example of effectively integrating nutrition, science education and youth development. UCCE teaching and extension programs across California communities are informed by UC ANR's active research efforts. Since 2009, UC ANR academics have published more than 100 peer-reviewed research articles addressing one or more of the Healthy Families and Communities strategic initiative's priorities of healthy living for obesity prevention, youth science literacy and positive youth development (http://ucanr.edu/sites/HFC/).

Shaping Healthy Choices

"You need to address several components at once to make a change," agrees UCCE Nutrition Science Specialist Sheri Zidenberg-Cherr, who codirects the UC Davis Center for Nutrition in Schools. She leads a multidisciplinary team that, with funding from an ANR competitive grant of $600,000 over 4 years, is evaluating a multicomponent K-6 nutrition education effort called the Shaping Healthy Choices Program.

Designed to both improve child health and support local agriculture, the program incorporates serving regional fruits and vegetables, a salad bar, a hands-on garden, and classroom nutrition and physical fitness lessons. Just as importantly, the program is aligned



ANR nutrition education targets diverse, low-literacy communities

ANR has developed new nutrition education materials tailored to California's low-literacy and culturally diverse communities. These materials are part of the Expanded Food and Nutrition Education Program (EFNEP), a federally funded program that offers nutrition education to limited-resource families and children.

The new materials include pictures and are easy to read. "We reduced the literacy level from the eighth-grade level to the third-grade level," says Connie Schneider, who directs ANR's Youth, Families and Communities program, which administers EFNEP in California. The materials have also been translated into several languages and are tailored to the individual cultures. "Before, we just had English and Spanish — now we also have Chinese, Hmong and Vietnamese," she adds. "We're giving people the information they need to make good choices."

In 2012, the University of California's EFNEP Checklist and Instruction Guide won a merit award from the Health Information Resource Center (HIRC), a national clearinghouse for consumer health information programs and materials. The guide, which includes a food behavior checklist, is multilingual and culturally customized; it is called the *Food Behavior Checklist for Low-literate Audiences in English, Spanish, Chinese, Vietnamese and Hmong with Instruction Guide*. The HIRC National Health Information Awards program honors the best U.S. consumer health programs and materials.

Above and left: K. Sylva, J. Shijo, M. Reed

Evaluation tools that are appropriate to a target audience's language, culture and literacy level will increase accuracy of participant data, enabling UC Cooperative Extension educators to better address participants' needs.

with the California State Board of Education's core content standards in science, math, language arts and social studies. "This is critical for teacher buy-in," Zidenberg-Cherr says.

The study is controlled, making it a rarity in the field of community research. Investigators will study matched schools in Northern and Central California, comparing those that are implementing the Shaping Healthy Choices Program with those that are not. Controls allow researchers to sort out behavior changes that are due to a given program from those that happen by chance or that are due to other environmental factors. "This is the only way to demonstrate that this type of program actually increases healthy behaviors," Zidenberg-Cherr says. "If the assessment is positive, we can inform policy, and other schools around the state can use our intervention schools as models."

Measures of success include whether children make healthier choices in the lunchroom, actually eat more of the fruits and vegetables they put on their plates and are more likely to try new produce such as jicama and kohlrabi. "We want to open up their minds to trying new foods instead of saying, 'This is all you're going to get'," she says. "We're saying, 'This is really enjoyable, you're growing it with your hands in the dirt, try this!'"

Inquiry-based learning

Another innovative aspect of the Shaping Healthy Choices Program is the curriculum. In contrast to the old-style workbook-driven lessons, students follow their interests through the curriculum. "They learn to ask questions instead of just listening to a lecture," Zidenberg-Cherr says.

Called inquiry-based learning, this approach also includes application to the real world. For example, after a lesson on food labels at school, students compare food labels on their own at home and in grocery stores. "Application is what makes learning stick," says Martin Smith, an associate UCCE specialist in youth science literacy, who helped develop the program's curriculum. "Inquiry-based learning takes longer, but it's deeper — kids own the knowledge because they figured it out themselves."

Inquiry-based learning also hones critical-thinking skills. After collecting and comparing information from nutrition labels, for example, children can make data-based decisions about what to eat. "It's part of scientific literacy, and hopefully over time they will make better choices," Smith says.

Teaching the teachers

Smith also instills the basics of inquiry-based learning in 4-H leaders, volunteers who provide nonformal education outside the classroom. He does this with inquiry-based training. "You can't teach it with


Carolyn Lagoyza

Shaping Healthy Choices incorporates serving regional fruits and vegetables, a hands-on garden, and classroom nutrition lessons. It is aligned with California's core content standards in science, math, language arts and social studies.

lectures or PowerPoints," he says. "They have to experience it themselves, and then they have an 'aha!' moment and say, 'I see what you mean'." The process is iterative, with the 4-H leaders meeting again to share what did and didn't work in their clubs. "They build knowledge and skills based on real-life experience," Smith says. "This makes them much better facilitators of inquiry-based learning. They've been there themselves and know how to encourage students."

Inquiry-based learning is a natural fit with 4-H, which emphasizes a "learn by doing" approach that boosts science literacy by encouraging exploration and critical thinking. Aimed mostly at upper elementary and middle school students, the 4-H curriculum includes animal education units ranging from veterinary science to livestock biosecurity as well as environmental education units ranging from water quality to protecting pollinators. Still in the works are units on animal welfare and preharvest food safety. "We're working toward integrating these systematically to have broader community impacts statewide," Smith says.

Healthy Living

Another component of 4-H is the Healthy Living initiative, which is a holistic approach to well-being, including physical fitness as well as choosing, growing and cooking healthy foods. As part of the 2013 centennial of 4-H in California, the Revolution of Responsibility Centennial Campaign is partnering with the 4-H Foundation to fund 1,000 service-learning projects at $1,000 each. "Service learning is core to the 4-H experience," says Connie Schneider, who directs Youth, Families and Communities, a statewide UC ANR program that includes nutrition programs such as the Expanded Food and Nutrition Education Program (see sidebar) and youth development programs such as 4-H. "In Healthy Living and other youth-led projects, learning takes place through leadership, collaboration and civic engagement," she adds. "These projects provide opportunities to make a difference in communities."

The Yolo County Cottonwood 4-H Club, for example, was awarded a grant for a school nutrition education project aimed at inspiring healthier eating habits. Implemented at a local elementary school, the project included classroom nutrition lessons, weekly deliveries of fresh fruit for 10 weeks, taste tests of seasonal fruits and making bicycle-powered fruit smoothies. A video of this project has been featured on the web page of the California Health and Human Services Agency's "Let's Get Healthy California" Task Force.

Obesity prevention

Important as it is to increase consumption of fruits and vegetables, that alone is not enough to combat obesity. "Increasing any kind of food without reducing overall calories won't make a dent in children's BMIs," says UCCE Nutrition Specialist Pat Crawford. BMI, or body mass index, is calculated from a person's weight and height, and is a proxy for measuring body fat. For children, overweight is defined as a BMI between the 85th and 95th percentile for children of the same age and sex on pediatric growth charts, while obesity is defined as a BMI in the 95th percentile or above.

A third of school-aged children in California are overweight or obese, and at current rates nearly half of the state's adults could be obese by 2030.

"Children are three times heavier than they were 30 years ago. Never have we seen increases of this magnitude," Crawford says. As childhood obesity has risen, so have the accompanying health risks. The number of adolescents with diabetes or prediabetes, for example, has risen from nearly 10% to nearly 25% in just the last decade. "How can we as a society say that's OK? These are our children!" she says.


Amber Robinson-Burmester

As part of the Cooperative Extension Centennial Campaign, the Yolo County Cottonwood 4-H Club received a grant for a nutrition project to inspire healthier eating habits. It included classroom nutrition lessons, weekly deliveries of fresh fruit for 10 weeks, taste tests of seasonal fruits and making bicycle-powered fruit smoothies.

Theresa Spezzano

Fresh fruit can substitute for sweetened beverages and fast food, two of the strongest factors driving obesity. *Above,* bicyclist participates in Get Fit Riverbank, a summer program in Stanislaus County.

Two of the strongest factors driving obesity are sweetened beverages and fast food, and decreasing their consumption is just as important as increasing the consumption of healthy foods. "You have to do both," Crawford says. "In the past, we worked to help people increase their intake of healthy foods, and now we realize that they also need to decrease their intake of less healthy foods."

She leads a multidisciplinary team that, with funding from an ANR competitive grant over the next 2 years, is evaluating a community-based approach to preventing obesity in elementary school children. This work was inspired partly by a 2012 report called *Accelerating Progress in Obesity Prevention: Solving the Weight of the Nation* from the National Academy of Sciences' Institute of Medicine. "The report cited the importance of a community-based approach to preventing obesity and identified Cooperative Extension as the on-the-ground leaders who could do this," she says. "It was almost a call for action."

The obesity prevention program under evaluation links schools and after-school programs with UCCE county nutrition advisors and 4-H. "This is the first attempt by UCCE leaders to link forces in the community in this way to prevent child obesity," she says. "Strong UCCE partnerships in the community are key to our success."

The team is studying fourth- and fifth-grade students who participate in school and after-school obesity prevention programs in Butte and Shasta counties, using BMI reductions after 2 years as a measure of success. "Two-thirds of Americans are overweight or obese, and the old model was to treat them one by one," Crawford says. "The new model is communitywide prevention to keep people from getting obese in the first place and to keep those who are overweight from getting heavier."

While these Healthy Families and Communities efforts underscore the complexity of the challenges facing youth, they also highlight the promise of taking an integrated approach to solving problems from obesity to science illiteracy to youth disengagement. Says Healthy Families and Communities initiative leader Campbell, "If we shift public thinking, policy and resource allocation, we can shift these trends in a positive direction." — *Robin Meadows*

Peter Bennett

The 24th Street School instructional garden in the West Adams neighborhood of Los Angeles includes California native gardens, 16 vegetable production beds, an orchard of fruit trees, and shaded teaching areas.

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Communitywide strategies key to preventing childhood obesity

by Patricia B. Crawford, Constance L. Schneider, Anna C. Martin, Theresa Spezzano, Susan Algert, Chutima Ganthavorn, Yvonne Nicholson, Marisa Neelon, Patti C. Wooten Swanson *and* Susan Donohue

Approximately 25 million children in the United States are obese or at risk of becoming obese, with anticipated negative consequences for individual health as well as the nation's future health-care costs. Effective interventions to prevent obesity require more than educating individuals. To bring about change, we must deploy tactics at multiple levels, from community facilities like parks and bike paths to foods offered in schools. The Spectrum of Prevention proposed in 1999 by L. Cohen and S. Smith first described this approach. UC Cooperative Extension (UCCE) has helped evaluate large-scale community-based obesity prevention programs and has experience aligning county nutrition programs with new dietary guidelines. This UCCE expertise enables UC to develop more effective obesity prevention strategies and to influence policy addressing childhood obesity. Notably, UCCE's expertise in nutrition and obesity prevention will be applied to implementing a new intervention program. The new program employs multiple components including UC Cooperative Extension materials and community networks and is designed to impact factors contributing to risk for childhood obesity.

Sara T. Bosse

Schools, where students eat one or two meals each weekday, are prime areas for reducing obesity risk. After participating in the UC CalFresh Nutrition Education Program, low-income youth in Fresno County improved their fruit and vegetable intake and increased physical activity. *Above,* CalFresh educator Nath Say explains the importance of eating a variety of fresh produce.

Most Americans continue to believe that weight is an issue linked almost exclusively to personal responsibility, and this view is a serious obstacle in the fight against obesity (Quinlan et al. 2010).

The rise in obesity in the United States is a severe health crisis that is undermining our well-being, economic competitiveness and even our national security (Glickman, Leavitt et al. 2012). Two-thirds of Americans are either overweight or obese, and the number of obese adults has doubled over the last 30 years. Even more troubling, the prevalence of obesity among children has tripled. From 1980 to 2010, obesity increased from 6.5% to 18.0% among 6- to 11-year-olds and from 5.0% to 18.4% among adolescents aged 12 to 19 (Ogden et al. 2012).

Currently, 25 million children in the United States are obese or overweight (Ogden et al. 2010). These youth are at increased risk for a variety of medical conditions that have lifelong consequences. One-sixth of all school-aged obese children are already experiencing heart disease risk factors, including high blood pressure and lipid disorders (Berenson 2005). In addition, it is now projected that one-third of the children born in this decade will develop type 2 diabetes in their lifetime and that our current generation of youth will have a shorter life span than their parents if we are not able to reduce the current rates of obesity in the United States (Olshansky et al. 2005).

These outcomes could be economically devastating for the U.S. medical care system, which will face the extraordinary expense of caring for vastly increased numbers of people suffering from chronic weight-related conditions. The current annual cost of obesity-related conditions in the United States is $147 billion for direct medical care (Finkelstein et al. 2009), and these costs are projected to double every decade if obesity rates are not curbed (Wang et al. 2008).

Preventing obesity

The primary cause of obesity is energy imbalance — too many calories consumed and too few calories burned. While the medical approach to combating

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v067n01p13&fulltext=yes
DOI: 10.3733/ca.v067n01p13

child obesity is oriented toward treating individuals, populationwide prevention may be a more effective and economical approach (Fisberg et al. 2004; Swinburn et al. 2005). Prevention efforts have the benefit of promoting healthy lifestyles for children of all weights, are less resource intensive than individual remediation and avoid the difficulty of case identification and the expense of intensive long-term counseling (Kumanyika et al. 2002). Further, individually oriented treatment can be damaging to children's self-esteem and psychological well-being (Zametkin et al. 2004). Moreover, efforts to prevent obesity may offer more promise for children than for adults, since youth have not had as many years to establish health-related behaviors that contribute to excessive weight gain (Fisberg et al. 2004).

To identify strategies for obesity prevention — ways to limit excess caloric intake or encourage adequate physical activity — population behaviors that may contribute to the rise in obesity have been looked at by expert panels convened by the Centers for Disease Control and Prevention (CDC), U.S. Department of Health and Human Services, U.S. Department of Agriculture, American Institute for Cancer Research and World Health Organization (WHO) (Kumanyika et al. 2002). In recommending obesity prevention strategies, these expert panels acknowledge that it is likely that environmental factors have contributed to the rapid rise in obesity, since human genetics cannot have changed in the brief period of the last 30 years. Indeed, it has been suggested that the community environment has a greater impact on individual health than genetic background or use of the health-care system (Cubbin et al. 2008).

. . . recent comprehensive school and community interventions are beginning to decrease children's body mass indices (BMIs) . . .

Therefore, to reverse the current obesity crisis, we must create environments that support health (Parker et al. 2009). In other words, to enable individual children to make healthy choices, we must focus on changing the communities where they live and go to school in order to provide an environment that makes healthful choices possible.

Local obesity prevention

The highest childhood obesity prevalence is among low-income groups as well as racial/ethnic groups including African Americans, Latinos and Native Americans (Madsen et al. 2010). Many of the factors that contribute to obesity are exacerbated in low-income communities, where healthy and affordable food options and safe opportunities for physical activity are lacking (Samuels et al. 2010). Individuals' behavior choices and weight status are believed to be influenced by various environmental factors such as easy availability of fast foods, increased portion sizes, availability of soft drinks and unhealthy snack food on school campuses, reductions in physical activity programs and increases in sedentary activities, inadequate parks and recreational facilities, limited access to healthy foods and advertising of low-nutrient-dense foods to children and their families (Koplan et al. 2005).

Prevention strategies can reach whole communities and populations, and there is an increasing sense of urgency in mounting these strategies (Kumanyika et al. 2002; US Department of Health and Human Services 2001). For example, it has become increasingly clear that children's environments strongly influence their behaviors, and that meaningful and sustainable behavior change is unlikely to occur without support from the home, school and the larger community (Ritchie et al. 2006). Schools — where students spend a large proportion of their waking hours and where they eat one or two meals each weekday — are a prime area for changing the environment of children (Crawford et al. 2011). In addition, local communities can also be an effective arena for change and may be more responsive to new initiatives and more likely to achieve consensus than legislative and administrative bodies at higher levels of government. Further, obesity prevention policies that are adopted locally may also be implemented more widely (Khan et al. 2009).

Effective prevention strategies

Early obesity prevention strategies were relatively unsuccessful, focusing on educational tactics rather than combining education with broadly based community change designed to support lessons learned. In contrast, recent comprehensive school and community interventions are beginning to show decreases in children's body mass indices (BMIs) on a case by case basis (Economos et al. 2007; Foster et al. 2008; Hollar et al. 2010). Strategies to support healthy eating patterns in communities and neighborhoods have included zoning that limits fast food restaurants, improving restaurant menu offerings for children, locating supermarkets in "food deserts" and increasing the availability of farmers markets and community gardens (Larson et al. 2009; Lovasi et al. 2009; Zenk et al. 2009). Strategies to encourage physical activity have included establishing parks and bike paths and

Elizabeth Gong

EFNEP educators such as Trinh Vo, *above*, deliver nutrition education programs to low-income families in Santa Clara County.

facilitating safe routes to schools (Parker et al. 2009).

Community-based intervention. Shape up Somerville, a comprehensive intervention undertaken in an ethnically diverse city of 77,000 near Boston, Massachusetts, united city and school officials and stakeholders to facilitate change in students' behavior patterns. A strong emphasis on school involvement was combined with changes in the broader community environment. Schools offered a new health curriculum as well as enhanced quality and quantity of healthful foods for students. In addition, the program encouraged walking to school with additional crossing guards and walking school buses, in which organized groups of students walk to school accompanied by one or more adults. Bike lanes and paths were improved, parks were renovated and sites were identified for new parks. Restaurants were encouraged to increase healthy options and/or alter portion sizes.

Documented improvements. Children's BMI z-scores were decreased by −0.1005 ($p < 0.001$) and the program demonstrated the effectiveness of broad-based community efforts to change the environment to one that is more supportive of behaviors that promote health and healthy weights (Economos et al. 2007). Examples of documented improvements included repainting crosswalks so people could see them better and hiring crossing guards, resulting in a 5% increase in children walking to school. In addition, schools featured more produce at breakfast and lunch, increasing their produce purchases from $90,000 to $165,000 (Berman and Russo 2007).

Large community interventions

California was the first state with private investments in large-scale, multisector community health initiatives designed to promote healthful eating and physical activity. Both the California Endowment's Healthy Eating, Active Communities (HEAC) Initiative and Kaiser Permanente's Healthy Eating Active Living (HEAL) campaign were initiated in the early part of this decade (2004 and 2005, respectively).

Healthy Eating, Active Communities (The California Endowment). The Healthy Eating, Active Communities (HEAC) Initiative created policy and environmental changes to increase children's access to healthy foods and physical activity (California Endowment 2005-2010). This initiative included six low-income communities — Baldwin Park, Chula Vista, Oakland, Santa Ana, South Shasta County, and South Los Angeles — with high rates of adult and childhood obesity. HEAC implemented programs and policies designed to increase healthy eating and physical activity in five environmental sectors: schools, after-school programs, neighborhoods, health care, and marketing and advertising.

Schools implemented state nutrition standards, increased physical education (PE) class time to meet state requirements, hired PE specialists, trained teachers in physical activity and involved parents in changing food and physical activity. After-school programs added physical activity and adopted SPARK, a research-based physical activity curriculum. Parks were outfitted with updated equipment, and walking and biking were encouraged.

To encourage healthy eating habits, unhealthy snack foods were no longer prominently displayed at grocery stores near schools, and convenience stores near schools began selling produce and other healthier items. Finally, local physicians and promotoras (community workers who provide education and referrals) were trained in obesity prevention and policy advocacy, weight management programs were implemented, healthful hospital vending policies were developed, clinical practices were changed to include BMI charting and counseling, and obesity prevention messages were created.

One of the most important outcomes of the HEAC Initiative was the number of health-promoting policies adopted by participating schools and communities. Policies are critical to sustain change initiated in programs and activities. Across the six HEAC sites, about 250 policymakers and public officials were engaged in some way in developing or supporting health policy activities. Policies adopted by schools and communities participating in the HEAC Initiative include: school food marketing policies, school fundraiser policies, school food and physical activity policies, after-school wellness policies, after-school physical activity and food policies, neighborhood healthy vending policies, fast food moratoriums, health promotion in general plans, walkability policies and park space policies (Samuels 2010).

Theresa Spezzano

More than 330 community residents spent the summer biking, doing group exercising in the park and learning to eat better with Get Fit Riverbank, a program that was codeveloped by a UCCE advisor.

HEAC was one of the first comprehensive community interventions documenting that communities could take a comprehensive approach to improving food and physical activity opportunities for youth. The California Endowment believes that California's prosperity depends on the health of its population. To this end, the Endowment has initiated a 10-year multimillion-dollar initiative to advance policies and forge partnerships to build healthy communities in California.

Healthy Eating Active Living (Kaiser Permanente). Designed to reduce obesity by improving nutrition, boosting physical activity and supporting community and organizational policy and environmental changes, the Healthy Eating Active Living Community Health Initiative (HEALCHI) campaign was implemented in three low-income communities in Northern California — Modesto, Richmond and Santa Rosa. The HEAL program helped communities develop strategies for an action plan targeting four sectors: (1) schools (improving cafeteria options, nutrition education and physical education), (2) health care (incorporating BMI measures into well visits at community clinics

and offering routine obesity counseling and referrals), (3) work sites (encouraging use of stairs and including physical activity and more healthful menu options in cafeterias) and (4) neighborhoods (building safe, lighted walking trails and establishing advocacy campaigns to increase healthy eating and physical activity options).

The HEAL-CHI campaign was successful in implementing sustainable policy and environmental strategies, with the most successful strategies identified as those that had an intense impact on more than 20% of the community population. In the three target communities, a total of 76 community health strategies were implemented, including 26 in organizational policy change, 19 at the program level, 14 in building community capacity, 12 in environmental change and five in public policy (Cheadle et al. 2012) (fig. 1). Strategies ranged from adding health elements to city general plans (policy) and improving school food offerings (environment), to cooking classes (programs) and training resident leaders (capacity building).

Significant population-level changes resulted from several high-dose strategies (fig. 2). Population dose includes both the strength of the intervention and the number reached. The highest-dose intervention activities were implemented in and around schools. For example, foods served at schools were modified and students' physical activity opportunities were enhanced.

EFNEP participants practice safe food-handling skills learned during their nutrition class in Sacramento County.

Lessons that emerged from the HEAL-CHI implementation can benefit other initiatives. These lessons include selecting intervention strategies of sufficient dose to have an adequate population reach and strength, focusing on specific subpopulations, and developing sensitive measures of impact, which can include behavioral measures of those directly exposed to community changes as well as intermediate measures of behavior change that may result in improvements in nutrition and physical activity. Kaiser Permanente has applied these findings to new HEAL-CHI communities in their Colorado, Northern California and Southern California regions and other Kaiser Permanente regions throughout the country.

UCCE community coalitions

Over a decade ago, UCCE nutrition specialists designed the first program in the country to train Cooperative Extension advisors to organize diverse, multisector community coalitions to promote community health (Ikeda et al. 2001). The purpose was to educate and empower coalitions to improve or create environments that foster healthy lifestyles for families and children at the local level. California counties implemented 13 of these projects, and the model has been used by numerous Cooperative Extension groups nationwide.

Spectrum of Prevention. The problem of pediatric overweight was addressed on multiple levels using the Spectrum of Prevention (fig. 3), an approach that has been applied successfully in a wide variety of initiatives, including violence prevention, injury prevention, traffic safety, nutrition, and fitness (Cohen and Smith 1999). The Spectrum identifies six levels of intervention that are complementary and, when taken together, can change the environment to promote healthy behaviors. By envisioning the individual within a rich and complex environment, the Spectrum's broad, multilevel approach to change provides a context within which individual change is most likely to occur.

The levels addressed by UCCE nutrition advisors ranged from educating individuals and providers to advocating for systemic and environmental change. The resulting programs were tailored to meet

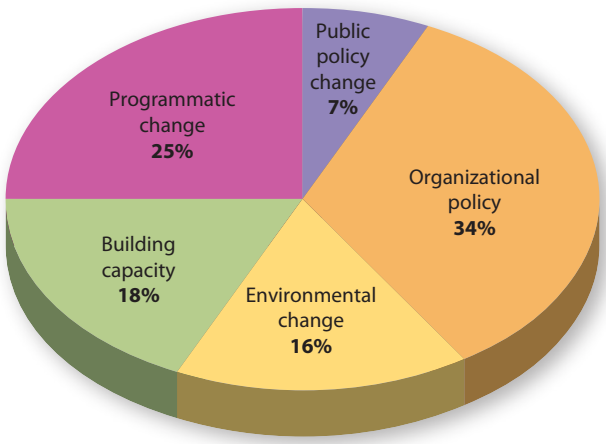


Fig. 1. Community change strategies by category and percentage of total effort applied in the HEAL study (Cheadle et al. 2012).

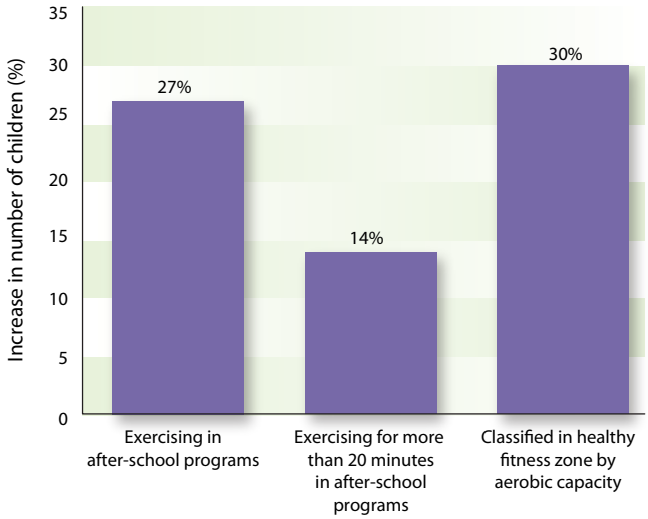


Fig. 2. High-dose community interventions with significant improvement ($p < 0.05$), as measured by percentage of children changing behavior in the HEAL program (Cheadle et al. 2012).

the needs and priorities of the advisors' various communities and provide diverse models of promising practices for the promotion of health behaviors elsewhere in the state and nation.

UCCE nutrition programs

Two UCCE nutrition programs work with community agencies and schools to deliver nutrition education to low-income families, adults and youth. These programs are the Expanded Food and Nutrition Education Program (EFNEP) and the UC CalFresh Nutrition Education Program (formerly known as the Food Stamp Nutrition Education Program). Historically, the programs have focused primarily on strengthening individual knowledge and skills (the first level of the Spectrum of Prevention) to change behaviors necessary for nutritionally sound diets.

Lessons emphasize appropriate portion sizes, label reading, meal planning, healthy choices, decreasing unhealthy fats, reducing sugar consumption and increasing physical activity and consumption of fruits, vegetables and whole grains. Although it was not the original intent of the program to prevent obesity, lesson topics link to nutrition factors that influence obesity. Measured outcomes have included increased consumption of fruits, vegetables, whole grains and low-fat dairy products as well as increased physical activity and improved budgeting skills (UC CalFresh 2011; UC EFNEP 2011).

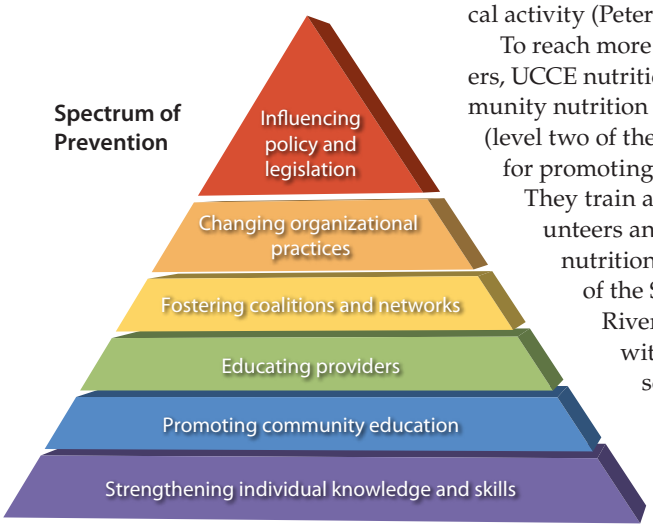


Fig. 3. The Spectrum of Prevention's multiple levels of intervention used together produce greater results than a single intervention activity (Cohen and Smith 1999).

Low-income, racial and ethnic groups. EFNEP and UC CalFresh educators reach out to underserved urban and rural community members. While poor nutrition and obesity cross all income levels, they are more prevalent in low-income and some racial and ethnic groups (Ogden and Carroll 2010; Ogden et al. 2010; Singh et al. 2010). Santa Clara UC CalFresh taught more than 500 Hispanic families with limited resources how to make the most of their grocery purchases nutritionally while saving money, and use saved dollars to purchase additional healthy foods. An inventory of the home food environment can demonstrate what families have available for healthy meals and snacks. The Santa Clara food inventory indicated that most families changed their home food environment after completing the classes: They increased fruit and vegetable variety by 30%, the amount of fresh fruit by 30% and the use of whole wheat bread by 100% (Algert 2011).

For families starting new lives in the United States, it is easy to succumb to the high-fat, high-sugar eating habits and sedentary lifestyle that are common here. EFNEP educators in San Diego worked with Somali refugee parents by showing them how to plan, shop for and prepare healthy family meals on a limited budget. In addition, along with UC Davis researchers, EFNEP advisors developed and implemented curricula and DVD video teaching aids for Hmong families to encourage healthful nutrition practices. Hmong families showed improvements in food purchasing, water intake and physical activity (Peterson 2010) (table 1).

To reach more low-income consumers, UCCE nutrition staff promote community nutrition efforts with partners (level two of the Spectrum of Prevention for promoting nutrition education). They train agency staff and volunteers and providers to teach nutrition education (level three of the Spectrum). UCCE in Riverside County partnered with nine middle and high schools to deliver the EatFit program to more than 4,400 students. EatFit was developed by UCCE and UC Davis researchers to help teens analyze their own diets and set personal eating and fitness goals. The *EatFit* curriculum was part of their physical education course work. A retrospective evaluation completed by nearly one-quarter of the students after the program showed increased consumption of fruits and vegetables and reduced consumption of fast foods, snacks and sweetened beverages (UC CalFresh 2011) (table 2).

TABLE 1. Hmong participants' self-reported improvements in nutrition practices after completing an EFNEP series of classes taught by Hmong educators with video clips and visuals (n = 166)

Nutrition practice	Improvement
	%
Shopped for food on sale or with coupons	44
Planned meals/made a grocery list	43
Increased physical activity	37
Drank more water (rather than sweetened beverages)	21

TABLE 2. Average improvement in food consumption behaviors of middle and high school students participating in the EatFit nutrition program (n = 1,051)

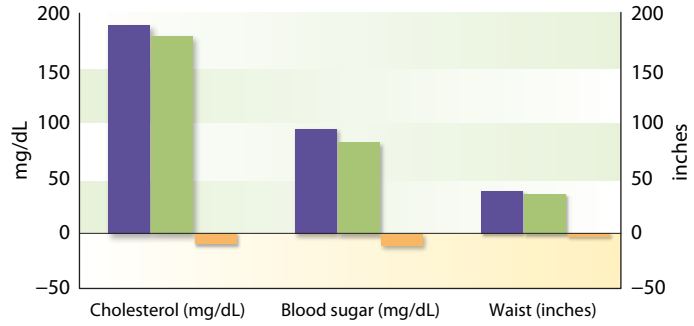
Food consumption behavior	Improvement
	%
Eat more fruits/vegetables	29.4
Eat less fast food/snack food	35.2
Drink less sweetened beverages	30.8

Community partnerships. UCCE works with community partners to teach nutrition. UCCE Sacramento and San Joaquin partnered with First 5 to extend nutrition programming within their communities. First 5 is a California program that educates parents and caregivers about the important role they play in their children's development during the first five years. Sacramento Head Start and child-care providers received professional development training on the nutritional needs of preschool youth, a critical age for learning positive behaviors and trying new foods. Head Start is a USDA Health and Human Services program that provides education, health, nutrition and parent involvement services to low-income children and families. Parents served by five San Joaquin community-based agencies were

trained to deliver nutrition education to children. Positive nutrition changes for preschoolers included trying new foods such as fish.

In addition, San Bernardino 4-H, EFNEP and the Master Gardener Program collaborated with the Norton Space and Aeronautics Academy on a gardening and nutrition project to provide youth with a Farm to Fork experience (Barnett et al. 2011). In Contra Costa County, UCCE is collaborating with two limited-income housing communities to promote healthy living with a goal of decreasing childhood obesity. Trained teen and adult volunteers deliver lessons to younger children, using hands-on activities to improve their nutrition, cooking, fitness and gardening skills (UC 4-H 2011).

Local coalitions and networks. UCCE nutrition advisors work closely with local coalitions and networks (level four of Spectrum of Prevention for promoting nutrition education). For example, a UCCE Stanislaus-Merced advisor codeveloped Get Fit Riverbank, a community-based 8-week nutrition and physical activity program designed to expose low-income families to inexpensive and fun ways to improve their health. More than 330 residents in the community united to spend the summer biking, walking and learning to eat better. Paired pre- and post-program clinical measurements showed that waistlines decreased an average of 2.3 inches, cholesterol levels dropped more than nine points and blood sugar levels dropped more than 10 points (Spezzano 2012) (fig. 4).



	Cholesterol (mg/dL)	Blood sugar (mg/dL)	Waist (inches)
Pre	189.7	94.9	39.6
Post	180.3	84.4	37.3
Change	−9.4	−10.5	−2.3

Fig. 4. Pre- and post-program mean clinical measurements and mean change among participants in Get Fit Riverbank community summer health fitness initiative; *n* = 26 matched pairs.

From 2010 to 2012, UCCE Fresno and UC Davis researchers partnered with the City of Fresno Parks and Recreation's Healthy Lifestyles Fitness Camp, using a family-centered teaching method in a summer day camp setting for low-income overweight youth. In 2011, Fitness Camp youth had lost weight (–1.06 kilograms in 9- to 11-year-olds and –1.58 kilograms in 12- to 17-year-olds), while control youth had gained weight (+0.33 kilogram), after accounting for baseline BMI for age (p = 0. 04). A decrease in waist circumference was also significantly different between Fitness Camp and control groups, after controlling for baseline BMI (p = 0.003) (George et al. 2012).

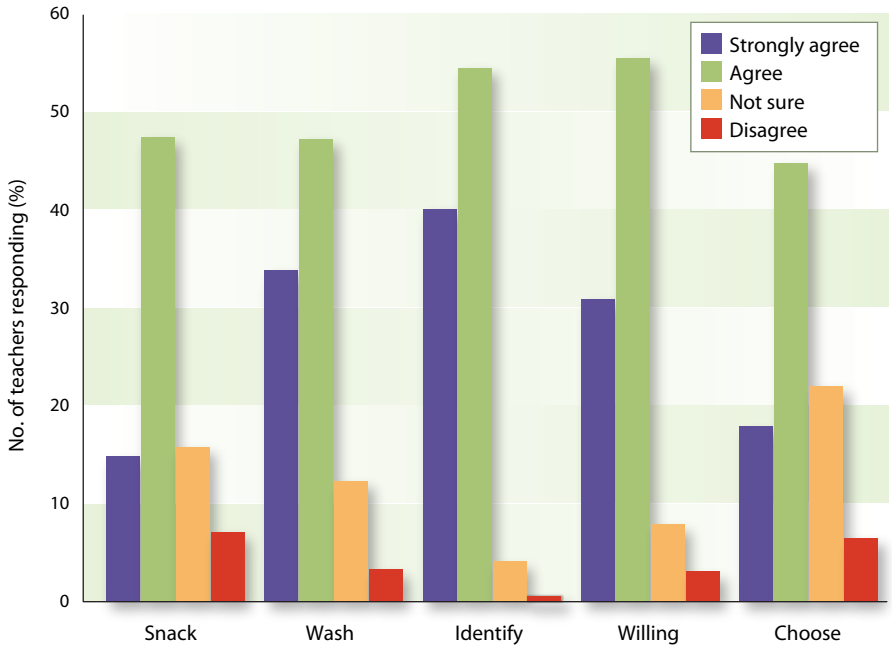


Fig. 5. After student participation in the CalFresh Nutrition Education Program, teachers reported improved student behaviors in the following areas: bringing fruit as a snack, washing hands often, identifying healthy food choices, willingness to try new foods at school, and choosing fruits or vegetables at school; *n* = 753 teachers; 18,672 students. 2011 preliminary data shown.

Classroom nutrition education. UC CalFresh's evaluation task force members from the UC Davis campus, the UC CalFresh state office and UCCE developed the Teacher Observation Tool for use with UC curricula for preschool through sixth grade. The Teacher Observation Tool is a retrospective evaluation measuring teachers' perceptions and observations related to changes in students' food-related attitudes and behaviors as well as of the teachers' impact on the classroom nutritional health environment (level five of the Spectrum of Prevention). Teachers reported that after completing the UC CalFresh Nutrition Education Program, more students could identify healthy food choices and were more willing to try new foods than they had been at the beginning of the school year (fig. 5). In 2011, 753 teachers reported that 17,551 of 18,672 students improved their ability to identify healthy food choices, with mean scores increasing from 71% to 81% ($p < 0.0001$) (Kaiser et al. In press).

New obesity prevention program

A new UCCE obesity prevention program will target children and their families in two California communities. This program is part of Healthy Families and Communities, an ANR strategic initiative that focuses on encouraging healthy lifestyles, boosting science literacy and fostering positive development among California's youth.

County-level UCCE advisors will lead this community-based program to change student attitudes, knowledge and behaviors in ways that are conducive

to healthier dietary and physical activity patterns. In accordance with the evidence-based 2010 Dietary Guidelines for Americans (USDA DHHS 2010), the intervention will emphasize key obesity prevention messages: reducing consumption of sugar-sweetened beverages, limiting fast food and decreasing time spent in sedentary pursuits. These strategies have shown promise, as have statewide school policies targeting unhealthy foods and beverages, and both may be linked to the fact that the rising rate of childhood obesity is beginning to plateau in California (Sanchez-Vaznaugh et al. 2010). At the same time that the program discourages consumption of sugar-sweetened beverages and fast food, it will encourage increased consumption of fruits and vegetables.

The 2-year intervention will integrate multiple components: (1) nutrition education in classrooms, (2) work with teachers, administrators, food service staff and school wellness committees, (3) after-school and summer programs, (4) youth engagement and empowerment using 4-H strategies and (5) parent/family activities to influence the home environment. Outreach to local business and policy leaders will encourage their involvement in changing the community milieu to one that better supports children's healthful eating and activity behaviors, creating an environment conducive to child health.

Designed by UCCE specialists, nutrition advisors, and 4-H advisors, the intervention will demonstrate a comprehensive community-based approach to preventing child obesity at the local level. Strengthened by advisors' long-standing community ties, the new program will build upon lessons learned from Cooperative Extension specialists' work in this area, nutrition advisors' education programs and 4-H advisors' youth development expertise.

Intervention materials will be adapted from current Cooperative Extension resources. UCCE links with California's agricultural community will strengthen the intervention's ability to positively influence nutritional intakes and to create communitywide support for interventions that promote child health. Programs including UC CalFresh, Farm to School, and a variety of community coalitions will deliver consistent evidence-based obesity prevention messages. Peer leadership will be a unique feature of the program, with 4-H youth serving as peer guides in school and after-school settings. In addition, the program will be continued during summertime activities for students. 4-H youth ambassadors will meet with community business and policy leaders to garner support for this health promotion effort.

UCCE links with California's agricultural community will serve to strengthen the team's ability to positively influence nutritional intakes and to create communitywide support for an intervention that promotes nutritional health and disease prevention for children.

The new program will be integrated with current nutritional approaches used by UCCE. UC CalFresh will be following the new SNAP-Ed guidelines to include an emphasis on obesity prevention in addition to nutrition education, at the same time permitting obesity outcome measures such as the body mass index (BMI). EFNEP will be following the 2010 Dietary Guidelines for Americans (USDA and DHHS 2010), which includes a community framework similar to the Spectrum of Prevention. Nutrition advisors can impact community health promotion and policy through education. Further, by aligning county nutrition programs with statewide goals and utilizing practices developed within county nutrition programs, statewide outcomes and impacts are likely to be more successful in addressing childhood obesity.

The current annual cost of obesity-related conditions in the United States is $147 billion for direct medical care, and these costs are projected to double every decade . . .

Programs in the past that have successfully impacted children's obesity rates have been both intensive and expensive. The new intervention will examine the potential of Cooperative Extension, with its existing community-based networks, to address this urgent societal problem in a cost-effective manner and to support positive community changes promoting the health and well-being of residents. The effectiveness of the program will be evaluated by comparing outcomes in the two targeted communities with those in comparison communities that do not receive the intervention.

The Institute of Medicine recently identified Cooperative Extension as a community leader well suited to guiding community interventions to prevent obesity (Glickman, Parker et al. 2012, 383). No other organizations have deep roots in communities throughout California and the country and longstanding involvement in youth programs and community nutrition programs. The confluence of these factors positions Cooperative Extension as a potential leader in the effort to solve one of the most critical health problems of our time: the epidemic of childhood obesity. If successful, the Healthy Families and Communities study will provide guidance to other California communities and Cooperative Extension affiliates, and will be a model of effective change in an area of critical importance to the state and nation.

By targeting childhood obesity, Cooperative Extension commits energy and resources to a crucial health issue of our time. By providing leadership for the

Theresa Spezzano

Participants in the 8-week Get Fit Riverbank program changed their nutrition and exercise habits, improving their weight, cholesterol level and blood sugar level.

new Healthy Families and Communities obesity intervention, Cooperative Extension will guide a community-based model that will inform future obesity prevention throughout the state. With its longstanding community ties, its experience in the areas of nutrition and 4-H and its history of using research-based knowledge to improve people's lives, Cooperative Extension is poised to significantly improve the future health of California's population.

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EFNEP is funded by USDA through the National Institute of Food and Agriculture. UC CalFresh Nutrition Education Program is funded through a joint agreement among the USDA Food and Nutrition Services, the California Department of Social Services CalFresh Branch and UCCE.

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Lessons of Fresh Start can guide schools seeking to boost student fruit consumption

by Patricia B. Crawford, Gail Woodward-Lopez, Wendi Gosliner *and* Karen L. Webb

Less than 11% of young school-aged children eat the recommended amounts of fruits and vegetables, despite abundant evidence that these foods protect against many types of cancer, heart disease and diabetes, and when combined with other dietary changes can help protect against obesity. In 2005, California became the first state to address the availability of fresh and local produce in the federal School Breakfast Program through state funding. The California Fresh Start Program doubled the number of different fresh fruits offered to students. With the greater variety, the number of fresh fruit servings taken by students in the Fresh Start pilot program more than doubled. Evaluation of the program revealed many lessons, which are especially important now, as schools across the country prepare to increase the number of fruits and vegetables offered in the School Breakfast Program by or before July 2014 as mandated by the Healthy, Hunger-Free Kids Act.

Anthony Bernard

Children consume up to half of their daily calories at school, which gives schools a potentially critical role in increasing children's consumption of fresh fruits and vegetables. *Above,* children eat breakfast at Centennial Elementary School, Fresno Unified School District.

While the health benefits of fruits and vegetables are widely acknowledged, consumption of these foods among children and youth is at a low level. Fewer than 11% of school-aged children eat fruits and vegetables at the recommended levels (Guenther et al. 2006); as many as one-third of high school students eat vegetables less than once a day, and 28% eat fruit less than once a day (CDC 2011). Further, data collected by the Centers for Disease Control and Prevention's National Health and Nutrition Examination Survey shows that the fruits and vegetables adolescents consume tend to be the less nutritious forms: Fruit juices and fried potatoes are major contributors (Kimmons et al. 2009). Children's low consumption of fruits and vegetables has been documented in numerous studies. It is clearly addressed in the 2010 USDA Dietary Guidelines (USDA DHHS 2010), which note that intakes of fried potatoes and fruit beverages have seen recent growth, while intakes of fresh fruits and vegetables have not.

Importance of school programs

The United States is confronting an epidemic of poor nutrition among children. Schools can play an important role in addressing this epidemic, both by serving food directly to students and by using the power of role modeling to demonstrate healthy diets to students and their families.

Despite educational efforts, at the population level fruit and vegetable intakes have changed very little, prompting some to suggest that alternative individual-, community- and population-level interventions are necessary (Thomson and Ravia 2011). One promising approach is to provide more servings of fruits and vegetables in schools and youth-serving programs (Delgado-Noguera et al. 2011; Knai et al. 2006). Findings suggest that if children are provided with healthful, appealing foods, they will eat them.

A European review of the literature found that availability and accessibility of fruits and vegetables and taste preferences were the determinants most consistently and positively related to consumption (Blanchette and Brug 2005). Furthermore, a combination of increased access to fruits and vegetables at school with nutrition education in the curriculum has a considerably greater impact than nutrition education alone, although both are important (Coyle et al. 2009; He et al. 2009; Knai et al. 2006). The USDA Fresh Fruit and Vegetable Program, which provides an extra serving of a fruit or vegetable as a between-meal snack to children at schools in low-income communities that apply for the program, is being evaluated and shows promise for increasing children's consumption (FNS 2010).

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v067n01p21&fulltext=yes

DOI: 10.3733/ca.v067n01p21

The greatest room for improvement in children's fruit and vegetable consumption is at school, where children consume up to half of their calories (Briefel et al. 2009). The National Academy of Sciences Institute of Medicine has urged school action to increase fruit and vegetable intake (Glickman et al. 2012), and federal policies resulting from the Healthy, Hunger-Free Kids Act of 2010 mandate this increase.

Students eating the school breakfast took more than twice as many fresh fruit servings during the California Fresh Start Program than before the program.

The California Fresh Start Program was a pilot school breakfast program that informed state and federal policymakers about the opportunities, challenges and benefits of programs to increase produce consumption in schools. Lessons from the program are especially important now for two reasons: School districts will be increasing offerings of fruits and vegetables in the School Breakfast Program in July 2014 to meet the new school nutrition guidelines in the Healthy, Hunger-Free Kids Act; and childhood obesity has escalated, with the consequent risk of serious chronic conditions including type 2 diabetes and heart disease. Here, we highlight the results of the California Fresh Start Program, which was conducted during the 2006-2007 school year, and recommend promising strategies for increasing produce consumption by children in the school setting. The barriers we identify to program implementation can provide guidance to policymakers and administrators in school districts nationwide. A comprehensive report on the California Fresh Start Program can be found at the Center for Weight and Health, UC Berkeley, website: http://cwh.berkeley.edu/sites/default/files/primary_pdfs/Evaluation_of_the_California_Fresh_Start_Program_Report.pdf.

California legislation

Responding to the critical state of children's nutritional health, California enacted Senate Bill 281, commonly known as the California Fresh Start Program (CFSP), which was signed into law in 2005. It was the first statewide legislation to specifically address fresh and local produce in schools.

The innovative pilot program offered a 10-cent per meal reimbursement to schools to increase the servings of fruits and vegetables they offered in the School Breakfast Program. Priority was given to serving fresh fruits and vegetables and, where possible, California-grown produce.

The program goals were to promote the consumption of fresh fruits and vegetables, increase school breakfast participation and ultimately improve children's lifelong eating habits and decrease the incidence of obesity. Supplementing fruits and vegetables in the breakfast program, which serves more than a million California students each day, was an important first step in reaching school-age children, nearly all of whom are at nutritional risk due to low produce consumption.

Program participation

Of California public school students who eat breakfast at school, 78% were reached by the California Fresh Start Program during the 2006-2007 school year. Fewer than half of California's school districts participated in the program, but participating school districts had larger student enrollments than nonparticipating districts (median enrollment was 4,069 and 1,047, respectively). A higher proportion of participating versus nonparticipating districts were in urban areas. The ethnic profile of students (mostly white and Hispanic) and the average school breakfast participation rates (about 20%) were similar in participating and nonparticipating school districts.

Program evaluation

An independent evaluation of the California Fresh Start Program was conducted to answer the following questions:

- How did schools spend the additional 10 cents per breakfast?
- To what extent did school purchases of fresh fruits and vegetables increase?
- What impact did the program have on children's dietary intake of fruits and vegetables and on their participation in the School Breakfast Program?
- What effects did the program have on school food service operations, including needs for equipment and facilities, labor, nutrition education materials and staff training on safe handling, serving and marketing of fruits and vegetables?

School districts were stratified according to their number of elementary, middle

USDA

To meet the nutrition guidelines in the Healthy, Hunger-Free Kids Act, schools need to increase servings of fruits and vegetables. *Above,* fresh oranges and kiwifruit are attractively combined to appeal to high school students.

and high schools, and the schools were randomly selected for participation in the evaluation. Of 93 schools that were contacted, 20 were ineligible because they were not participating in the program and four declined to participate in the evaluation. Of the remaining 69 schools, 61 were able to supply sufficiently complete data for the evaluation. The Committee for the Protection of Human Subjects at UC Berkeley approved the study. Parents received letters about the study, and students consented verbally to participate.

Data were collected before and during the program. Breakfast menu production records and invoices were sought from the schools' child nutrition directors on 20 randomly selected days during the months of September, October and November in the year before the program was implemented and during the program (2006 and 2007). Data from the menu production records included the nature and number of fruit servings prepared and taken by students at breakfast. Nonfood expenses directly relating to operating the program were also reported.

Of the 61 nutrition directors, 55 recorded their views of the program's impact on nutrition services operations, perceived student satisfaction, challenges and barriers to operating the program, nutrition education and promotional techniques, and staff training and needs. A stratified random sample of 18 schools was selected for site visits, which were successfully conducted at 16 schools: six elementary, six middle and four high schools. This sample was similar to other schools participating in the program in terms of school level, enrollment, geographic location, free- and reduced-price enrollment and student ethnicity.

Interviews with nutrition directors were conducted at each of the 16 schools.

Student surveys were completed by 1,205 students in grades 4 to 12 in a convenience sample of one or two classes at each of the 16 visited schools (total of 28 classes) as well as at the school cafeterias during breakfast service. Questions were asked about where breakfast is eaten, how often fruits and vegetables are consumed at breakfast, favorite fruits to eat at breakfast, importance of eating fruits and vegetables at breakfast, change in fruit and vegetable consumption compared to the previous year and basic sociodemographic information. The cafeteria questionnaire asked additional questions regarding opinions about the school breakfast and perceptions of change since the previous year. The classroom questionnaire included questions regarding barriers to eating the school breakfast.

In addition, trained research staff facilitated classroom discussions with students in 28 classes in grades 4 to 12 (a convenience sample of one or two classes at each of the 16 schools). Students were questioned about their views on breakfast in general, the School Breakfast Program, the California Fresh Start Program and factors influencing their school breakfast participation and food choices.

Nutrition directors recorded School Breakfast Program participation on a standardized form. The researchers obtained monthly participation data during the course of the evaluation, including number of operating days and school average daily attendance. In addition, observations of the breakfast environment were made at each of the visited schools.

Costs of specific fruits and vegetables were calculated from invoices provided by the nutrition directors. The costs of fruits and vegetables prepared and served were based on the total value of the prepared items reported on the menu production records. Nonfood expenses identified on invoices were classified as transportation, facilities, large and small equipment, material, promotional, training, additional staff time, and other. The percentage of total nonfood expenses for each category was calculated.

The California Endowment

Student surveys revealed a preference for fruit to be served in salad bar style. *Above*, a Sacramento school offers fruit alongside vegetables in its salad bar.

Differences in both fresh fruit and total fruit taken by students and in the variety of fruits offered at each school were calculated from menu production records and analyzed by *t*-test. Descriptive findings were reported for schools demonstrating more successful program implementation, specifically, schools with increases of 0.10 or more units of total and fresh fruit taken and increases greater than 0.90 for number of different fresh fruits offered.

Although the California Fresh Start Program was designed to increase fruit and vegetable consumption, its effect was almost completely seen on fruit consumption, since vegetables were rarely included in the breakfast menu; vegetables represented less than 1% of produce offered to students. Thus the results presented here are based on fruit offerings.

Increased fruit consumption

The California Fresh Start Program resulted in substantial increases in the variety of all, and especially fresh, fruits offered to students. More than twice as many different fresh fruits were offered per day during the program compared with the same period a year before: an average of 1.38 fruits compared to 0.66 (table 1). When considering all forms

TABLE 1. Number of different fruits, by form, offered per day at breakfast before and during the California Fresh Start Program (*n* = 61 schools)

Fruit	Before program	During program	Increase (decrease)*
	..... *mean*		%
Fresh	0.66	1.38	110†
Juice	0.75	0.73	(2)
Canned/frozen	0.30	0.37	25
Dried	0.05	0.07	42
Total (all forms)	**1.75**	**2.55**	**46†**

* Percentages were rounded to the nearest whole number.
† Differences were computed using paired *t*-tests; significant at $P < 0.01$.

of fruit (fresh, juice, canned, frozen and dried), there was a 46% increase in the average number of fruits offered per day: 2.55 fruits compared with 1.75 prior to the program (table 1). The California Fresh Start Program brought the offerings into compliance with dietary recommendations for two produce servings at breakfast.

During the program, fresh fruit made up the majority of the fruit offered at breakfast. Juice, which previously had been the primary source of fruit, decreased substantially as a proportion of total fruit. All types of fresh fruit were offered with greater frequency; however, apples remained the most commonly offered individual fruit, followed by oranges and bananas. Stone fruits, though offered less frequently, showed the greatest percentage increase during the program (table 2).

Our findings suggest that when offered a greater variety of fruits and less juice, students will increase their intake of fruit, especially fresh varieties (fig. 1). Students eating the school breakfast took more than twice as many fresh fruit servings during the California Fresh Start Program than before the program, 0.32 servings compared to 0.14, while taking substantially less juice and nearly the same amounts of canned, frozen and dried fruit offerings (fig. 1).

Although there were no direct measures of student consumption in this evaluation, the amounts taken, as recorded by food service personnel, provide a reasonable indirect basis for assessing student consumption. Observations by research staff and food service personnel confirmed that most students who choose to take a fruit at breakfast do eat it. Therefore, student consumption of fresh fruit at breakfast appears to have doubled as a result of the California Fresh Start Program.

During the program, students took more of almost all types of fruit; however, the percentage increases were greatest for less common fruits such as cantaloupe, tangerines/tangelos and blueberries, which were not often offered before the program. Increases of about 20% to 30% were observed for common fruits such as apples, bananas and oranges; increases

TABLE 2. Frequency (% of observation days) with which different fresh fruits were offered at school breakfast before and during the California Fresh Start Program (*n* = 61 schools)

Fruits	Before program mean	During program mean	Increase*
	..... %		
Apples	16	37	130†
Oranges	9	25	170†
Assorted fresh fruit	17	24	39
Bananas	10	19	84‡
Stone fruits	2	5	221‡
Grapes	2	5	98
Strawberries/ blueberries	2	3	43
Melons (all)	2	3	38
Kiwi	< 1	2	—§
Pineapple	0	< 1	—
Tangerines/ tangelos	< 1	2	—
Pears	< 1	2	—

* Percentages were rounded to the nearest whole number.
† Significant at $P < 0.01$, using paired *t*-tests.
‡ Significant at $P < 0.05$, using paired *t*-tests.
§ Percentages were too small for meaningful estimates.

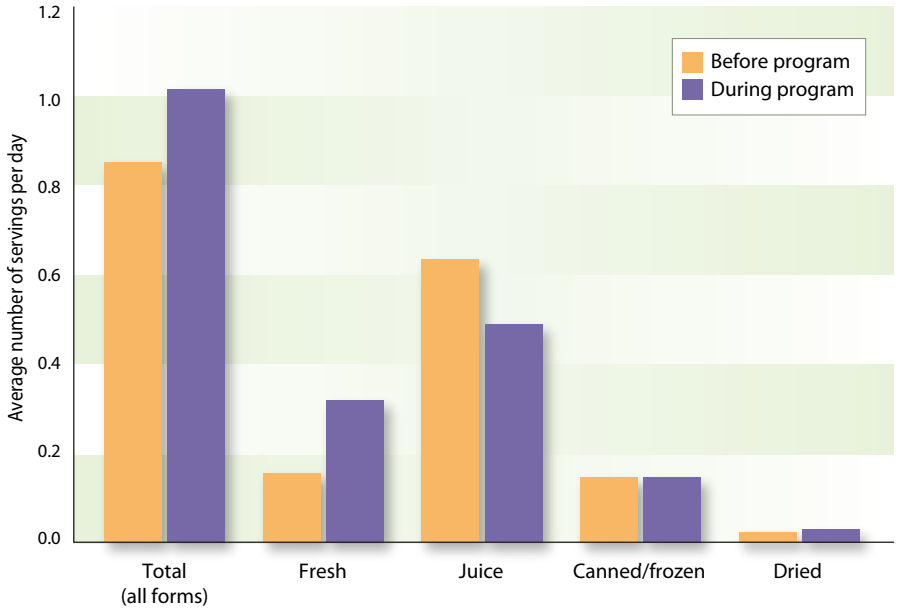

Fig. 1. Average number of servings of fruits taken by students per day at breakfast before and during the California Fresh Start Program (*n* = 44 schools).

Anthony Bernard

During the California Fresh Start Program, students eating school breakfast took more than twice as many fresh fruit servings as before the program. Juice, the largest source of fruit, decreased substantially as a proportion of total fruit offered. *Above*, Fresno students at Cooper Academy enjoy breakfast.

were 100% or more for tangerines, berries and cantaloupe, reflecting their appeal among students, and the low frequency with which they were offered before the program. Although the greatest increase in offerings occurred for the most common fruits — apples, oranges and bananas — the relative increase in servings of fruits was highest for the less common fruits. The demand for more common fruits may be approaching saturation, but unmet demand exists for a wider variety of fruits. Thus, future increases in the fruit servings students take at breakfast will likely require offerings of fruits other than apples, oranges and bananas.

Schools with greatest success

While the overall impact of the program on the amount of fruit — particularly the amount of fresh fruit — taken by students is impressive, this impact is even more dramatic when looking specifically at the schools that experienced the greatest success in implementing the program. At these schools, the California Fresh Start Program led to a 46% increase in the total amount of fruits taken by students, and a 383% increase in the fresh fruits and vegetables taken (table 3). It had the most impact in schools where students took the lowest number of fruit servings before the program — schools with the greatest need for an increase in produce intake. Schools that offered increased quantities of fruit, more variety of fruits and more unusual fruits and less juice were most successful in increasing student selection of fresh fruit. Limiting juice and providing fruits other than apples, oranges and bananas appear to be particularly important for increasing student consumption of fresh fruit. The fruits most often served at breakfast are rarely the ones that students most prefer (e.g., watermelon and strawberries).

Students' attitudes

Students' attitudes toward eating fruit, already positive, showed modest changes during the program. Most students (77%) reported it was important to have fruit at breakfast, saying that fruits and vegetables are "good for you because it's healthy, makes you strong; there is natural sugar, and it contains vitamins like A and C." However, only 13% said they always eat fruits and vegetables at breakfast, and only 19% said they often do. This may

TABLE 3. Number of total and fresh fruits taken per student, and variety offered, before and during the California Fresh Start Program, for more- and less-successful schools*

	More-successful schools (n = 22)			Less-successful schools (n = 22)		
Outcome variable	Before program	During program	Increase (decrease)	Before program	During program	Increase (decrease)
	..... *mean*		%	..... *mean*		%
Total fruits taken	0.82	1.20	46.1	0.91	0.84	(7.7)
Fresh fruits taken	0.08	0.40	383.0	0.30	0.27	(11.4)
No. of different fruits offered	1.42	3.13	120.0	2.22	2.34	5.6

* More-successful schools were those ranking above the cutoffs in all three of the following criteria; less-successful schools were those ranking below all three cutoffs:
- Change in the mean number of total servings taken per student per day (cutoff > 0.10)
- Change in the mean number of fresh servings taken by students per day (cutoff > 0.10)
- Change in the variety of fruits and vegetables offered per day (cutoff > 0.90)

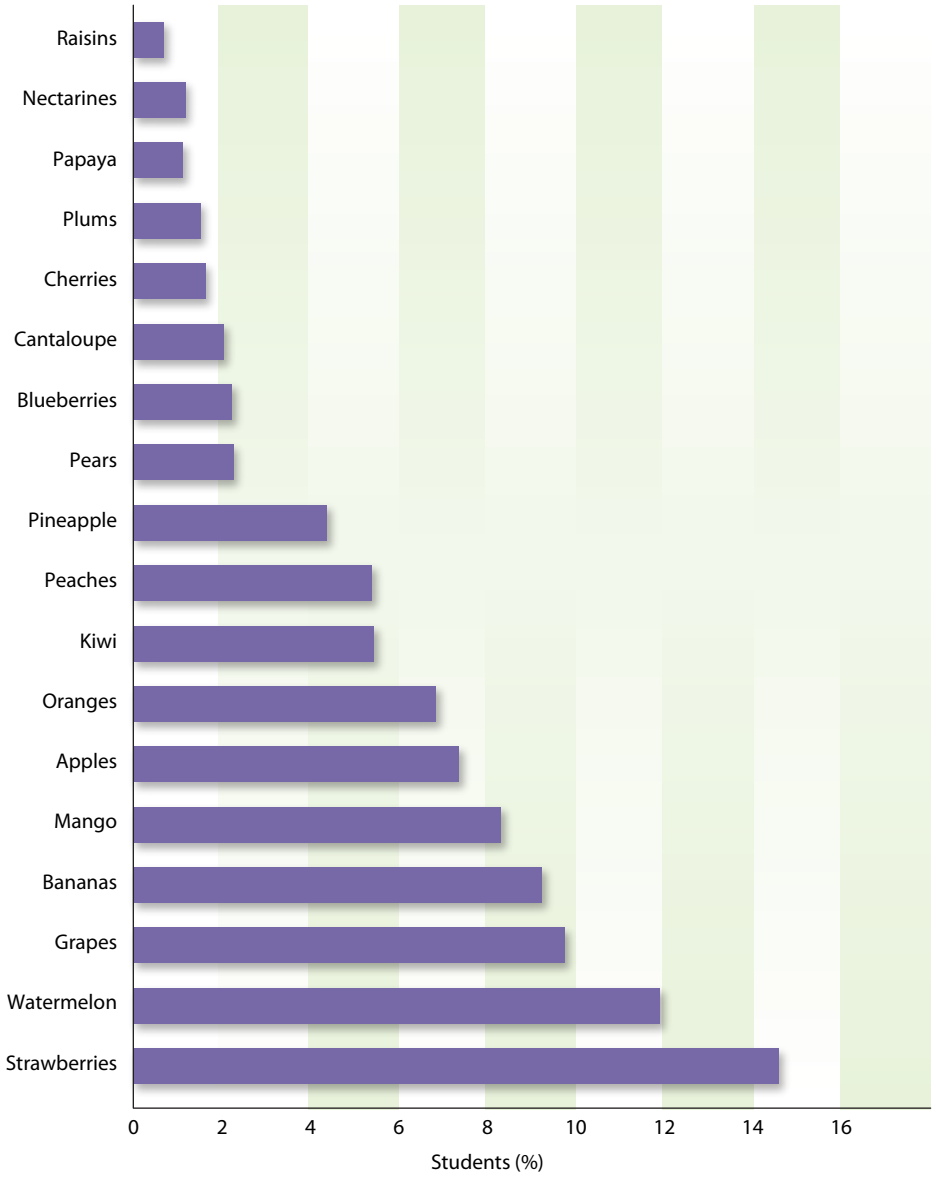

Fig. 2. Student survey responses regarding which one fruit was their favorite (n = 1,205 students surveyed).

A test kitchen for healthier school meals prepared a variety of vegetables, fruits and homemade vinaigrette to tempt students to try more fresh produce. Variety, convenience, quality and freshness are key concerns among students.

be due in part to the fruits most often served at breakfast not being the fruits students prefer.

Students prefer more exotic fruits than they are currently served. Fruits mentioned were mangos, kiwi, strawberries, peaches, pineapple, watermelon and grapes, with melons and berries being most popular (fig. 2). Students also want more variety in the ways fruit is presented, including chopped fruit, fruit salads, salad-type fruit bars, fruit with condiments and ethnic favorites. Variety, convenience, quality and freshness are key concerns. High school students, in particular, expressed a desire for more tropical fruits such as mangos.

Factors associated with success

Successful implementation of the California Fresh Start Program was not significantly related to school characteristics or student socio-demographics. The type of school (elementary, middle or high), ethnicity/race of the students, rural-urban geographic location, percentage of free- and reduced-price meal participation and size of student enrollment did not have any statistically significant association with the program's success in terms of the number of fresh and total fruit servings students took or the variety of fruits offered.

Whether students were offered and/or took more fruit was affected by a variety of school institutional and economic factors, including the physical layout of the school's food service department and the availability of funding for program support. Because the California Fresh Start Program did not mandate or provide funding for facility improvements, it is not surprising that only about 9% of the schools made improvements to their kitchen, dining area, serving areas or points of service. Data from the evaluation indicated that adequate dining space for students was related to students taking more fruit and an appealing dining ambience was related to students taking more fresh fruit.

Almost one-third (31%) of schools did not have sufficient facilities to seat all students comfortably. The temperature was uncomfortably cold in many of the serving and dining areas, which may have played a role on cold days in students' preference for hot breakfast items rather than cold fruit. The student survey revealed that a majority of students want more options regarding when and where they can eat breakfast, particularly the options of eating in the classroom and indoors or outdoors. Only about one-third of schools offered students the choice of eating indoors or outdoors. Our findings suggest an investment in facilities has the potential to attract higher participation in the breakfast program and to increase students' intake of fresh fruit.

Schools that offered more variety of fruits were more likely to have made improvements in customer service, nutrition education, student attitudes and the quality and appeal of the fruit offered. Quality concerns were prominent in discussions with students about the changes in foods offered. Students noticed both positive and negative changes in food and beverage temperatures, freshness, taste, portion size and preparation.

In addition to presentation, the position of fruit in the serving sequence might affect student selections. At one site, the fruit was not visible; it had to be requested. Fresh fruit was the first item offered in the serving sequence at only three of the 13 sites where these data were recorded.

Nutrition directors at schools where students chose more fresh and total fruit were more likely to describe inadequate storage space and facilities. (Perhaps having to expand offerings heightened their awareness of inadequate facilities.)

Nutrition education, promotion

Many schools increased nutrition education and promotion efforts among students as part of the California Fresh Start Program but lacked the staff time and resources to mount a sufficiently intensive effort. Of the nutrition directors surveyed, 96% reported that lack of opportunity (time allotted in students' school day or an appropriate school location) was a barrier to fully providing the nutrition education component of the program, 87% reported a lack of staff time as a reason, and 81% reported that lack of funding was a barrier (table 4).

Lack of nutrition education for students was the third most commonly cited barrier to successfully providing additional servings of fresh fruit. Although it was intended that the program include a nutrition education component, schools were provided with only 1 cent per meal served (i.e., 10% of the 10 cents provided) for all nonfood expenses related to the program, including nutrition education and promotion. Yet, in spite of the limited funding, over half (57%) of the schools did report using some nutrition education or promotional materials.

TABLE 4. Barriers to providing California Fresh Start Program–related nutrition education and promotion, as reported by child nutrition directors (*n* = 53)

Barrier	Directors reporting
	%
Lack of opportunity, time or forum	96
Not enough staff time	87
Inadequate funding	81
Lack of materials	66
Lack of school support	55
Lack of student interest	46
Lack of staff training	44

Although slightly more than half of nutrition directors had implemented some form of staff training, 40% reported that staff needed more training in the areas of fruit and vegetable handling and management and nutrition education in order to more effectively market fruits and vegetables to students. Nutrition, Family and Consumer Science advisors are poised to provide this kind of education and training.

Elephant in the room: Finances

The 10 cents per meal the program provided was substantially less than the amount required to cover a supplementary serving of fruit. Without considering the labor and other costs associated with serving additional fruit, the cost of the fruit alone was 3 cents higher than the 10 cent reimbursement, 4 cents above the 9 cents designated for food cost. The cost per serving for apples, oranges and bananas is 12 to 15 cents, whereas the other fruits offered in the program range from 14 to 25 cents per serving (table 5).

The 1 cent intended for all other costs, including labor, education and administrative expenses, was totally inadequate; labor costs for school food service departments usually account for 30% to 50% of expenses, and costs associated with storage and produce loss from perishability add to the expense of handling fresh produce. If the California Fresh Start Program were to offer a greater variety of fruits and higher-quality fruit, as students would prefer, fruit consumption would likely increase, leading to substantial increases in labor costs and costs of facility modification, as well as produce costs.

Most nutrition directors (81%) reported that the program reimbursement was inadequate to cover the cost of implementing the program. Most schools either absorbed or could not quantify their nonfood expenses. Those that did report nonfood expenses spent an average of $2,784, primarily on small equipment and educational materials.

Nutrition directors identified cost as the main barrier to providing a greater variety of fruits. They tended to serve fruit whole to reduce waste, increase shelf life and reduce labor costs associated with chopping fruit. They served apples, bananas and oranges most frequently because they are the most affordable. Student favorites such as strawberries cost much more (table 5). To keep costs down, nutrition directors obtain their fruit whenever possible through the commodity food and Department of Defense programs. According to the nutrition directors, they could serve a greater variety of produce if these programs offered a more consistent supply and greater variety of fruits and vegetables.

Despite the perceived inadequacy of the reimbursement, many (45%) nutrition directors thought the program was helpful financially and made it easier for them to provide more fruits because enrollment in the breakfast program increased. Higher participation rates in school breakfast might help to improve the bottom line by bringing in more federal reimbursement dollars. Participation increased slightly during the program, but the increase was too low to be statistically significant; it is not clear what would have happened over a longer period of time.

TABLE 5. Cost per serving of fresh fruits offered at school breakfast before and during the California Fresh Start Program (*n* = 61 schools*)

	Before program		During program	
Fruits	Observation days	Mean cost	Observation days	Mean cost
	no.	*$*	*no.*	*$*
Assorted fresh fruit	149	0.13	331	0.15
Melons (all)†	30	0.17	33	0.17
Stone fruits (all)‡	11	0.22	41	0.16
Apples	195	0.15	426	0.14
Bananas	124	0.12	238	0.13
Cantaloupe	10	0.18	24	0.18
Grapes	27	0.14	58	0.19
Honeydew	3	0.44	1	0.25
Kiwi	2	0.18	23	0.23
Nectarines	2	0.30	12	0.15
Oranges	116	0.13	282	0.14
Peaches	0	—	5	0.24
Pears	20	0.20	94	0.17
Pineapple	1	0.05	1	0.15
Plums	9	0.20	24	0.15
Strawberries/blueberries	31	0.22	37	0.20
Tangerines/tangelos	3	0.15	20	0.20
Watermelon	17	0.11	8	0.14

* All schools with cost data were included in this analysis.
† Melons include watermelon, cantaloupe and honeydew.
‡ Stone fruits include peaches, plums and nectarines (no cost data for pluots).

TABLE 6. Estimated percentage of the Fresh Start program fruit that was grown in California

Fruits	Grown in California
	%
Grapes	97
Oranges	95
Strawberries/blueberries	95
Tangerines/tangelos	95
Stone fruits	75
Kiwi	53
Pears	45
Apples	35
Bananas	0

Purchase of California fruit

During the program, more California-grown fruit was sold and distributed because the quantities of fruit and varieties of fruit purchased by schools increased. Using production records from schools participating in the program evaluation and interviews with selected produce distributors, we were able to estimate the proportion of produce the schools purchased that was California grown (see table 6).

If all schools in California were to increase fresh produce offerings at breakfast, annual school purchases of California-grown fruit would increase by an estimated 26 million servings, valued currently at approximately $4 million per year. These estimates are based on an average increase of at least one-third of a serving of fresh fruit per school breakfast meal served, an assumption that 47% of the fresh fruit served would be California grown, and an average cost per serving of 15 cents. Given this scenario, an additional $8.3 million would be spent on fresh produce, of which approximately $3.9 million would be spent on California-grown produce and $4.4 million would be spent on fresh produce from other sources. If students' favorite fruits, which are primarily California grown, were served more often, our findings suggest students would take even more fruit at breakfast and therefore the increase in the value of school purchases of California-grown produce would be even higher.

According to school nutrition directors, produce vendors were a program asset, making it possible to increase fresh fruit servings by providing dependable service, high quality and reasonable prices, and providing access to locally grown produce. While nutrition directors were enthusiastic about using more locally grown produce, some felt that they needed a go-between to procure the produce from local growers. Some reported that there were few, if any, local growers, and even if there were multiple local growers, it would be difficult to work directly with them. Directors expressed concern about supply, distribution, dependability, food safety and cost issues when dealing directly with local growers. Produce vendors were seen as necessary intermediaries between the schools and the growers as some directors felt that food service departments are not equipped to deal with many small growers. They preferred to continue dealing with the major suppliers with whom they have ongoing relationships.

Increased purchase of California-grown produce can be a win-win for schools, students, distributors and farmers. Food distributors (vendors) indicate that they prefer to purchase fresh fruit from California farmers, when available, as it is more affordable than fruit imported from out of state. Schools benefit from these savings, and farmers benefit from an increased market demand. The ultimate beneficiary is the student, whose increased consumption of fruit will contribute to long-term health.

The California Endowment

Using fresh tomatillos in a new recipe for California schools, Rodney Taylor, director of nutrition services at Riverside Unified School District, gave school leaders from across the state a taste test. Purchases of California-grown produce could rise significantly as schools expand their offerings of fruits and vegetables.

Lessons for future programs

While the California Fresh Start Program was designed to provide more fruits and vegetables to students, its application to the breakfast program led to an overwhelming emphasis on fruit, and it is therefore impossible to draw conclusions about its potential impact on vegetable consumption from our data. However, other studies have indicated that increasing student vegetable consumption at other times in the school day presents greater challenges than are found with fruit (Hoffman et al. 2010; Ohri-Vachaspati et al. 2012). A systematic review of 27 school-based programs (26,361 students) designed to increase fruit and vegetable intake found that although the programs moderately improved fruit intake, they had minimal impact on vegetable consumption. The authors called for additional studies to address barriers to changing dietary behavior, particularly in relation to vegetables (Evans et al. 2012).


USDA

If melon and students' other favorite fruits were served more frequently, consumption would increase but so would costs. *Above,* an employee of Arlington Food Services prepares cantaloupe for students at Washington-Lee High School in Virginia.

As implemented, the California program was effective in increasing the amount of fruit, particularly the amount of fresh fruit, offered to and taken by California school children each day. Further, the variety of fruits offered, especially those that were fresh, increased substantially. The success of the program demonstrated that schools can have a positive impact on students' consumption of fruit, which is particularly important since produce consumption at school is lower than at home.

Piloting the program also provided lessons for the future implementation and expansion of such a program. Given the well-documented health risks that poor nutrition poses for California's school children and, at the same time, the likelihood that a school fruit program may decrease children's intake of unhealthy snacks at school (Overby et al. 2012), it is critical to closely examine those lessons.

The significant increase in the number of fruit servings students took at breakfast during the program was observed even in the absence of adequate funding to promote the effort or to upgrade facilities and equipment so that the fruit could be served in a way that would make it more attractive to students. Infusing additional resources for training, technical support

and facilities upgrades, including, for example, improvements in storage capacity, adequacy and attractiveness of cafeteria seating, and creative presentation such as the use of salad-type fruit bars and point-of-service displays, could lead to even more substantial increases in the servings students take.

The program also was successful at shifting student consumption away from fruit juice toward fresh fruit. When schools serve less juice at breakfast, students take more fresh produce. Fruits are a healthier option than juice because of their higher levels of fiber and associated micronutrients. While the program resulted in a doubling of fruits offered to students at breakfast and a doubling of fresh fruit taken, a limitation of the study is the lack of assessment of the amount of fruit consumed. While not assessed in this study, improved variety and appeal in produce offerings, improved facilities, and more nutrition education could all potentially result in higher total consumption as well.

Our evaluation of the program suggested that school food service personnel faced a dilemma: If they took steps to improve the variety, presentation and promotion of fruit, their labor and food costs would increase beyond the 10 cents per meal provided by the program. At the same time, more students would likely take more fruit servings, particularly servings of fresh fruit, thereby further straining food service budgets. Our study suggests that additional financial resources will be required to ensure that most or all students take the recommended two servings of fruits and vegetables at breakfast.

If the program reimbursement were increased to 15 cents to better cover estimated actual costs (fruit cost of 13 cents plus 2 cents for labor, transportation and related nonfood costs) and if all eligible schools participated, the total reimbursement figure would be about $26 million per year. School programs would further benefit from additional funding to make food service facilities adequate to store, prepare and serve fruits and vegetables in a safe and appealing manner. Interestingly, the USDA's Food and Nutrition Service recently estimated that the final meal pattern ruling mandating increases in whole grain and fruits in the School Breakfast Program would necessarily increase the cost of food and labor by 14 cents, an amount similar to our estimate for fruit (FNS 2012).

As part of the Healthy, Hunger-Free Kids Act of 2010, an extra 6 cents per meal in reimbursement was provided for school nutrition programs that complied with the mandate to increase the kinds and amounts of fruits and vegetables. As the final provisions of this act are implemented in schools across the nation, it will be important to evaluate school programs.

California has recognized the need to reverse the trend toward poor youth diets and has acknowledged the responsibility of schools to promote health. Unfortunately, lack of financial resources led the state to discontinue funding for the California Fresh Start Program after the pilot. However, new programs can benefit from lessons learned from the California program. There are currently changes taking place in school nutrition policy at the federal level. Partnerships among influential organizations and sectors, including growers, schools, public health agencies and others have been suggested as a lynchpin of the National Action Plan of the National Fruit and Vegetable Alliance (Thomson and Ravia 2011). The health of future generations depends upon our commitment to ensuring that everything possible is done to help today's youth adopt healthy food habits.

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Funding for this research was provided by California Healthy Kids Resource Center and the Nutrition Services Division of the California Department of Education. The authors would like to thank the administrators, food service personnel and students of the participating schools for their involvement as well as Sheila Stern and Lauren Goldstein for their editorial assistance.

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Integrating local agriculture into nutrition programs can benefit children's health

by Rachel E. Scherr, Rachel J. Cox, Gail Feenstra *and* Sheri Zidenberg-Cherr

Childhood obesity has multiple interrelated causes and so should be addressed with multiple interventions, including innovative nutrition education programs that encourage healthy lifestyle choices in children. Research indicates that garden-based nutrition education increases fruit and vegetable preferences and consumption in children. Additionally, many reports on Farm to School programs indicate they promote both increased consumption of fruits and vegetables and participation in the National School Lunch Program. Within California, UC Agriculture and Natural Resources plays a leadership role in school garden and Farm to School programs. We provide a relevant literature review and assess the role of UC Cooperative Extension (UCCE) in program implementation and assessment, including results from a survey of UCCE advisors and directors. All respondents reported implementation of garden-based nutrition education and Farm to School programs; however, evaluation occurred much less frequently.

Kelley Brian

Having established a school garden, students at a Northern California elementary school take measurements of plant growth as a part of their science curriculum. It has been repeatedly shown that garden-enhanced nutrition education has a positive effect on children's fruit and vegetable choices and intake.

The epidemic of childhood obesity in the United States is a leading public health concern. Recent estimates indicate that 31.7% of children aged 2 to 19 years are overweight (at or above the 85th percentile for body-mass-index-for-age) and 16.9% are obese (at or above the 95th percentile) (Ogden et al. 2010). The issue of obesity is complex, with numerous interrelated causes. It stands to reason that any problem with this degree of complexity cannot be solved through programs that address a single contributing factor. Multiple government agencies have echoed this logic in a call for integrative and innovative strategies that demonstrate promise in promoting healthy lifestyle choices among children.

These strategies include implementation at multiple levels, from individual to family to community to society (CAPOP 2012). The need for healthier school environments, improved dietary and physical activity behaviors at home and community engagement in efforts to improve the health and well-being of our nation's children was emphasized in a recent joint initiative released by first lady Michelle Obama, the surgeon general and the Department of Health and Human Services (US DHHS 2010). To help reach these goals, President Obama issued a memorandum on Feb. 9, 2010, calling for the establishment of a federal task force on childhood obesity (WHTF 2010).

In an Institute of Medicine (National Academy of Sciences) report, key stakeholders were urged to commit to childhood obesity prevention and to strive not only to develop innovative programs but to monitor the progress and evaluate the efficacy of new and existing obesity prevention policies and programs and work to disseminate promising practices for maximum impact (CPPCO 2007). The committee cited nutrition education and gardening as examples of promising, innovative practices to increase fruit and vegetable consumption through both Farm to School programs and school gardens. Other organizations, including the Centers for Disease Control and Prevention, encouraged creating a school environment that supports regular physical activity and healthy eating habits (Action for Healthy Kids 2008; CDC 1996, 2003).

Conceptual frameworks are key to the development, implementation and evaluation of successful health programs, as they can provide a system for linking and evaluating the multiple components that influence health behavior (Story et al. 2008). Effective, sustainable programs targeting obesity prevention for the individual are needed within the context of the socio-ecological model, which succinctly

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v067n01p30&fulltext=yes

DOI: 10.3733/ca.v067n01p30

describes the relationship of choices made by an individual to the other spheres of influence within the environment and society. These spheres of influence are multifaceted and include factors such as income, ethnicity and cultural values and settings such as schools and retail food establishments. Consequently, measurable progress in reducing childhood obesity requires a multifaceted approach: a coordinated, comprehensive program that integrates messages regarding nutrition, physical activity and health with a child's immediate environment and surrounding community (CPPCO 2007). Adequate access to healthy food and physical recreation opportunities is essential to promote sustained behavior changes (Briggs et al. 2010).

Schools and after-school programs provide a unique setting for this approach, as they provide access to children, parents, families, educators, administrators and community members (Economos et al. 2007). The purpose of this article is to examine garden-enhanced nutrition education and Farm to School programs. Further, a questionnaire was developed and distributed to UC Cooperative Extension (UCCE) advisors and directors to assess their role in garden-enhanced nutrition education and Farm to School programs. Results from this questionnaire highlight UCCE's integral role in this field.

Garden-enhanced education

School gardens were first implemented in the United States at the George Putnam School in Roxbury, Massachusetts, in 1890, and by 1918 there was at least one in every state (Kohlstedt 2008). During World Wars I and II, more than a million children were contributing to U.S. food production with victory gardens, which were part of the U.S. School Garden Army Program (Hayden-Smith 2006; Subramaniam 2002). More recently, incorporating gardens into the educational environment has become more popular worldwide, due partly to the appreciation of the importance of environmental awareness and integrated learning approaches to education (Kane and Hayden-Smith 2008).

As the agricultural powerhouse of the nation (California Economy 2011), California is poised to serve as a model for agriculture-enhanced nutrition and health education. Within California, the impetus to establish gardens in every school gained momentum in 1995, when then-State Superintendent of Public Instruction Delaine Eastin launched an initiative to establish school gardens as learning laboratories or outdoor classrooms (Hazzard et al. 2011). Assembly Bill (AB) 1535 created the California Instructional School Garden Program, allowing the California Department of Education to allocate $15 million for grants to promote, develop and sustain instructional school gardens. About 40% of California schools applied for these grants, and $10.9 million was awarded (Hazzard et al. 2012).

Providing children with options to make healthy choices rather than imposing restrictions has long-term positive effects on weight.

It has been repeatedly shown that garden-enhanced nutrition education has a positive effect on children's fruit and vegetable preferences and intakes (Graham et al. 2005; Morris et al. 2001). For example, after a 17-week standards-based, garden-enhanced nutrition education program, fourth-grade students preferred a greater variety of vegetables than did control students. The program included nine in-class nutrition lessons coordinated with garden activities. For example, students learned that plants and people need similar nutrients. Many of these improvements persisted and were maintained at a 6-month follow-up assessment (Morris and Zidenberg-Cherr 2002). In a similar study of a 12-week program combining nutrition lessons with horticulture, sixth-grade students likewise improved their vegetable preferences and consumption (McAleese and Rankin 2007). In addition, after a 13-week garden-enhanced nutrition program, middle school children ate a greater variety of vegetables than they had initially (Ratliffe et al. 2011).

While garden-enhanced nutrition education is one innovative method to improve children's vegetable preferences and intake, researchers and educators consistently call for multicomponent interventions to have the greatest impact on student health outcomes. Suggested additional components include classroom education, Farm to School programs, healthy foods available on campus, family involvement, school wellness policies

Researchers in the Shaping Healthy Choices Program have established cool-weather crops in this Northern California school garden. The program will be sustainable with existing infrastructure, addressing barriers such as time constraints, lack of funding and lack of teacher interest.

and community input (Briggs et al. 2010; Ozer 2007; Robinson-O'Brien et al. 2009). Moreover, the literature indicates that providing children with options to make healthy choices rather than imposing restrictions has long-term positive effects on weight (Gubbels et al. 2011). Taken together, it is reasonable to suggest that we are most likely to achieve long-lasting beneficial changes by coordinating a comprehensive garden-enhanced nutrition education program with school wellness policies, offering healthy foods on the school campus, fostering family and community partnerships and incorporating regional agriculture.

Farm to School programs

Farm to School programs connect K-12 schools and regional farms, serving healthy, local foods in school cafeterias or classrooms. General goals include improving student nutrition; providing agricultural, health and nutrition education opportunities; and supporting small and mid-sized local and regional farms (National Farm to School Network 2012). Born through a small group of pilot projects in California and Florida in the late 1990s, Farm to School is now offered in all 50 states, with more than 2,000 programs nationwide in 2010 (National Farm to School Network 2012). The dramatic increase in the number and visibility of Farm to School programs can likely be attributed to factors including heightened public awareness of childhood obesity, expanding access to local and regional foods in school meals, concerns about environmental and agricultural issues as well as the sustainability of the U.S. food system.

Farm to School programs provide a unique opportunity to address both nutritional quality and food system concerns. From a nutrition and public health standpoint, these programs improve the nutritional quality of meals served to a large and diverse population of children across the country. From a food systems and economic perspective, Farm to School programs connect small and mid-sized farms to the large, stable and reliable markets created by the National School Lunch Program (Allen and Guthman 2006). Farm to School programs require partnerships that include a state or community organization, a local farmer or agricultural organization, a school nutrition services director and parents. Historically, Farm to School programs are driven, supported and defined by a community. Because they reflect the diverse and unique communities they serve, individual Farm to School programs also vary from location to location, in addition to sharing the characteristics described above.

Rachel Miller Cox

A fourth-grade student in a Northern California school district participates in a vegetable preference taste-test survey, part of a project funded by the California Department of Food and Agriculture Speciality Crops program. Farm to School programs improve nutritional quality of meals served to children, and connect small and mid-sized farms to large, stable and reliable markets.

The first national Farm to School programs were initiated in 2000 and soon gained momentum in California, with support from the USDA Initiative for Future Agriculture and Food Systems as well as the W.K. Kellogg Foundation. In 2005, Senate Bill 281 established the California Fresh Start Program to encourage and support additional portions of fresh fruits and vegetables in the School Breakfast Program. This bill also provided the California Department of Education with $400,000 for competitive grants to facilitate developing the California Fresh Start Program (National Farm to School Network 2012). Concomitant with the growth of Farm to School programs, the National Farm to School Network was formed in 2007 with input from over 30 organizations and today engages food service, agricultural and community leaders in all 50 states. The evolution of this network has influenced school food procurement and nutrition/food education nationwide (Feenstra and Ohmart 2012).

Farm to School impact

Evaluations of Farm to School impact have been conducted since the program's inception. A 2008 review of 15 Farm to School evaluation studies, which were conducted between 2003 and 2007, showed that 11 specifically assessed Farm to School–related dietary behavior changes (Joshi et al. 2008). Of these 11 studies, 10 corroborated the hypothesis that increased exposure to fresh Farm to School produce results in positive dietary behavior changes. In addition, a 2004-2005 evaluation of plate waste at the Davis Joint Unified School District salad bar showed that 85% of students took produce from the salad bar and that 49% of all selected salad bar produce was consumed (Feenstra and Ohmart 2004, 2005). Additionally, school record data demonstrates that throughout the 5 years of the 2000-to-2005 Farm to School program, overall participation in the school lunch program ranged from a low of 23% of enrollment to a high of 41%, with an overall average of 32.4%. This compared to

26% participation before salad bars were introduced. Overall participation in the hot lunches averaged 27% of enrollment (Feenstra and Ohmart 2005).

While Farm to School evaluations generally indicate positive outcomes (Joshi and Azuma 2009; Joshi et al. 2008), conclusive statements regarding the overall impact of such programs on dietary behavior cannot be made. This can be attributed to the substantial variation in Farm to School structure from district to district, and variation in the study design and methodologies of early program evaluations. Methods for evaluating dietary impact outcomes most commonly include using National School Lunch Program participation rates and food production data as proxies for measuring consumption. Additional evaluation methods include using self-reported measures of consumption such as parent and student food recalls or frequency questionnaires, and direct measures of consumption such as school lunch tray photography and plate waste evaluation.

There are relatively few studies using an experimental design to evaluate the impact of Farm to School programs on fruit and vegetable intake, and even fewer of these studies use controls. Moreover, the Farm to School evaluation literature has no peer-reviewed dietary behavior studies using a randomized, controlled experimental design, which is undoubtedly due to the complex challenges inherent in community research. For example, schools may view the demands of research (such as allowing evaluations of program outcomes) as burdensome or may question the benefits of serving as control sites.

UC ANR's role

Due partly to its year-round growing season, California has more Farm to School programs than most, if not all, states. UC Davis pioneered some of the early uncontrolled studies quantifying Farm to School procurement, costs and consumption. UC ANR is now conducting new controlled studies to collect more rigorous data, which will differentiate outcomes of Farm to School programs from those due to other environmental factors.

To clarify the role(s) of UC ANR in garden-based nutrition education and Farm to School programs, a questionnaire was developed and administered through Survey Monkey in November 2011. This survey was sent to 60 UCCE academic personnel, including county directors; Nutrition, Family and Consumer Sciences (NFCS) advisors; 4-H Youth Development (4-HYD) advisors; and others. For the purposes of this questionnaire, Farm to School was broadly defined as a program that connects K-12 schools and local farms and has the objectives of serving healthy meals in school cafeterias; improving student nutrition; providing agriculture, health and nutrition education; and supporting local and regional farmers.

Survey. A cover letter describing the purpose of the survey and a link to the questionnaire was emailed to representatives (n = 60) from all UCCE counties. The questionnaire was composed of 26 items that were either categorical "yes/no/I'm not sure" questions or open-ended questions allowing for further explanation. An additional item was provided at the end of the questionnaire for comments. Respondents were instructed to return the survey within 11 days. A follow-up email was sent to all participants after 7 days. This protocol resulted in a 28% (n = 17) response rate, typical in a survey of this kind. Respondents represented 21 counties, with some representing more than one county; in addition, one was a representative from a campus-based unit of ANR. Questionnaire respondents included three county directors, six NFCS advisors, four 4-HYD advisors, one NFCS and 4-HYD advisor, and three other related UCCE academic personnel (an environmental horticulture advisor, a 4-H Healthy Living coordinator, and a strategic initiative leader). The responding counties were Riverside, San Mateo and San Francisco; San Bernardino, Stanislaus and Merced; Contra Costa, Yolo, Amador, Calaveras, El Dorado and Tuolumne; Mariposa, Butte, Tulare, Alameda, Shasta-Trinity, Santa Clara, Ventura and Los Angeles. (Grouped counties are served by a single UCCE office.)

Farm to School and school gardens. All 21 counties responding to the survey reported that they had provided a leadership role in school gardens, after-school gardens and/or Farm to School programs during the previous 5 years (2006–2011). Five out of 17 respondents reported that their counties provided a leadership role in Farm to School programs. Fourteen out of 17 respondents indicated that they individually played a leadership role in school garden programs, including serving as a key collaborator on a project, organizing and coordinating community partners, acting as school/agriculture stakeholders and/or serving as a principal investigator, coprincipal investigator

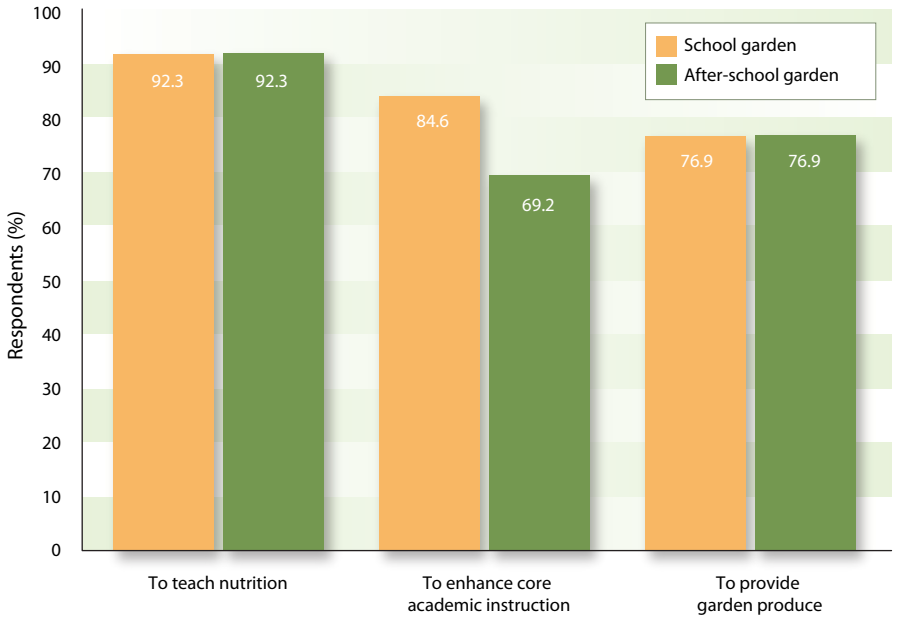

Fig. 1. Top three answers to a question on the purpose of school and after-school garden programs. Respondents (n = 13) first answered "yes" to the question: "Over the past 5 years, has your UCCE county program provided a leadership role in any pre-kindergarten to 12th grade school garden programs?"

or key collaborator on a research study. The most frequently reported reasons for having school and after-school gardens were to teach nutrition, enhance core academic instruction and provide garden produce (fig. 1). Additional reasons cited in the free responses included to study the psychological impacts of school gardens, enhance science and environmental education, teach composting, increase agricultural literacy, teach food origins, participate in service learning (which integrates community service with instruction and reflection) and provide a Gardening Journalism Academy.

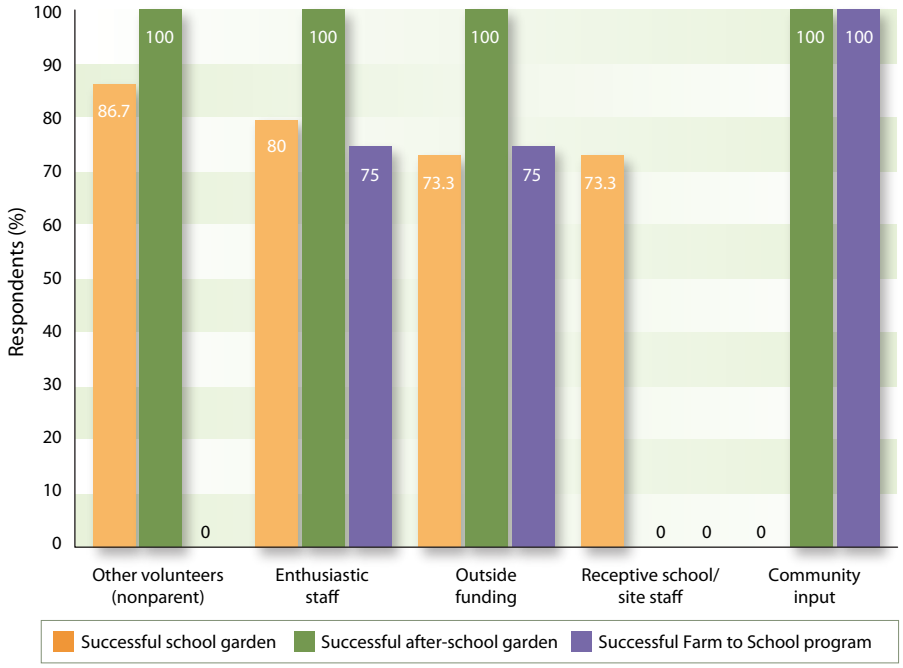

Fig. 2. Top answers to a question on the perceived factors contributing to successful school and after-school gardens and Farm to School programs. Respondents (*n* = 15) first answered "yes" to the question: "Over the past 5 years, has your UCCE county program provided a leadership role in any pre-kindergarten to 12th grade school garden programs?"

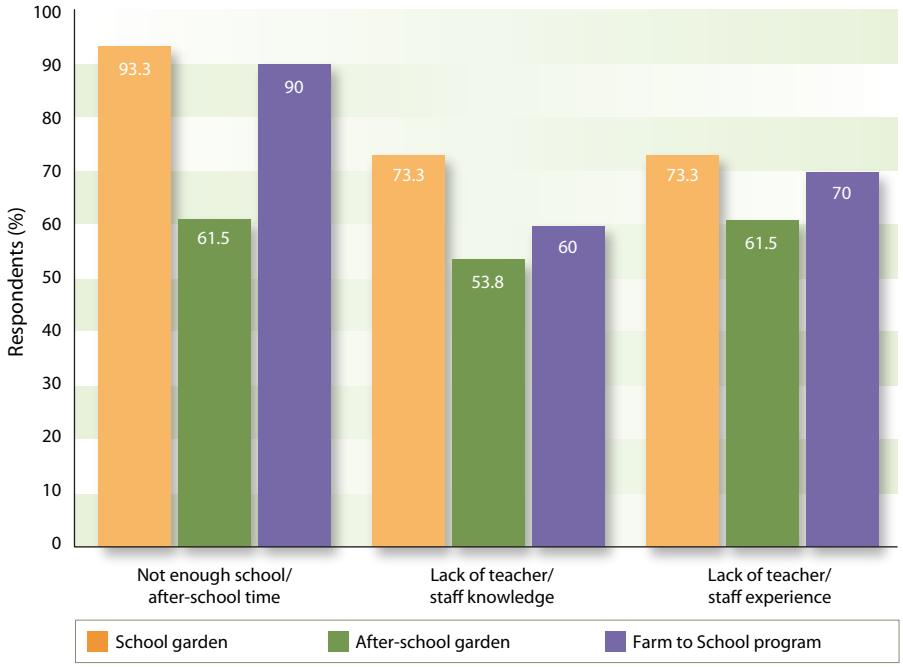

Fig. 3. Top three answers to a question on the perceived barriers to successful school and after-school gardens and Farm to School programs. Respondents (*n* = 15) first answered "yes" to the question: "Over the past 5 years, has your UCCE county program provided a leadership role in any pre-kindergarten to 12th grade school garden programs?"

Reasons for success. The factors most frequently cited as contributing to successful school and after-school garden and Farm to School programs were community and nonparent volunteers, outside funding and enthusiastic staff (fig. 2). The 17 respondents indicated that the success of these programs was also aided by the multidisciplinary efforts within UC ANR (Master Gardeners, Expanded Food and Nutrition Education Program, UC CalFresh, 4-H Youth and Development advisors, farm advisors), Farm Bureau, Fair Board and 4-H Teens as Teachers.

Barriers. The most common factors cited as barriers to school and after-school gardens and Farm to School programs were lack of time and lack of knowledge and experience among teachers and staff (fig. 3). Additional barriers included lack of staff, cutbacks, competing programs for youth (sports) and lack of after-school garden-related educational materials for mixed-age groups. With regard to the Farm to School programs, one respondent perceived increased expense to schools, absence of tools to link local farmers with schools, a lack of growers and a lack of appropriate facilities in school kitchens.

UC ANR internal program coordination. Additional information gathered from the questionnaire included a more in-depth description of UC ANR's internal programs and activities. Thirteen of the 17 respondents indicated that their counties have an active Master Gardener Program, and 10 indicated that their master gardeners work with school or after-school garden programs or Farm to School programs. This internal program coordination was cited as an important factor for implementing successful school and after-school garden programs and Farm to School programs. These results suggest that the multidisciplinary and highly collaborative UC Cooperative Extension network has the potential to provide an important framework for successful school gardens, after-school gardens and Farm to School programs.

Highlights from UCCE-evaluated programs are provided below.

Contra Costa County

A unique UCCE program in Contra Costa County brings many young school-aged children, especially those in grades 1 and 2, to an edible garden at the county fairgrounds. The site is also home to an agriculture museum. Approximately 1,700 students, 67 teachers and many parents visited the site during the 2010-2011 school year. Process evaluation, which documents and evaluates the development of a program from its inception, has demonstrated positive attitudes toward the program among teachers, and results support the concept that teachers value the emphasis on local agriculture in the education process. However, these evaluations lack control groups of children who did not visit the edible garden, making it difficult to draw authoritative conclusions about the program's success.

Contra Costa and Nevada counties

UCCE Contra Costa and Nevada counties collaborated to initiate the UC Sustainable Community Project, a federally funded Children, Youth and Families at Risk (CYFAR) Sustainable Community Project that will begin participant enrollment in February 2012. A key element of the project is place-based learning, including at least one field trip to a farm. Both counties are partnering with master gardeners, and all intervention sites have gardens. The program will use the 4-H Teens as Teachers model to deliver the majority of the education to the younger participants (in grades 2 to 5). The short-term goals of the program include improvement in youth knowledge about nutrition, gardening, agriculture, cooking and health; improvement in the ability to act on this knowledge; and improvement in physical fitness. The program leaders expect to provide participants with the skills to grow and cook their own food to support their personal health goals.

As this is a nationally funded project, evaluation tools have already been developed, and a research team at Arizona State University will analyze pre- and post-intervention data. An exciting aspect of this project is that it supports the recent Institute of Medicine (of the National Academy of Sciences) call for innovative techniques, integrating gardening and Farm to School programs with new technologies. For example, teens will use iPad 2 applications to identify and map safe routes to school and will share their findings by teaching children about walking and biking paths in their communities. Several education lessons will be delivered using accredited applications, and all data analysis will be collected with "clicker" technology, which uses wireless student response pads that allow instructors to instantly assess how well students understand the material presented.

Sheri Zidenberg-Cherr

Nutrition and food education in schools has increased nationwide. Partnerships have formed among school nutrition directors, farmers, community organizations and parent volunteers. *Above,* students at Madison Middle School, Oakland, CA, prepare a vegetable medley for the Harvest of the Month tasting and nutrition demonstration.

San Bernardino County

In San Bernardino County, a team consisting of UCCE staff (a 4-H Youth Development advisor, an environmental horticulture advisor and county master gardeners) and academic personnel from the Fielding Graduate University Department of Psychology used a multidisciplinary approach to evaluate the impact of school gardens on nutrition knowledge and psychological parameters including attention and mood. Students in first- and second-grade classrooms were assessed pre- and post-intervention for nutrition knowledge using the *Eating Healthy from Farm to Fork: Promoting School Wellness* assessment tool. Teachers were trained to deliver this curriculum in its entirety and to use the 4-H gardening curriculum *See Them Sprout.* In addition, students spent 30 minutes in the garden each Friday.

At the end of the 14-week semester, the post-test results showed a statistically significant increase in fresh fruit and vegetable knowledge. A unique aspect of this project was the attention given to the psychological impact of the school garden. Children worked in the garden for only one semester, allowing investigators to use a cross-over design to compare gardening and nongardening children both within and between groups. Assessments of mood and attention were conducted before and after the 30-minute garden session and before and after the matched control nongardening activity sessions each Friday over two semesters. The following semester, this procedure was repeated with the group assignments reversed. Assessments of self-efficacy and well-being were conducted with individual students, using longer measures at the beginning and end of each semester. Results of this study are pending analysis.

Sheri Zidenberg-Cherr

Northern California elementary students participate in a tasting and nutrition demonstration. Of 11 studies that specifically assessed Farm to School–related dietary behavior changes, 10 showed that increased exposure to fresh Farm to School produce led to positive dietary behavior changes.

Stanislaus and Merced counties

While randomized controlled interventions are needed, studies using an observational pre- and post-test design can still be highly informative, especially with respect to process evaluation. UCCE in Stanislaus and Merced counties has taken a leadership role in implementing Farm to School programs that reach over 3,000 children per year. Taste tests, teacher evaluations and teacher interviews were conducted to determine taste preferences and nutrition-related behavior changes in children participating in Farm to School programs. Results of these evaluations show high baseline vegetable preferences among participating children. This is likely the result of prior exposure to school garden and Farm to School programs, as these have been operational for several years. Given these high baseline preferences, no improvements in children's taste preferences were observed.

While the finding that children participating in Farm to School programs prefer fruits and vegetables is encouraging, the information we gain is limited, reinforcing the need for randomized control studies. Without controls, it is impossible to conclude that the program being evaluated actually resulted in the measured outcomes. With controls, however, researchers can sort out any outcomes that might have happened by chance or simply as a result of other factors in the environment. Similarly, with randomization, researchers can ascertain whether outcomes were the result of one study site being more determined to make changes.

The Shaping Healthy Choices Program (SHCP) uses a randomized controlled design to determine the outcomes of a multicomponent nutrition education program on student health–related outcomes. Findings will help ascertain the impact of a coordinated comprehensive nutrition education program on students' dietary behavior and health status.

Nutrition programs and obesity

While UCCE has implemented and partially evaluated Farm to School and garden-enhanced nutrition education programs, it is important to integrate these strengths into a research and education program that incorporates the constructs of the socio-ecological model. Consistent with this, the ANR Healthy Families and Communities strategic plan addresses childhood obesity prevention with a multidisciplinary approach that involves a statewide network of researchers and educators creating, developing and applying knowledge in agricultural, natural and human resources.

Funded by the ANR Competitive Grants Program, the research and extension project A Multi-Component, School-Based Approach to Supporting Regional Agriculture, Promoting Healthy Behaviors, and Reducing Childhood Obesity (now called the Shaping Healthy Choices Program) builds upon the multidisciplinary, comprehensive approach to investigate dietary and lifestyle habits with the greatest potential for sustainable childhood obesity prevention. This 4-year study will use the socio-ecological model to implement and measure the effectiveness of an integrated, school-based, multicomponent intervention. The long-term goal of the Shaping Healthy Choices Program is to prevent childhood obesity by improving students' diets and increasing physical activity. A collaborative research team will work with four schools in two counties to develop a systemwide, sustainable program to achieve the following objectives: (1) increase availability,

Sheri Zidenberg-Cherr

School gardens and nutrition education, launched together, produce significant improvements in students' vegetable preferences, and followup assessments suggest the results may be long-lasting. *Above,* students plant their gardens as part of a lesson.

consumption and enjoyment of fruits and vegetables, (2) improve dietary patterns and increase physical activity consistent with the 2010 U.S. Dietary Guidelines for Americans, (3) improve science-processing skills to sustain patterns learned and adopted through participating in the program, (4) promote positive changes in the school environment to support dietary and exercise patterns and student health and (5) facilitate the development of an infrastructure to sustain the program beyond the funding period. To document student outcomes and environmental changes resulting from this multicomponent, multidisciplinary approach to obesity prevention, a randomized, controlled, double-blind intervention will be implemented for one academic year through collaboration among faculty and staff from UC Davis, UC ANR, the Agricultural Sustainability Institute at UC Davis and the UC Davis Betty Irene Moore School of Nursing.

The factors contributing to obesity are numerous and interrelated. Meeting the complex challenges of obesity prevention will require extensive and diverse collaboration with shared responsibility and common goals. The study will explore and document the effectiveness of an interdisciplinary team in developing comprehensive nutrition and lifestyle education programs that can be delivered throughout the state. In the future, these teams will include UC faculty; UCCE nutrition and youth development specialists and advisors, and Agricultural Sustainability Institute staff; food and agriculture industry representatives; public school educators, administrators, afterschool providers and families; community members; health practitioners; farmers; and state/county agency nutrition, food science, agriculture and health-care representatives — all developing coordinated programs that can be delivered throughout the state.

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Positive youth development merits state investment

by David Campbell, Kali Trzesniewski, Keith C. Nathaniel, Richard P. Enfield *and* Nancy Erbstein

In the last three decades, positive youth development has emerged as the new paradigm for youth-related research and programming. The literature provides strong evidence that high-quality youth programs can have positive and significant effects. Positive youth development is strongly associated with three outcomes of particular public significance: improved school achievement and graduation rates, decreased incidence of risk behaviors and increased sense of personal efficacy and empathy. A strong economic case could be built for increasing public investment in positive youth development programs. What is needed now is more and better data, and measurable goals at the state level.

Gema Miller

Researchers increasingly view young people as community assets to be nurtured, rather than focusing on high-risk youth behaviors and interventions after the fact. *Above*, 4-H state ambassadors at Point Bonita orientation build their competence and connection skills through group problem solving.

Research over the last 30 years has borne out the value of positive youth development (PYD), resulting in a major shift in youth development research (Lerner and Benson 2003). Before this shift, researchers, scholars and practitioners developed youth-serving programs and institutions mainly on a deficit model: They considered high-risk youth behaviors and problems to be the focus of their work (Lerner et al. 2011). Youth were problems to be managed, and this mind-set generated strategies oriented toward intervening after the fact rather than prevention. In today's research environment, however, youth are increasingly considered community assets to be developed and nurtured (Damon 2004; Irby et al. 2001).

Research suggests that far too many California youth are not thriving. Approximately one out of six 16- to 24-year-olds in California is out of school and out of work (Benner et al. 2010; Lamming et al. 2006; Sum 2003). Each year, about 100,000 California youth reach graduating age but do not graduate from high school (Taylor and Rumberger 2010). These youth have a higher unemployment rate, lower lifetime earnings and a greater likelihood to be the target of public expenditures for health, welfare and criminal justice services (London and Erbstein 2011). Promotion of healthy pathways to college, work and community engagement is of urgent concern, not only for the youth and their immediate families and communities but for California as it seeks to replace an aging workforce, sustain a vibrant democracy and remain competitive in the global economy.

What is positive youth development?

Drawing on the work of Hamilton (1999), Lerner et al. (2011) describe a three-part conception of PYD as a developmental process, a philosophy or approach to youth programming, and situations in which youth programs and youth-serving organizations foster the healthy development of youth. Here we identify the characteristics held in common by positive youth development programs that are effective in helping youth develop competence in many areas of life, including social connections (i.e., access to people, institutions and networks), personal character, confidence and the ability to care and to contribute to society (Gomez and Ang 2007). Although they are critically important, strategies to support these programs via systems change within schools, juvenile justice, healthcare and social welfare institutions are beyond the scope of this review (Pittman 1991, 2000).

Guiding frameworks and principles

Scholars have used a number of research-derived youth development frameworks to describe the needs of youth and guide the development of PYD programs. As summarized by Heck and Subramaniam (2009), these frameworks include the assets model of the Search Institute (Benson et al. 2006; Oman et al. 2002; Theokas et al. 2005), the four essential elements framework promoted by the national and state 4-H Youth Development Program (Kress 2003;

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v067n01p38&fulltext=yes

DOI: 10.3733/ca.v067n01p38

Peterson et al. 2001), the five (sometimes six) C's of positive youth development (Lerner 1995; Lerner et al. 2000; Pittman et al. 2000; Roth and Brooks-Gunn 2003) and the Thrive framework (Heck et al. 2010; Thrive Foundation for Youth 2010). While these frameworks have some notable differences, both in their terminology and in the extensiveness of their lists of critical youth competencies, they have much in common. Heck and Subramaniam (2009, 21) identify six key developmental competencies common to them all.

Mastery and competence. All of the PYD frameworks emphasize skill building, with a shared focus on skills for learning and academic success and skills relevant to crafts, arts, sports, work, management of emotions, and building and sustaining relationships. Through success in developing personal skills, youth increase their confidence and establish a foundation for developing other competencies. For example, the 35 life skills promoted in 4-H programs have been used to develop successful initiatives and as a framework for evaluations of other youth programs (Heck and Subramaniam 2009; Hendricks 1996). Taylor-Powell and Calvert (2006) found that the 4-H Arts and Communication program in Wisconsin improved participating youth's general sense of competence.

Independence and confidence. Youth need to be able to differentiate themselves from others, and they need the confidence to exercise that independence in a variety of settings and situations, including those that are complex or difficult. Confidence indicates self-esteem and positive identity (Roth and Brooks-Gunn 2003) as well as resiliency (Benard 1991, 1993, 2004). Benard (1993, 44) notes that resilient youth have "the ability to bounce back successfully despite exposure to severe risks." Her research links this capacity to certain attributes that allow youth to overcome adversity and stress. These attributes include social competence, problem-solving skills, autonomy and a sense of purpose and future. Resilient children tend to be good learners and good problem solvers (Masten et al. 1990).

Generosity, caring and compassion. The PYD frameworks stress the need to nurture character and a strong sense of personal values, which lead to empathy and caring for others. The frameworks recognize that individual development cannot be divorced from the relationships, social contexts and public settings in which young people find themselves. In a survey of 6,000 youth, grades 6 through 12, Scales et al. (2000) found "helping others" to be strongly related to the presence of developmental assets as identified in the Search Institute framework, particularly time spent in one's religious community and time spent in youth programs. Phelps et al. (2009) validated caring (defined as feeling sorry for the sadness of others) as a key developmental asset.

Initiative and purpose. Healthy youth have an increased capacity to initiate work and to act on the world. They can sustain self-motivation as they direct their attention and action toward achievement of a challenging goal (Larson 2000, 170). With a sense of purpose, youth are possessed of a deep reason, a sense of inspiration or meaning that motivates them to learn and achieve. Research shows that youth with a sense of purpose have more-positive developmental outcomes (Damon 2004). One source of purpose can be spiritual growth. Shaped both within and outside of religious traditions, spiritual growth is often an important driver in the search for meaning in life (Benson et al. 2003). Another source of purpose highlighted by researchers and practitioners of social justice youth development is the desire to improve conditions for one's family and community (Ginwright and James 2002).

Involvement and contribution. Youth need meaningful ways to contribute within their home, school, organizations and civic institutions. Surveys of youth participating in PYD programs characterize their ability to contribute as highly significant (Alberts et al. 2006). As Campbell and Erbstein (2012) note:

> . . . engagement can deepen civic commitment, extend social capital, create meaningful relationships with adults, foster self-esteem and identity development, and build a sense of self and collective efficacy (Hughes and Curnan 2000; Irby et al. 2001; Gambone et al. 2006).

Ginwright and Cammarota (2007, 694) highlight the transformative power of a "critical civic praxis," a strategy for putting social theory into practice. It can give our most marginalized youth populations access to the networks, ideas and experiences that build individual and collective capacity to foster equitable opportunities and outcomes.

Ian Patterson

Through animal science projects, 4-H members gain a greater sense of purpose, which leads to improved contributions to their communities. *Above,* a 4-H member at a spring exposition, San Mateo County fairgrounds.

Belonging and connections. All of the frameworks discussed here point to the importance of positive, supportive relationships with peers and adults, whether family members, teachers, mentors or other adults. Supportive relationships help create a sense of appropriate boundaries and expectations while enhancing feelings of personal safety and development of a positive identity. Programs and activities that support social skill acquisition and relationship building can result in improvements in both academic achievement and self-perception (Durlak et al. 2007).

Hensley et al. (2007) found that with increased involvement in 4-H, a youth's sense of belonging increased. As Russell and Van Campen (2011) argue, many mainstream youth programs such as the Boy Scouts and YMCA do a much better job of providing connections for middle-class youth, traditional families and dominant cultural groups than they do in reaching more marginal populations such as immigrant youth, young people growing up in low-income households or lesbian, gay, bisexual or transgender (LGBT) youth.

One strategy to increase belonging and connection for a greater diversity of young people is to build upon ethnic and cultural networks, youth culture and knowledge within communities (Burciaga and Erbstein 2010; Yosso 2005). For example, drawing on the Chicana/Chicano tradition of community art workshops (Jackson 2009), the Department of Chicana/o Studies at UC Davis has collaborated with the Yolo County Housing Authority to launch Taller Arte del Nuevo Amanecer (TANA). This studio engages youth living in nearby subsidized housing and beyond, documenting their experience and hopes through silk-screen printing and mural painting, providing access to new skills and a safe space for community building. (See http://ucdavismagazine.ucdavis.edu/issues/su10/drawing_on_culture.html.)

Ian Patterson

After-school programs that promote personal and social skills result in improved test scores and grades — even more than programs focusing on academics alone. 4-H helps young people discover the things that give them joy, energy and passion for making the world a better place.


Ian Patterson

As 4-H members become more competent and confident working with their animals, they are introduced to basic practices in veterinary medicine.

PYD program results

There are many types of youth-serving entities that offer PYD programs, including government agencies, universities and schools, nonprofit organizations, faith-related institutions and ethnic networks. Backed with public funding and operating through the auspices of land-grant universities, the 4-H Youth Development Program is among the most long-standing of them. It creates a safe environment where adults and youth can work together on meaningful, inquiry-based learning. Another example is the nonprofit Boys and Girls Clubs of America, which solicits grants and donations to further its mission of providing a safe place for youth to learn, grow and experience ongoing relationships with caring adult professionals.

Thousands of churches and faith-related nonprofits across the nation offer youth programs such as tutoring, spiritual exploration, camping, crafts, career exploration and community service. Still other programs engage youth in exploring and celebrating their cultural identity or defining community challenges and getting organized to create meaningful community change (Campbell and Erbstein 2012).

Study approach. Our first question was whether these PYD programs result in positive outcomes for youth. For this analysis, we reviewed a wide variety of peer-reviewed publications from the past two decades that used formal evaluation data to track the effects of PYD programs. Within this growing body of literature, we paid particular attention to metareviews that synthesized the findings of previous studies and to individual longitudinal studies with large sample sizes.

Because this article aims to provide a concise literature review that identifies promising policy and program directions, we will not provide a detailed accounting of the methodological strengths and limits of individual studies. However, several general caveats regarding the literature should be noted. While many studies provide evidence of a relationship between PYD programs and beneficial youth outcomes, this relationship is not present in all cases. When such effects are found, they range widely in magnitude across different studies. The relationships discussed are stronger in high-quality

programs. (We discuss what constitutes a high-quality program below.)

Overall, the findings tend to reflect correlational rather than causal relationships. Many studies do not control for self-selection into programs or exposure to PYD support in families and communities, and that makes it difficult to distinguish the outcomes that flow from informal efforts by parents, peers and communities from outcomes that can be created in structured youth programs. Also, many PYD programs have not been formally evaluated, and existing evaluations often have not disaggregated youth experience by demographic, cultural and geographic characteristics to assess whether the outcomes are consistent across different populations and places.

Despite these caveats, there is strong evidence that high-quality youth programs can have positive and significant effects. Support for PYD in a young person's life is positively associated with three outcomes of particular public significance:

- Improved school achievement and graduation rates.
- Decreased incidence of risk behaviors.
- Increased sense of personal efficacy and empathy.

Improved school achievement, graduation. Research shows a strong correlation between involvement in PYD programs and improved academic achievement (Gomez and Ang 2007; Guest and Sneider 2003). Indeed, Meltzer et al. (2006) found that the length of time spent in PYD programs during childhood and adolescence predicted positive outcomes during adulthood, including increased high school graduation rates and improved college attendance.

A qualitative review of 161 PYD programs found that school achievement and attachment were improved among participants (Catalano et al. 2004). Also, strong evidence from a recent meta-analysis of studies that employed experimental designs indicates that participation in after-school programs that promote personal and social skills has resulted in increased achievement test scores, grades, school attendance and school bonding, when compared to control conditions (Durlak et al. 2010). Impressively, the overall increase in achievement gained by participating in these social-emotional learning programs was larger than is typically found for programs that focus only on academics.

Decreased incidence of risk behaviors. Many researchers have found correlations between PYD and the prevention of self-destructive behaviors (Beets et al. 2009; Benson 1997; Benson and Pittman 2001; Benson and Scales 2009; Benson et al. 1998; Benson et al. 2006; Catalano et al. 2004; Goldschmidt et al. 2007; Hawkins et al. 2009; Oman et al. 2002; Tebes et al. 2007; Weissberg and Utne O'Brien 2004). A formal meta-analysis of rigorous evaluations found that after-school programs promoting personal and social skills were effective in reducing problem behaviors and drug use (Durlak et al. 2010). Other research has linked PYD to a reduction in potentially dangerous sexual activity, including early or frequent sexual intercourse, multiple sexual partners, not using birth control and failing to protect against sexually transmitted diseases (Catalano et al. 2004; Gavin et al. 2009; Gloppen et al. 2010; Sieving et al. 2011; Weissberg and Utne O'Brien 2004).

Increased efficacy and empathy. Multiple studies have found that PYD programs promote positive personal traits and relationships, built on both self-assertive and self-regulative efficacy and empathy (Anderson et al. 2007; Catalano et al. 2004; Roth and Brooks-Gunn 2003). Higher levels of key PYD indicators predict greater contributions to family and community (Lerner et al. 2008). And meta-analytic findings show that after-school programs promoting personal and social skills improved self-esteem and self-efficacy and increased positive interactions with others (Durlak et al. 2010).

High-quality programs

The achievement of these outcomes across a wide range of programmatic settings is indicative of the payoffs the public might expect from high-quality PYD programs. However, the degree to which these outcomes may be evident in any given program or community setting appears to depend on program quality. To bring about the desired outcomes for youth, a program must embody specific key characteristics.

Characteristics. The most exhaustive review of the literature on this topic remains the National Research Council's report of the Committee on Community-Level Programs for Youth (NRC/IOM 2002). The authors identified eight characteristics of positive developmental settings (see pp. 9–10 of report): physical and psychological safety, appropriate structure, supportive relationships, opportunities to belong, positive social norms,

Scientific inquiry is a primary educational practice in 4-H, which builds youth competence and love of learning. *Above,* participants in a National Youth Science Day activity at San Mateo County's 4-H World of Water workshop.

support for efficacy and mattering, opportunities for skill building, and integration of family, school and community efforts. The study notes that these features work in synergistic ways, such that "programs with more features are likely to provide better supports for young people's positive development" (2002, 8).

In their meta-analysis, Durlak et al. (2010) categorized successful interventions as following sequential, active, focused and explicit (SAFE) practices that are structured and youth focused. These practices include sequential activities linked over several days rather than unstructured, drop-in opportunities; active involvement of youth rather than passive reception of messages from adults; focus on personal or social skills (achieved by setting aside time and elements of the program to work on those skills) and explicit identification of skills youth are expected to develop. Durlak et al. found that programs that included SAFE practices had stronger outcomes than programs that did not. In fact, all of the outcomes (personal, behavioral and academic) were significantly improved for SAFE programs, and none of the outcomes were significantly improved for non-SAFE programs.

Drawing on more than a dozen after-school program evaluations, Huang and Dietel (2011) and colleagues at the UCLA Center for Research on Evaluation, Standards, and Student Testing developed a model that posits five key components of effective after-school programs: clear and rigorous goals, experienced leadership that sets high expectations, staff with longevity at the site, programs that align with school goals and evaluation that uses both formative and summative methods. (Formative assessment assists the leader in forming lessons based on the progress of student understanding, while summative assessment comes at the end and summarizes what the student has learned.)

Mary Meyer

At a National Youth Science Day at San Mateo County's 4-H World of Water workshop, members improve their competence in understanding science. 4-H programming helps address the critical need for more scientists and engineers in the workforce.

Recent years have seen a proliferation of program quality assessment tools, which provide one way to summarize key research findings and provide guidance on program design and management. A review of these tools by the Forum on Youth Investment finds that there is a common core of concerns: relationships, environment, engagement, social norms, skill-building opportunities and routines and structures (Yohalem et al. 2009). Some tools also look in more detail at participation, management, staffing and community linkages as important variables.

Researchers at the Weikart Center for Youth Program Quality focus their efforts on improving instructional practices at the point of service by means of a structured approach to assessment. Their research (Smith et al. 2012) identifies four important domains of quality practice:

- Safety (physical and emotional).
- Support (welcoming setting, conflict resolution, active learning, skill building, etc.).
- Interaction (peer group interaction and community building).
- Engagement (higher-order choice, planning and reflection).

Limits in current research. As Heck and Subramaniam (2009) conclude, relatively little literature addresses how race, class, ethnicity or other demographic characteristics impact the ability of youth development programs to achieve positive outcomes. We add to this list the lack of attention to the ways in which place or regional geography matters. Universal frameworks are useful, but they have a tendency to downplay or ignore the need to tailor youth programs to particular situations or populations. As Campbell and Erbstein (2012) note:

> An important segment of the literature argues against universal, one-size-fits-all approaches and in favor of tailoring initiatives to the circumstances of particular disadvantaged, and typically underrepresented, youth populations and communities.

Emerging research (Russell and Van Campen 2011) seeks to identify qualities held in common by programs that effectively serve populations marginalized on the basis of race or ethnicity, socioeconomic status, immigration status, language background or sexual orientation. Some research suggests particular efficacy for community engagement strategies that explicitly help youth identify and act upon the root causes of challenging community conditions (Erbstein 2010; Ginwright et al. 2006). These are seen in programs that connect young people with what Ricardo Stanton-Salazar (2011) describes as empowerment agents and

programs that attend to cultural and organizational factors that might be limiting the participation of underrepresented populations (Erbstein 2010; Romero et al. 2010; Russell and Van Campen 2011).

An example of a project that addresses the circumstances of disadvantaged youth is an effort funded by UC Agriculture and Natural Resources (ANR) to extend indices of youth well-being and vulnerability in California (see sidebar below). The aim is to produce accurate, compelling and actionable data at the community scale, by targeting resources to neighborhoods or subpopulations that have a particular need for support.

Costs and benefits

We also need better data to assess the costs and benefits of investing in PYD programs. The available data suggests that the economic rationale is potentially strong, but more supporting evidence is needed. Some progress is being made in developing this data. One strand of research documents the costs of running high-quality youth programs (Grossman et al. 2009), so that policymakers can estimate the scope of investment required. Another strand estimates the costs to society of failure to make sufficient youth investments.

Using estimates developed by Belfield and Levin (2007a, 2007b), researchers at UC Davis calculated that the approximately 9,000 students in the nine-county Sacramento capitol region who leave high school without graduating each year represent a combined loss of nearly $215 million in wages and purchasing power, while adding $480 million to state and local tax burdens for services and more than $1 billion to the federal budget for services (Benner et al. 2010; London and Erbstein 2011). Likewise, teen births are not only associated with a higher likelihood of becoming a high school dropout, they also directly impact public expenditures: "In the United States, the annual cost of teen pregnancies from lost tax revenues, public assistance, child health care, foster care, and involvement with the criminal justice system was estimated to be $9.1 billion in 2004" (Geraghty 2010).

Substance abuse rates also impact public expenditures both directly and by reducing graduation rates. Currently, California faces a crisis, with more youth and adults in need of substance abuse treatment than there are available facilities (Geraghty 2010, 45–46). PYD programs hold promise in reducing the demand for treatment services, reducing societal costs.

State policy: Two action steps

While more and better data is needed, the work to date suggests that if PYD programs and strategies were to take deeper root and every young person had access to high-quality opportunities, many economic and social benefits could accrue to society. The research we have reviewed suggests two important foundational action steps toward building a state policy infrastructure that promotes youth development.

Data gathering. First, we need to build a data-gathering infrastructure to ensure that state policy-making is well informed. For example, we need to strengthen local administration of the California Healthy Kids Survey (CHKS), the only routinely collected source of data about youth development in California. The move to a statewide sampling strategy has eliminated capacity to generate localized assessments of youth well-being and access to support. Conversely, protecting and further developing CHKS, and linking it to broader individual tracking of student data, would enable even more robust analyses. The state might also invest in Youth Impact Assessments (a way of tracking the impact of various policies on youth outcomes), perhaps as part of broader Health Impact Assessments, which many communities are beginning to conduct as part of a community vitality strategy (Schmidt and Coffey 2010).

We need to build a data-gathering infrastructure to ensure that state policy-making is well informed.

A key part of the data-gathering infrastructure is evaluation capacity building, to ensure that state investments are targeted to high-quality programs and services. California is promoting youth development in school, after-school and nonschool settings through a variety of current or pending state programs:

Putting youth on the map

Californians want — and need — the state's youth to thrive, not merely survive or face fewer problems. But how to tell whether our young people are doing well? To answer this question the Center for Regional Change and UC Cooperative Extension are partnering to create and disseminate a Youth Well-Being Index.

The index provides scores ranging from 0% to 100% for study areas across the state that are defined by the boundaries of California school districts. The scores take into account measures of teenagers' physical and emotional health, educational outcomes, social relationships and community contexts. The composite scores and associated data are reported in a series of color-coded maps.

Another measure, the Youth Vulnerability Index (with associated maps), identifies places where young people might suffer from a lack of support for their well-being. This index measures the relative rates at which youth in each California census tract experience conditions that are associated with inadequate support: school dropout/push-out rates, foster care referral, teen pregnancy and very low household income.

Indices, maps, downloadable data and links to other relevant data sources are available online at www.pyom.ucdavis.edu.

The website features a recorded webinar that gives an overview of the analysis behind the indices, information on navigating the site and ideas about how to use these resources.

4-H Thrive in California

4-H Thrive is a research-based PYD program developed in partnership with the Thrive Foundation for Youth of Menlo Park, California. The program helps youth

- Understand their spark, their inner source of motivation.
- Adopt a mind-set that is oriented toward learning and growth.
- Effectively set goals and work systematically toward their achievement.
- Practice self-reflection on personal growth and learning.

Researchers are conducting an extensive, rigorous evaluation of Thrive's effectiveness during the program rollout. To date, they have developed educational materials for a Leadership Project, which is provided free to participating junior and teen leaders. Master trainers (a statewide team of 209 specially trained youth and adults) are working in their communities, training local volunteers in how to teach youth the skills that will help them to thrive. Pilot evaluation data have been gathered from 4-H youth statewide through the new 4-H Online Record Book, as well as from master trainers and other volunteers. In addition, four counties will participate in a more in-depth evaluation.

Future research and extension activities will include the development of introductory leadership projects for primary members and pre-teen members, development of educational materials for the introductory leadership projects, and a randomized, controlled trial of 4-H Thrive in six counties.

Research update: Youth, social capital and vibrant communities

Research on improvement of positive outcomes for young people typically focuses on the impact of one program. Comparatively few researchers have looked at the reciprocal relationship between support for young people and creation of vibrant, prosperous communities. A UC ANR team led by Richard Enfield and Keith Nathaniel is investigating whether the creation of social capital within a 4-H program also creates social capital within the larger community, and, if so, how that happens.

The research builds on an ongoing multistate project in which 4-H members use the community capitals (e.g., natural capital, fiscal capital, human capital) framework (Emery and Flora 2006; Emery et al. 2006) to map the local impact of their work. Data collected from diverse communities in 10 states led to some initial findings on characteristics of 4-H Youth Development Program experiences that link social capital development to civic engagement for youth. For example, researchers found that when you engage 4-H youth in activities that are important to non–4-H adults and to other community organizations, community members change their perception of the youth and are more ready to engage with them in civic activities.

The new research intends to revise and test key questions related to a young person's sense of agency within his or her community. The hypothesis postulates that community-oriented 4-H programs create more social capital, both for participants and for the community overall. This in turn may create additional capacity for youth and community betterment programs. The study hopes to identify how 4-H program practices and structures contribute to networking and the development of social capital. Results will be shared to inform youth development staff and volunteers as well as other researchers.

- State-funded after-school programs under Proposition 49 (The After School Education and Safety Program Act of 2002).
- The California Department of Education's Education and Safety Program.
- California Friday Night Live Partnership programs of the California Department of Public Health.
- Violence and gang prevention programs.
- Bullying prevention programs.
- School climate and safety programs.

Rigorous program evaluations are needed to determine the effectiveness of these programs. UC ANR, for example, is evaluating the implementation of 4-H Thrive in after-school settings to gain new data on the program's efficacy and develop ways to strengthen it (see sidebar at left).

The list of intended outcomes that have been the focus of evaluations should be expanded. Education and risk behavior, which have been the primary concerns, have clear economic and policy implications, but other outcomes such as civic engagement and social capital are also pivotal in youth, community and broader U.S. societal well-being. As noted by Campbell and Erbstein (2012), "Young people are a powerful — if often untapped — resource in promoting community change that benefits children, youth and families."

Putnam's (2000) national survey found that states with high social capital — that is, where residents trust one another and join organizations and socialize with friends, and so on — are states where children are more likely to thrive. More research is needed to document the impact of these outcomes on individuals and society and to show how they can be improved through PYD programs. One such study, by UC ANR, is seeking evidence that investments in high-quality positive youth development programs might create higher levels of community social capital (see sidebar at lower left) (Emery and Flora 2006; Emery et al. 2006; Enfield and Owens 2009).

Measurable goals. Once a data-gathering infrastructure is in place, the state can begin to set measurable goals for youth outcomes, the second necessary action

step. A national study estimates that only 9% of youth are currently receiving a high level of support for acquiring key developmental capacities, suggesting significant room for improvement in both the scope and quality of youth programming (Scales et al. 2011, 272). National data also shows that approximately 68% of youth are in some youth development program or youth activity, but only 35% of these programs and activities have high-quality features linked to the most positive outcomes (Scales et al. 2011, 274). It might be particularly useful to increase the overall percentage of youth who are constructively engaged as active participants in their own learning, both in and outside of school and ensure equitable outcomes across subpopulations and places.

In developing a state policy framework and particular policies, it will be useful to draw on the work of organizations such as the Forum for Youth Investment, which promotes information sharing among states and localities across the nation. While it hasn't been the focus of this article, their work and that of many other researchers suggests the need to look carefully at how our youth-serving institutions (schools, probation departments, hospitals and health-care providers, parks and recreation programs, social welfare, public housing, etc.) can align practices with PYD research, and how community and regional planning can facilitate all young people's access to developmentally supportive environments. Similar findings emerged in a Sacramento-region analysis of the relationship between youth well-being and regional vitality and sustainability (London and Erbstein 2011).

Looking forward

As we face the next two decades of transformational change, nurturing the healthy development of youth is critical to the future of the state and nation. Drawing from previously published peer-reviewed empirical research and literature reviews, our research points to two foundational steps needed to build state policies and infrastructure that promote youth development: improvement of data systems and setting broad youth policy goals at the state level. The need for positive pathways to adulthood is immediate and urgent, and critical to our future prosperity and democracy. As it has for the past century, UC Cooperative Extension's county-based 4-H Youth Development Program will continue to address this challenge by implementing programs at the cutting edge of youth development knowledge and practice.

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The authors would like to acknowledge the research assistance of Ramona Carlos, Katherine Heck and Aarti Subramaniam, on whose collective work we have drawn extensively.

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More effective professional development can help 4-H volunteers address need for youth scientific literacy

by Martin H. Smith *and* Lynn Schmitt-McQuitty

Nonformal education programs like 4-H can help address the need to improve scientific literacy among K-12 youth in the United States. To accomplish this, however, it is imperative that adult volunteers who serve as 4-H science educators engage in effective professional development. Currently, most 4-H volunteers who lead science projects and activities with youth participate in professional development opportunities involving episodic workshops that are considered largely ineffective with regard to fostering meaningful change in educators' knowledge and skills. In contrast, professional development models that involve communities of practice (CoPs), whereby groups of educators work toward shared learning goals through authentic work, have been shown to be effective. Professional development models that utilize CoPs represent potential strategies to help meet the professional development needs of 4-H volunteers who implement science programming with youth. Further investigation of these models within the context of 4-H science is recommended.

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4-H programs emphasize hands-on inquiry and experiential learning, approaches known to be effective in increasing scientific literacy. Kitchen science activities provide opportunities to explore science in everyday life, as shown by these kids at the Sacramento County 4-H Day Camp.

Most aspects of life in twenty-first-century society are impacted by science, and many political and economic decisions require that sound choices be made by a population that is scientifically literate (Miller 2006). Citizens of the United States need a fundamental understanding of scientific concepts and theories as well as the capacity to use scientific thinking to address important national and global challenges (Miller 2006). The way to accomplish this is through deliberate education efforts (Lappan 2000).

Project 2061, launched in 1985 by the American Association for the Advancement of Science (AAAS), targeted the need for improved scientific literacy by establishing it as a goal for all school-aged children (AAAS 1990) and specifying the most important knowledge and skills necessary for elementary, middle and high school students in its landmark publication *Benchmarks for Science Literacy* (AAAS 1993). Subsequently, the National Science Education Standards (National Research Council 1996) and state frameworks such as the California Science Content Standards for Public Schools (California State Board of Education 1998) were developed to help guide instructional content and pedagogical processes.

Despite state and national benchmarks and standards, however, assessments have shown poor science achievement among K-12 youth in the United States for many years (Grigg et al. 2006; NCES 2011). Additionally, results from international tests in science have revealed that U.S. students lag behind grade-level peers from other countries, which has prompted concerns about the future of the nation's economy and national security (National Research Council 2007). Furthermore, the low level of youth scientific literacy in California is particularly disconcerting. As a whole, California students scored below national averages on recent achievement tests (Grigg et al. 2006; NCES 2011). More specifically, males outperformed females, African Americans and Latinos performed significantly more poorly than whites and Asian Americans, and high-income youth outperformed low-income youth, even though high-income youth as a group did not meet targeted national proficiency levels (Grigg et al. 2006; NCES 2011). Building a foundation in science through public school instruction has not been a priority in recent years in California (Bland et al. 2011; Smith and Trexler 2006), and this has weakened the delivery of science education in the state's classrooms.

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v067n01p47&fulltext=yes
DOI: 10.3733/ca.v067n01p47

Scientific literacy and 4-H

Although focusing on improvements in school-based instruction is one strategy to address the low levels of academic achievement in science among U.S. youth (Smith and Trexler 2006), education programs that occur during out-of-school hours are receiving increasingly more recognition as viable options for sparking youths' interest in science, improving scientific literacy and reinforcing classroom learning by helping to expand curriculum offerings and complement formal instruction (Kahler and Valentine 2011; Mørch and du Bois-Reymond 2006). Falk and Dierking (2010) maintain that most science is learned outside the school setting and emphasize the importance of these educational experiences in developing scientific literacy. Additionally, recent work by Bell et al. (2009) calls attention to the role and value of community-based programs in providing science education experiences. Furthermore, Sullenger (2006) offers that out-of-school science education may be more effective in improving scientific literacy than science courses taught in schools.

The 4-H Youth Development Program, administered by land-grant universities in all 50 states, provides learning opportunities for young people aged 5 to 19 during out-of-school hours. The origins of 4-H can be traced to Boys and Girls Agricultural Clubs, which appeared in different parts of the country around the turn of the twentieth century (Enfield 2001). Youth participating in these early 4-H clubs gained real-world education related to agriculture through hands-on learning experiences (Enfield 2001). Today, 4-H is considered to be one of the largest youth organizations in the world (USDA 2010).

Nearly 50% of all 4-H members participate in hands-on science experiences through county, state and national 4-H programs, projects and activities (USDA 2010). Although 4-H continues to provide educational opportunities for youth in the agricultural sciences, the scope of its curriculum offerings has been expanded to include a wide selection of program options in the biological, environmental, engineering and technological sciences. By providing science education programming in more content areas, 4-H is able to reach a broader audience and address the needs and interests of youth from urban and suburban populations, as well as expand curriculum offerings to youth enrolled in after-school programs, summer camps and other shorter-term learning opportunities.

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In 2007, National 4-H launched the 4-H Science Mission Mandate as its official response to the low levels of scientific literacy and workforce preparedness among youth in the United States (Garrett and Locklear 2007). Congruent with program priorities outlined by the National 4-H Science Mission Mandate, the California 4-H Youth Development Program developed the statewide 4-H Science, Engineering, and Technology (SET) Initiative in 2008 (Junge et al. 2009). The overarching goal of the California 4-H SET Initiative is to help advance scientific literacy among youth in the state through improved science programming, involving a variety of interrelated strategies: the development and implementation of curriculum materials that utilize inquiry and experiential learning, effective professional development of 4-H staff and volunteers, the development of new partnerships that help advance 4-H programming and reach new youth audiences, and expanded fund development to support 4-H SET programming.

The California 4-H SET Initiative also complements the University of California, Division of Agriculture and Natural Resources (UC ANR) Strategic Vision 2025 (Regents of UC 2009), a vision statement intended to help guide ANR research and extension programs through the early part of the twenty-first century. The goal of improved scientific literacy among California's population is specifically included as a major area of inquiry within the Healthy Families and Communities (HFC) Strategic Initiative, focusing on the investigation of the impacts of community-based education programs on science knowledge, process skills and attitudes toward science among K-12 youth in California and the impacts of professional development in science on the pedagogical and content knowledge and skills of science educators (Campbell et al. 2010). Furthermore, these research and extension priorities are congruent with the 4-H SET Initiative's Plan of Action, which targets improved youth science programming and effective professional development for science educators (Ambrose et al. 2011).

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4-H volunteers would benefit from professional development opportunities of longer duration. At a 4-H National Youth Science Day activity in Siskiyou County, a 4-H member watches closely to see what will happen next.

Courtesy of 4-H Youth Development Program

About half of all 4-H curricula are science related. 4-H youth in Orange County test water quality, checking for specific chemicals, turbidity and other factors.

Educating the educators

There are many factors that contribute to the low level of scientific literacy among school-aged youth in the United States, including instructional methods and professional development strategies for science educators. Most science is taught using methods that focus on the direct delivery of information (e.g., lectures and demonstrations), emphasizing the memorization of known facts (Jorgenson and Vanosdall 2002). Although some literature supports the use of these methods when teaching science (e.g., Schwerdt and Wuppermann 2011), strategies that focus on direct instruction do not provide learners with an in-depth understanding of science content and do little to contribute to their ability to use scientific thinking processes (Cole et al. 2002). Conversely, constructivist-based teaching strategies such as inquiry, which are learner centered and encourage knowledge discovery and the development of science-process skills, hold promise for improving scientific literacy. A recent synthesis of research on the impacts of inquiry-based science instruction on learner outcomes provided evidence of clear and consistent trends associated with improved learning of science among K-12 youth (Minner et al. 2010).

The perpetuation of didactic teaching methods in science is largely the result of the approaches to professional development used with science educators. In a national study, Garet et al. (2001) reported that the majority of participating science teachers engaged in what they defined as traditional professional development activities. These included workshops, conference presentations, institutes and courses, all of which can be characterized as episodic events that occur at a set time and location, with content delivered by someone external to the educators' learning setting, and lacking in sustained support (Garet et al. 2001). This type and design of educator professional development in science is broadly viewed as ineffective (Garet et al. 2001; Loucks-Horsley et al. 2003; Penuel et al. 2007). Participating educators are passive recipients of knowledge, the strategies used typically do not model effective teaching practices, and the methods used do not foster meaningful change in the teachers' practices (Loucks-Horsley et al. 2003). Furthermore, such traditional approaches to educator professional development do not promote the advancement of educators as leaders, a critical factor necessary for long-term, sustainable educational change (Lambert et al. 2002).

In contrast, several researchers have summarized key features of effective professional development approaches in science (Garet et al. 2001; Guskey 2003; Guskey and Yoon 2009; Loucks-Horsley et al. 2003; Penuel et al. 2007; Supovitz and Turner 2000). Referred to by some

Courtesy of 4-H Youth Development Program

Increasing evidence suggests that out-of-school education may be more effective in improving scientific literacy than courses taught in school. *Above,* a 4-H volunteer uses content knowledge and teaching skills to facilitate a science activity in a natural setting.

researchers as reform approaches to professional development, salient characteristics include:

- Extended duration.
- Active learning.
- Emphasis on pedagogical knowledge.
- Authentic context.
- Use of data.
- Connections to broader organizational and systemic efforts.

Duration. Professional development offered over an extended duration provides educators time to challenge their prior knowledge and beliefs by creating a high level of cognitive dissonance through discussions and review of literature (Loucks-Horsley et al. 2003; Supovitz and Turner 2000). By making sense of new information and experiences, educators can enhance their teaching practice and improve learner outcomes (Garet et al. 2001; Guskey and Yoon 2009; Loucks-Horsley et al. 2003; Supovitz and Turner 2000).

Active learning. Active learning allows participants to challenge prior ideas or understanding and make sense of new knowledge (Mestre 2005). Through active learning experiences such as observation, planning lessons or review of learners' work, educators are connected to their practice in the role of learners and are more likely to improve their knowledge and skills (Garet et al. 2001) and to have an investment in and ownership of their professional development (Torres-Guzman and Hunt 2006).

Emphasis on pedagogical knowledge. According to Loucks-Horsley et al. (1998), "it is difficult if not impossible to teach in ways in which one has not learned," and without a transformation in the way science teachers are prepared, the use of strategies that emphasize direct instruction will continue. Additionally, in order to use constructivist-based teaching strategies effectively, educators must have multiple experiences with them as learners themselves (Dantonio and Beisenherz 2001). Thus, with the goal of improving scientific literacy among K-12 youth, it is imperative to build the pedagogical knowledge of science educators through ongoing professional development opportunities that model effective practices (Guskey and Yoon 2009; Loucks-Horsley et al. 2003).


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Nearly 50% of 4-H members participate in hands-on science experiences. While continuing to offer agricultural science, 4-H curricula now include biological, environmental, engineering and technological sciences. *Above,* the Sacramento 4-H Environmental Education Camp.

Emphasis on subject matter knowledge. Another key to changing teaching practice in a manner that improves student learning is professional development that focuses on subject matter knowledge (Guskey and Yoon 2009; Loucks-Horsley et al. 2003; Penuel et al. 2007). Educators who are more competent in subject matter content are more disposed to encourage student questioning and discussion, essential features of the inquiry process (Penuel et al. 2007). Additionally, improvement of educators' science knowledge is critical because "science content increases and changes, and a teacher's understanding in science must keep pace" (National Research Council 1996).

Context. Professional development is most effective when it occurs within the context of authentic settings where educators work collaboratively to identify and address issues related to improving learner outcomes (Garet et al. 2001; Loucks-Horsley et al. 2003; Penuel et al. 2007; Supovitz and Turner 2000). When it occurs within authentic contexts, professional development has a closer "proximity to practice" and provides educators with greater opportunities to apply their learning directly to their educational settings (Penuel et al. 2007). Furthermore, Garet et al. (2001) maintained that professional development that occurs within the context of the education setting is more likely to be sustained over time.

Use of data. Guskey (2003) and Loucks-Horsley et al. (2003) emphasized the importance of using authentic data from target audiences as a key component of effective professional development. The purpose behind this is to better connect the professional development process to learner outcomes — using learner data to help direct the process of advancing educators' practice — which is an additional, critical link to the emphasis on contextualization.-

Connections to broader efforts. Profes sional development efforts are more effective if they are part of an articulated program focused on advancing educators' knowledge and skills (Garet et al. 2001; Loucks-Horsley et al. 2003). This can be accomplished in a variety of ways, including linking professional development opportunities to broader goals and systemic efforts (e.g., science standards), aligning professional development with educators' needs and goals and including strategies that foster professional communication among participants (Garet et al. 2001; Loucks-Horsley et al. 2003; Supovitz and Turner 2000).

Communities of practice

Communities of practice (CoPs) represent one example of reform-based professional development. Specifically, CoPs are organized networks of peers within a profession and represent a model for situated professional development whereby groups of educators work toward shared learning goals that arise through authentic practice (Buysse et al. 2003). Communities of practice provide educators with a forum for reflection, and learning occurs "within the context of social relationships with other members of the community who have similar, if not identical, issues and concerns from the realm of practice" (Buysse et al. 2003). Participants co-construct knowledge within CoPs through social interactions; however, individuals enter into these communities on the periphery and, through time and the acquisition of knowledge and an understanding of the socio-cultural norms of the community,

the level and complexity of their interactions increase (Lave and Wenger 1991; Wenger 1998). Mycue (2001) asserts that such group interactions among peers are essential for educator professional development, and Lambert et al. (2002) describe how CoPs advance not only the growth of educators but also the educational institution as a whole. Specific models of educator professional development that utilize CoPs include action research and lesson study.

Action research. Action research can be defined as "systematic, intentional inquiry" by educators into their own practice (Cochran-Smith and Lytle 1993). From a constructivist viewpoint, action research represents "inquiry as stance" (Cochran-Smith and Lytle 2001), whereby educators develop knowledge relative to their practice through direct experience. Furthermore, this reform model exhibits many of the characteristics of effective professional development outlined by Garet et al. (2001). Action research occurs within authentic contexts over an extended period of time, it links to broader goals and initiatives and fosters communication among participants, and it involves educators in active learning through which they challenge their existing ideas about teaching and learning and develop new knowledge that is data driven.

Procedurally, action research involves educators working collaboratively in a learning community to identify issues or concerns within their practice that focus on student learning and developing researchable questions around these topics. Using a systematic, intentional process that involves data collection, analysis and interpretation, the educators investigate these questions with the purpose of gaining new insights and understanding related to their teaching that will enhance students' learning. Mills (2003) summarizes the process by describing it as a 5-Step Action Research Cycle:

1. Select the area for investigation.
2. Collect data.
3. Organize data.
4. Analyze and interpret data.
5. Take action.

Once completed, the cycle can be repeated in successive iterations that address refined questions as a result of educators scaffolding their learning. Taken collectively, these steps set action research apart from traditional educational inquiry in that it is done "with" or "by" teachers rather than being done "on" or "to" them (Loucks-Horsley et al. 2003). Through action research, educators can "examine [their] practice, suggest changes in that practice, and assess the effects of those changes" (Lyle and Robinson 2002).

Lesson study. Lesson study is a form of action research that has gained increasing recognition in the United States (Lewis and Baker 2010). *Jugyou kenkyuu*, which translates into English as "lesson study" (Lewis, Perry and Murata 2006), has long been the main professional development model for teachers in Japan (Lewis, Perry, Hurd et al. 2006; Lewis, Perry and Murata 2006). Grounded in constructivist thinking, educators involved in the lesson study model work in teams to formulate goals, improve specific lessons within discrete contexts and explore deeper issues surrounding teaching and learning (Lewis 2009; Lewis et al. 2004; Lewis, Perry, Hurd et al. 2006; Lewis, Perry and Murata 2006; Rock and Wilson 2005).

The lesson study process is iterative and occurs over extended periods of time, often up to several years (Lewis, Perry and Murata 2006). By adopting an inquiry stance on their practice that involves the systematic collection, analysis and reporting of data, educators design, test and revise one or more lessons (Rock and Wilson 2005; Wiburg and Brown 2007). Integral to the lesson study process is "the belief that discussing others' points of view enhances the learning process and the final product" (Loucks-Horsley et al. 2003). Although relatively new to the United States (Wiburg and Brown 2007), lesson study has been shown to have positive effects on classroom educators' knowledge, skills and confidence (Rock and Wilson 2005; Wiburg and Brown 2007) and their abilities to design and teach science lessons (Marble 2006; Mutch-Jones et al. 2012).

4-H volunteer development

Volunteers are essential to the 4-H Youth Development Program, serving most commonly as nonformal educators who lead curriculum projects and

Courtesy of 4-H Youth Development Program

In a California survey of 4-H Youth Development advisors and program representatives (who train adult volunteers), 90% wished to explore the use of models like lesson study and action research as part of their county-based 4-H Science Engineering and Technology (SET) efforts. Shown is a 4-H technology leadership team presenting a workshop on computer hardware.

activities with youth (Boyd 2004; Stedman and Rudd 2006). Approximately 414,000 adults are involved as 4-H volunteers nationally each year (17,000 in California) (USDA 2010), and these individuals are commonly parents whose children are eligible to enroll in 4-H (Fritz et al. 2003). However, in order for 4-H volunteers to be successful in their role as nonformal educators they must have access to and participate in effective professional development opportunities (Hoover and Connor 2001).

Effective professional development has been shown to improve volunteers' skills and confidence (Hoover and Connor 2001; Kaslon et al. 2005; Smith et al. 2005), increase the rate of volunteer retention (Van Winkle et al. 2002) and improve the sustainability of 4-H programs (Snider 1985). However, the most common approach to the professional development of 4-H volunteers has been through the use of traditional models such as one-time, face-to-face workshops of short duration that are led by Cooperative Extension personnel (Kaslon et al. 2005). For science education, professional development opportunities that are episodic in nature are considered ineffective (Garet et al. 2001; Guskey and Yoon 2009; Loucks-Horsley et al. 2003), and numerous sources have indicated a need to address the quantity, quality and design of professional development opportunities for 4-H volunteers in order to impact their ability to deliver nonformal science education programs effectively (e.g., Barker et al. 2009; Kaslon et al. 2005; Smith and Enfield 2002).

The investigation of reform-based professional development strategies represents an opportunity to help address the professional development needs of 4-H volunteers who implement SET programming with youth. In California, there is an interest among 4-H academic and program staff in exploring reform-based professional development models for use in 4-H SET programming. Survey results from an all-staff conference revealed that over 74% of California 4-H Youth Development advisors and program representatives (n = 57) expressed a preference for professional development models like lesson study or action research, and over 90% (n = 55) had an interest in exploring the possibility of using such strategies with volunteers as part of their county-based 4-H SET efforts (Junge et al. 2008). However, although some preliminary efforts to investigate the use of reform-based professional development strategies with program representatives and Youth Development advisors involved in science programming have occurred, only one study has been undertaken with 4-H volunteers. In this investigation, a sequential explanatory mixed-methods design was used to examine the influence of lesson study on 4-H volunteers' understanding and use of inquiry methods and veterinary science content knowledge in three rural counties (see page 54). The results from this investigation were encouraging; however, no further testing on lesson study or other reform-based professional development models with 4-H volunteers has been done to date.

Effective professional development has been shown to improve volunteers' skills and confidence.

Improving the quality of professional development for 4-H volunteers who implement science programming with youth will require the careful investigation of new strategies such as action research and lesson study. However, this will take time and persistence and will require commitment from the individuals involved, as well as goals that are clearly defined by the organization (Loucks-Horsley et al. 2003). The motivation behind investigating reform methods of professional development in 4-H is to improve 4-H volunteers' abilities as science educators. The investment in developing a more competent cadre of volunteers will help strengthen 4-H SET programming and enhance the capacity of 4-H as an organization to have an impact on improving scientific literacy among California's youth population.

Courtesy of 4-H Youth Development Program

Participants in a 4-H Science, Engineering and Technology (SET) entomology project track the movements of bees in an observation hive. To enhance youths' learning, 4-H volunteers ask open-ended questions that promote inquiry.

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RESEARCH ARTICLE

Findings show lesson study can be an effective model for professional development of 4-H volunteers

by Martin H. Smith

The 4-H Youth Development Program can help address low levels of scientific literacy among K-12 youth in the United States by providing opportunities to learn science in out-of-school settings. To help ensure quality program delivery, effective professional development for adult volunteers who serve as 4-H science educators is essential. Lesson study, a constructivist-based professional development model, is one potential strategy to help meet this need. A sequential explanatory mixed-methods design was used to investigate the influence of lesson study on 4-H volunteers' science content and pedagogical knowledge. In mixed-methods research, both quantitative and qualitative data are collected and analyzed in an investigation. Survey data revealed improved understanding and use of subject matter knowledge among participants. Focus group interview data elaborated on participants' understanding and use of inquiry processes. Results from this study could benefit 4-H volunteers, other nonformal educators, and researchers.

Courtesy of the California 4-H Youth Development Program

Preserved specimens from the UC Davis Veterinary School give 4-H youth and volunteer leaders a close-up view of livestock anatomy. Over 400,000 adult volunteers serve as 4-H educators nationwide. One-time workshops, common in volunteer development, have been shown to be less effective than professional development of longer duration involving communities of practice.

There is a documented need to improve the level of scientific literacy among the K-12 population in the United States (e.g., Fleischman et al. 2010; National Center for Education Statistics 2011). To achieve this improvement will require not only effective classroom-based instruction, but opportunities for youth to learn science in nonformal settings that occur during out-of-school time (Bell et al. 2009).

The 4-H Youth Development Program is one nonformal youth education organization that has the potential to help address this area of concern (Kress et al. 2008). 4-H has developed into one of the largest youth organizations in the world. Administered through the national Cooperative Extension System, 4-H offers curriculum projects and activities through county-based programs in all 50 states as well as in the District of Columbia. Internationally, 4-H is available to youth through programs in American Samoa, Guam, the Northern Mariana Islands, Micronesia, Puerto Rico, and the United States Virgin Islands, as well as at United States military installations around the world. Approximately half of all 4-H curriculum offerings are science related (USDA 2010) and program delivery emphasizes pedagogical strategies that include hands-on inquiry and experiential learning (Enfield et al. 2007), approaches that have been shown to be effective in advancing scientific literacy (Minner et al. 2010). Furthermore, recent research has demonstrated positive impacts related to youth participation in 4-H programming in terms of their interest and engagement in science (Heck 2009; Heck et al. 2012; Mielke et al. 2010).

Adult volunteers serve as the nonformal educators in 4-H; they lead curriculum projects and activities with youth (Stedman and Rudd 2006). Over 400,000 individuals function in this capacity nationally, and approximately 17,000 in California (USDA 2010). To be successful in this role, 4-H volunteers must engage in effective professional development opportunities (Hoover and Connor 2001). To this end, it has been suggested that episodic workshops that are used most frequently to train 4-H volunteers are inadequate

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.v067n01p54&fulltext=yes
DOI: 10.3733/ca.v067n01p54

to build their teaching and knowledge capacity in science. Instead, alternative models of professional development that are of longer duration should be explored in order to provide volunteers with sufficient opportunities to develop the knowledge and skills necessary to effectively facilitate science projects and activities (Barker et al. 2009).

The lesson study approach

One alternate approach to professional development for 4-H volunteers who lead science projects and activities is lesson study (Smith 2008), a model that has long been the principal professional development model in Japan (Lewis et al. 2004). Grounded in constructivist thinking, whereby new experiences draw upon earlier experiences and modify them in some way (Dewey 1933), lesson study involves groups of educators who work collaboratively to formulate learner outcome goals associated with each specific lesson; plan and implement the lesson with their target audiences; collect and analyze data on the desired results; and use outcomes to improve the lesson as well as subsequent instruction (Lewis 2002). Taken collectively, these steps set lesson study apart from traditional approaches to professional development for educators (e.g., one-shot workshops or seminars that lack sustained support or followup) in that the work is done "with" or "by" educators rather than being done "on" or "to" them (Loucks-Horsley et al. 2003).

As a professional development strategy in school-based settings, lesson study has gained increasing recognition and use in the United States in recent years (Lewis and Baker 2010). In-service and pre-service teachers from different disciplines, including history, language arts, math, science, and social studies, have made effective use of the process (Blum et al. 2005; Marble 2006; Ogden et al. 2008; Rock and Wilson 2005; Sibbald 2009). Specific to science, educators engaged in lesson study have been shown to be effective in developing and implementing science lessons (Marble 2006; Mutch-Jones et al. 2012). Furthermore, lesson study exhibits certain characteristics of effective professional development in science as outlined in the literature (e.g., Guskey and Yoon 2009; Loucks-Horsley et al. 2003; Penuel et al. 2007): It occurs within authentic contexts over an extended duration; it fosters communication among

. . . recent research has demonstrated positive impacts related to youth participation in 4-H programming in terms of their interest and engagement in science . . .

Courtesy of UC ANR Publications

The *Youth Development through Veterinary Science* series is a 4-H curriculum that introduces youth to many aspects of veterinary science. It includes 11 modules, each with background, subject-specific concepts and vocabulary, an activity with procedures, and an appendix with further reading.

participants; it involves active learning where participants challenge their existing ideas about teaching and learning; and it develops new knowledge and skills among educators, informed by data collected through implementation of lessons (see page 47).

Pilot study in 4-H

This small-scale pilot study used a sequential explanatory mixed-methods design (Creswell and Plano Clark 2007) to investigate the use of lesson study on 4-H volunteers' understanding and use of inquiry strategies and subject matter knowledge related to the *Youth Development through Veterinary Science* curriculum (Smith et al. 2009). The investigation occurred within the context of 4-H club-based settings in rural California. In mixed-methods research, both quantitative and qualitative data are collected, analyzed, and mixed within an investigation (Creswell and Plano Clark 2007). The first phase of this inquiry was quantitative, using survey data to measure the influence of lesson study on the pedagogical and subject matter knowledge of the participating 4-H volunteers. The second phase of the investigation was qualitative, drawing upon focus group interview data from study participants to expand upon the survey outcomes.

Participants. Study participants included 16 4-H adult volunteers from three county 4-H programs in California: Lake, Marin, and Siskiyou. Fifteen of the participants (94%) were female and one (6%) was male. Fourteen of the participants (88%) resided in rural areas and two (12%) lived in small towns. All participants had a minimum of 1 year of experience leading 4-H animal or veterinary science projects with 4-H youth members. Specifically, nine participants (56%) had between 1 and 5 years of experience as 4-H volunteers, three (19%) had 6 to 10 years of experience, three (19%) had 11 to 15 years of experience, and one (6%) had more than 16 years of experience serving in this capacity.

The 4-H volunteers were subdivided into three lesson study groups based on county of residence. The lesson study groups in Lake and Marin counties had five members each; the lesson study group in Siskiyou County had six members.

Process and project materials. Simply organizing lesson study groups is not enough to make them effective: Participating educators also require "models, tools, and structures from which to work" (Wiburg and Brown 2007). Thus, 4-H volunteers who participated in this inquiry were provided an overview of the lesson study process and received necessary support and materials. Instruction on the lesson study process included one face-to-face workshop as well as follow-up conference calls with each lesson study group. Materials supplied to participating 4-H volunteers included resources that outlined the procedures of the lesson study process (Lewis 2002) and additional information on inquiry-based teaching. Each participant also received a copy of the *Youth Development through Veterinary Science* curriculum (Smith et al. 2009), which consists of 11 inquiry-based activity modules.

Courtesy of the California 4-H Youth Development Program

Animal and veterinary science projects have large enrollments in California 4-H. Professional development opportunities for 4-H volunteers that improve their teaching skills and subject matter knowledge help enhance youth experiences in these projects.

Project implementation. The lesson study groups in this investigation met on a regular basis over a period of several months. The lesson study group in Lake County met seven times at 3-week intervals (four meetings were in person, three others were held via teleconference), the lesson study group in Marin County held five face-to-face meetings at 3-week intervals, and the lesson study group in Siskiyou County met seven times in person at 3-week intervals. During this period the 4-H volunteers also held regular meetings with their 4-H youth groups to implement the veterinary science activities. Meetings with 4-H youth in all counties were held, on average, every 3 to

4 weeks; one or two curriculum activities were implemented during each meeting.

Agendas for lesson study group meetings were set by the participating 4-H volunteers in each county. The goals for these meetings were to review and discuss curriculum activities, plan lessons, and reflect on data collected during previous curriculum implementations (e.g., observations and authentic work from 4-H youth). Curriculum revisions and adjustments to instructional strategies were based on volunteers' interpretation of their data and applied, as appropriate, to the planning and implementation of subsequent activities.

Data sources

Surveys. Two retrospective surveys were administered at the completion of the lesson study intervention: the Use of Inquiry Practices Survey and the Veterinary Science Content Knowledge Survey. These instruments were adapted from self-report questionnaires used in previous studies (Gejda and LaRocco 2006; Smith and Meehan 2007). The Use of Inquiry Practices Survey included 20 Likert-type questions that aligned with indicators of respondents' understanding and use of inquiry-based instruction. Three categorical questions that requested demographic information were also included. The Veterinary Science Content Knowledge Survey included 11 Likert-type questions that measured veterinary science content knowledge as it pertained to the *Youth Development through Veterinary Science* curriculum (Smith et al. 2009) and three categorical questions that were demographic in nature.

A retrospective design was chosen for both surveys because it can mitigate the risk of response-shift bias, a threat to internal validity that can occur when using a pre-/post-survey design. Specifically, response-shift bias can occur when participants have limited knowledge or skills to respond accurately to questions asked on a pre-survey and overestimate their abilities in advance of participation in a program (Pratt et al. 2000). In such instances, pre-test/post-test comparisons can be misleading because participants' frame of reference has changed subsequent to program intervention (Pratt et al. 2000).

The correlation of related survey items on both instruments was tested using item analysis. The resulting Cronbach alpha scores were 0.7495 and 0.7358 for the Use of Inquiry Practices Survey and the Veterinary Science Content Knowledge Survey, respectively, verifying the internal consistency of the survey items in relation to their constructs.

Focus group interviews. The second phase of this investigation was qualitative, drawing upon focus group interview data from study participants to assist in the interpretation and explanation of survey outcomes. Focus group interviews are appropriate for explanatory studies and are frequently used to supplement quantitative data (Hatch 2002).

Two focus group interviews were conducted separately with each lesson study group at the conclusion of the investigation. The first interview addressed the lesson study process as it pertained to participants' understanding and use of inquiry-based methods; the second concentrated on perceived changes in participants' veterinary science content knowledge. All interviews were recorded and transcribed.

TABLE 1. List of interview codes and descriptions*

Code	Description
CBN	Collective benefits
CFD	Improved volunteer confidence
DCON-V	Discussing science content – Volunteers
NCON-V	New science content – Volunteers
PCON-V	Prior science content knowledge – Volunteers
CON-Y	Science content gain – Youth
SPS-Y	Science process skills gain – Youth
DC	Data collection strategies
DDD	Data-driven decision making
DLRN	Distance learning
DUR–	Duration – Negative
DUR+	Duration – Positive
LGO	Lesson study group organization
PED-AP	Pedagogy – Application
PED-EX	Pedagogy – Exploration
PED-LI	Pedagogy – Learning inquiry
PED-RI	Pedagogy – Reinforcing inquiry
PED-LE	Pedagogy – Learning environment
PED-LS	Pedagogy – Learning styles
PED-Q	Pedagogy – Questioning strategies
RFP-I	Reflective practice – In action
RFP-O	Reflective practice – On action
STF	4-H staff involvement

* The second step in the analysis of the focus group interview was to identify themes and categorize results. The table includes the initial coding scheme used during the analysis.

Data analysis

Phase 1: Quantitative data analysis. Survey data were analyzed using a repeated measures general linear model (GLM) (Hill and Lewicki 2007) and MiniTab software. The factors in the model for this analysis were time and county of residence. Data analysis examined the interactions of these factors on the dependent variable, which was the overall score for each survey. A significance level of $P \leq 0.05$ was established for all analyses.

Use of a repeated measures GLM requires that the sample distribution be normal and that it exhibit homogeneity of variance (i.e., the variance within populations must be the same, which is important for meaningful interpretation of data). A Goodness of Fit test (Gravetter and Wallnau 2008) was used to determine if data were normally distributed. In situations where the data were not distributed normally, a Box-Cox Transformation (Hill and Lewicki 2007) was applied. Homogeneity of variance for the data sets was determined using the Bartlett's Test, a measure used to determine whether multiple samples are from populations with equal variances (Snedecor and Cochran 1983).

Phase 2: Qualitative data analysis. The long-table approach (Krueger and Casey 2000) was used to categorize results germane to the investigation through the development and execution of an initial coding scheme (table 1). Data were then analyzed inductively using the constant comparison method (Hatch 2002), whereby themes emerged from the coded data, as opposed to assigning a priori categories (Patton 1990). Where relevant, some codes were combined based on generalizations during data analysis (Hatch 2002). The interpretation of focus group interview data placed an emphasis on how frequently codes occurred (Sandelowski et al. 2009).

Results

Quantitative findings. Scores on the Use of Inquiry Practices Survey improved significantly. Data analysis revealed a significant effect of time. The resulting Least Squares Means (LSM) and Standard Error (SEM) for post-survey scores were $n = 16$,

LSM = 3.32, SEM = 0.74. The Least Squares Means and Standard Error for pre-survey scores were n = 16, LSM = 2.92, SEM = 0.74. The difference between post-survey and pre-survey scores was significant: GLM F(1,31) = 13.71; $P < 0.01$. There was no interaction of county of residence on the dependent variable: GLM F(2,31) = 2.50; $P = 0.10$.

Scores on the Veterinary Science Content Knowledge Survey also improved significantly. Analysis of the data revealed a significant effect of time. The resulting Least Squares Means and Standard Error for post-survey scores were n = 16, LSM = 3.65, SEM = 0.13. The Least Squares Means and Standard Error for pre-survey scores were n = 16, LSM = 3.09, SEM = 0.13. The difference between post-survey and pre-survey scores was significant: GLM F(1,31) = 9.87; $P < 0.01$. There was no interaction of county of residence on the dependent variable: GLM F(2,31) = 2.27; $P = 0.12$.

Qualitative findings. Emergent themes from the analysis of focus group interviews were based on highest frequency of occurrence of qualitative codes. These themes included understanding and use of inquiry, duration of professional development experience, reflective practice, data-driven decision making, and collective benefits to 4-H volunteers.

Theme: Understanding and use of inquiry. Several lesson study group members for whom inquiry-based teaching was a new strategy revealed that the lesson study experience helped them understand the process and apply it to their practice. For study participants who indicated they had some prior knowledge of inquiry, lesson study served to reinforce their understanding and increased their confidence to use it. Focus group interview responses included

> I would say that it really helped me because I'm kind of a "tell-you-how-to-do-it person," . . . so I think it helped me tremendously to find out what inquiry-based learning was and to help me be way open to it now.

> I felt that participating in the lesson study group kind of crystallized and fine-tuned a teaching technique I knew was available, but I myself didn't feel like I had the confidence to commit to it because I didn't understand it as well as I could have.

Courtesy of the California 4-H Youth Development Program

With guidance from experienced, trained volunteer leaders, 4-H members learn how to prepare a steer for an auction or livestock show. Subject matter knowledge is key to volunteer development. Knowledgeable educators encourage youth questioning and discussion, essential features of the inquiry process.

A number of focus group responses were congruent with Use of Inquiry Practices Survey questions and exhibited study participants' knowledge and application of specific strategies associated with inquiry, such as open-ended questioning. For example, interview responses from 4-H volunteers provided numerous references to the benefits they saw in using open-ended questions during curriculum implementations. In particular, study participants noted that they observed how open-ended questions engaged their youth audiences in the learning process and promoted independent thinking. Representative focus group interview responses included

> The open-ended questioning . . . allowed the [youth] to discover answers and discover questions.

> The open-ended questions were good because they made [our 4-H members] think.

Another key element of inquiry included on the Use of Inquiry Practices Survey was learner-centered instruction. Participating 4-H volunteers commented several times during focus groups about how they used facilitation strategies that focused more on youth exploration than on providing direct instruction. Among the participants' responses were

> I try to incorporate hands-on [activities] for the kids to explore and ask questions and have them formulate the answers and have me guide them.

> [Using inquiry has] completely flipped the way we'll run our meetings. [We are] seeing how letting [youth] explore on their own can be a better [experience] than having someone stand up there and throw facts and figures at you.

The application of knowledge was also addressed through the Use of Inquiry Practices Survey and emerged as a theme from the focus group interviews. Interview data revealed how, through the lesson study process, several of the 4-H volunteers had incorporated knowledge application into curriculum activities they were leading with 4-H youth, while others had made concrete plans for their youth participants to apply their learning in real-life settings. Interview responses included

> Our goal for the [4-H] group was that when we finished this the kids would be able to call the vet and answer the first five or six questions that the vet would ask them. That was our goal.

> [Our lesson study group] talked about visiting a vet clinic where you can learn more by observing the actual live animals. And [our youth] could apply what they've learned to actual live animals.

Theme: Duration. When discussing the organization and functioning of their lesson study groups, 4-H volunteers commented numerous times on the benefits of having a professional development opportunity that included multiple meetings over an extended period. Participants indicated that meeting regularly was a challenge, but worth the effort. Specifically, volunteers expressed that these meetings helped them improve their time management and meet their goals, and also provided them time to review and discuss curriculum materials, reflect on their prior work with youth and make instructional modifications they thought necessary. Specific comments related to the duration included

> Regular group meetings helped a lot. Absolutely! Sometimes the logistics of [meeting] are difficult. It is a big time commitment, but I think in the long run it's definitely worth the time put into it.

> We [volunteers] talk about the lack of time for planning when using a new curriculum. Lesson study helped. Meeting every 3 weeks or so helped with preparation and lesson planning.

Theme: Reflective practice. Having opportunities to reflect on their practice through interactions with other 4-H volunteers during lesson study group meetings was another theme that emerged from focus group data. Systematic reflection helped participants target strategies to improve the learning of their youth audiences by discussing data they had collected and making modifications to their practice and curriculum activities prior to subsequent implementations. Additionally, some volunteers commented that through reflection they had begun to contemplate changes to their teaching practices and organizational strategies with respect to other 4-H projects they lead. Relevant quotes included

> As far as how the lessons were presented, if we thought that the kids had not picked up on the curriculum the way we presented it we would bounce ideas off on how we could make it better for those of us who maybe had not gotten to the level that other group members had.

> I think that we all had things to bring back and improve upon every time that we met because we were talking about our process, working with different ages and stages vs. just the curriculum.

Theme: Data-driven decisions. Data-driven decision making also emerged as a theme from focus group interviews. Participating 4-H volunteers collected a variety of types of data (e.g., observations, authentic youth work) and used those data to inform their practice. The lesson study groups in Lake and Siskiyou counties used the data to inform modifications with respect to adapting or modifying individual curriculum activities or how they were taught; the lesson study group members in Marin County shared information on curriculum implementations that helped lead them to combine youth members from three smaller 4-H clubs into one larger group for curriculum implementations, a change in practice that they found to be effective. Representative focus group interview responses included

> We talked [about our observations] afterwards. We wrote everything down and summarized it to bring to each meeting, which I think helped all of us to hear what everyone had done.

> It was nice to get input from [other lesson study group members] on what worked and what didn't work because I could kind of readjust or think about what things to put out for [the youth] to touch and feel or that type of stuff. . . . I think it helped a lot.

Theme: Collective benefits. Beyond their roles as individual educators, participating 4-H volunteers commented frequently on collective benefits they derived from the lesson study process. Benefits included working cooperatively to develop

Courtesy of the California 4-H Youth Development Program

4-H members and volunteer leaders learn about animal jaw function and characteristics of animal teeth at the UC Davis School of Veterinary Medicine. This knowledge helps them understand feeding preferences and nutritional needs of different animals.

skills, feeling empowered (as opposed to isolated) through collective work, and working toward common goals that benefit not just the youth members but also their county programs. Examples of focus group responses included

> I thought it was great that we could all come together and actually work toward a common goal instead of being so segregated all of the time.

> I think our goal to function as a team worked for the betterment not only of the lessons that we were teaching and for each other, but also for the county.

Analysis of the qualitative data from this study afforded a more comprehensive understanding of participating 4-H volunteers' lesson study experience. In particular, focus group interview data corroborated the outcomes from the Use of Inquiry Practices Survey with respect to participants' understanding and application of key inquiry processes. In contrast, data from focus groups did not provide strong support for quantitative outcomes from the Veterinary Science Content Knowledge Survey that revealed statistically significant changes in study participants' content knowledge. Although a few individuals commented on specific science content they had learned, the majority of study participants believed their educational and practical backgrounds in animal and veterinary science were already sound, and that the lesson study group process was most beneficial in influencing their pedagogical skills.

Interpreting the results

Constructivist-based professional development models like lesson study help advance educators' knowledge and skills by engaging them in the process of inquiring into their own practice (Loucks-Horsley et al. 2003). The 4-H volunteers who participated in this investigation formed lesson study groups and took an inquiry stance with regard to their practices, investigating strategies that targeted improved learning among their 4-H youth audiences, and did so in a collaborative manner. Through active reflection, a strategy whereby educators challenge their thinking and gain new insights into teaching and learning (York-Barr et al. 2005), participating volunteers systematically developed learner outcome goals, discussed data they collected during a sequence of curriculum implementations, and made modifications to the curriculum activities and their teaching that were informed by data they had collected during curriculum implementations.

Although no prior research had been done on lesson study in nonformal education settings, outcomes from this study were consistent with research in school-based settings where in-service and pre-service teachers who participated in lesson study groups improved their teaching skills and subject matter knowledge (Lewis et al. 2004; Marble 2006; Perry and Lewis 2003; Rock and Wilson 2005). Specifically, both quantitative and qualitative data from this investigation revealed improvements in participating 4-H volunteers' knowledge and use of inquiry-based teaching strategies, methods that are important to the advancement of scientific literacy (Minner et al. 2010).

Gains in science content knowledge among 4-H volunteers were shown through the analysis of survey data; however, these findings were not well supported by focus group interview data. A possible explanation for this discrepancy is that the Veterinary Science Content Knowledge Survey questions targeted subject matter that was specific to the *Youth Development through Veterinary Science* curriculum (Smith et al. 2009) as opposed to broader animal and veterinary science content knowledge conveyed by study participants during focus group interviews. Participating volunteers had considerable prior knowledge and experience related to animal and veterinary science and may have been considering this when responding to more general focus group questions. Thus, specific changes in their content knowledge related to the curriculum may have been underreported during the qualitative phase of this study.

Implications and recommendations

There is a need to explore alternative models of professional development for 4-H volunteers who facilitate science projects and activities with youth (Barker et al. 2009). Results from this study provided some evidence that lesson study has potential as an alternate strategy. However, Guskey and Yoon (2009) cautioned against embracing new approaches to professional development without thoroughly vetting them. New professional development strategies "should always begin with small-scale, carefully controlled pilot

Courtesy of the California 4-H Youth Development Program

Learning livestock anatomy — including the function and normal appearance of internal organs — is a critical part of animal science education. 4-H members and volunteer leaders alike gain from their participation in Future Day at the UC Davis School of Veterinary Medicine.

studies" to evaluate their effectiveness within specific contexts. For this reason, it is recommended that efforts be made to investigate lesson study in 4-H through long-term, coordinated efforts that are systematic in nature. The research design used in this pilot study would be recommended as a strategy to consider.

Results from this investigation provided early evidence for the promising nature of lesson study as a professional development model for 4-H volunteers who lead science projects and programs with youth audiences. Specifically, data showed improvements with respect to volunteers' understanding and use of effective pedagogy and some gains relative to science content knowledge. However, it must be noted that the broad application of these results is limited by the size and scope of the investigation. Only 16 volunteers from rural, club-based 4-H programs participated in this study. It is recommended that additional research be carried out on the use of lesson study with other 4-H volunteers involved in club-based programs. Additionally, because lesson study experiences are unique to the particular context within which they are situated (Wiburg and Brown 2007), results from this investigation may not translate directly to lesson study use in other settings. For this reason, the use of lesson study with volunteers involved in other 4-H program-delivery modes (e.g., after-school programming, camp settings) also warrants investigation. Science subject matter beyond the scope of veterinary science should also be explored.

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RESEARCH ARTICLE ABSTRACT

Nitrogen fertilizer use in California: Assessing the data, trends and a way forward

by Todd S. Rosenstock, Daniel Liptzin, Johan Six *and* Thomas P. Tomich

Nitrogen fertilizer is an indispensable input to modern agriculture, but it also has been linked to environmental degradation and human health concerns. Recognition of these trade-offs has spurred debate over its use. However, data limitations and misinformation often constrain discussion, cooperative action and the development of solutions. To help inform the dialogue, we (1) evaluate existing data on nitrogen use, (2) estimate typical nitrogen fertilization rates for common crops, (3) analyze historical trends in nitrogen use, (4) compare typical nitrogen use to research-established guidelines and (5) identify cropping systems that have significant influence on the state's nitrogen cycle. We conclude that a comprehensive grower self-monitoring system for nitrogen applications is required to improve nitrogen-use information and to better support evidence-based decision making. The discussion here presents a primer on the debate over nitrogen fertilizer use in California agriculture.

Jack Kelly Clark, UC Statewide IPM Program

Tractor applies fertilizer to cole crop plants near Pigeon Point Lighthouse, Santa Cruz County. Nitrogen fertilizer is an essential resource for agriculture, but its overuse can threaten human health and the environment.

Nitrogen fertilizer is an essential resource for agriculture and its use has undoubtedly benefited California and its citizens. However, overuse of nitrogen fertilizer threatens the health of the state's agricultural, human and natural resources. On the one hand, nitrogen is necessary for crop growth and development, and thus nitrogen fertilizer use supports California's robust agricultural economy and rural society. On the other hand, applying nitrogen in excess has been linked to water and air pollution, depletion of the ozone layer, climate change and numerous human health concerns (Galloway et al. 2003; Millennium Ecosystem Assessment 2005). The trade-offs that nitrogen fertilizer use present to society have been documented in California for more than 50 years (Harding et al. 1963; Proebsting 1948). It is worth noting that fertilizer is just one way humans add reactive nitrogen into the environment, and other activities such as fossil fuel combustion and waste discharge contribute to the aforementioned concerns. However, a forthcoming report indicates that inorganic nitrogen fertilizer use is responsible for the largest fraction, by far, of new nitrogen introduced into California's environment each year (Liptzin and Dahlgren, unpublished data).

The amount of inorganic (chemical) nitrogen fertilizer sold in California has risen dramatically over the past 70 years (fig. 2). By the 1970s, nitrogen fertilizer sales — and presumably use — exceeded 400,000 tons of nitrogen – contained in inorganic fertilizer per year, and in the subsequent decade sales grew more than 25% to more than 500,000 tons of nitrogen per year. Between 1980 and 2001, the average amount of nitrogen sold per year was no longer increasing significantly, but annual sales have surpassed 600,000 tons of nitrogen in some years. Large upward trends in fertilizer sales in the last half of the twentieth century are not unique to California; similar increases are evident throughout the developed world (Millennium Ecosystem Assessment 2005). As nitrogen fertilizer use has expanded, so has the evidence documenting the negative consequences of reactive nitrogen on human health and the environment (Davidson et al. 2012; Townsend et al. 2003).

To read full text of this peer-reviewed article, go to the current issue at http://californiaagriculture.ucanr.edu

(Editor's note: Full text also includes assessment and critical analysis of datasets on nitrogen fertilizer use in California, past and present.)

Online: http://californiaagriculture.ucanr.edu/landingpage.cfm?article=ca.E.v067n01p68&fulltext=yes

DOI: 10.3733/ca.E.v067n01p68

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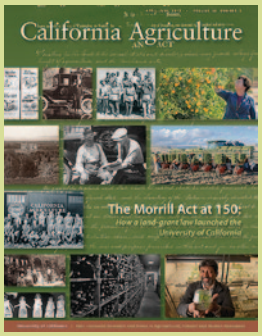

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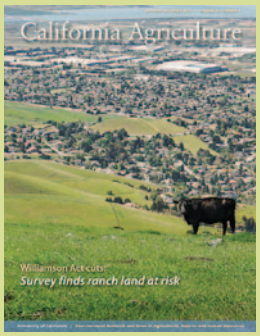

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COMING UP *in California Agriculture*


Bruce Hoar

Sheep graze an alfalfa field east of Brawley, in the Imperial Valley.

Researchers define buffer zones between grazing and crop systems

Known as the nation's "winter salad bowl," the Imperial Valley produces fresh fruits and vegetables on more than 100,000 acres. With nationwide product distribution, the industry has a tremendous impact on the U.S. food supply. Because growers integrate crop and animal agriculture, sheep or cattle may graze on alfalfa close to food crops such as leafy greens. While growers follow guidelines for buffer zones set by the California Leafy Green Products Handler Marketing Agreement, to date there has been little scientific data on the best setback times and distances between livestock operations and crop systems.

In the next issue of *California Agriculture* journal, investigators report results of studies to accurately define buffer zones appropriate for grazing of sheep near production of leafy greens. Given that there are approximately 650,000 sheep and lambs in California and up to 150,000 in the Imperial Valley on a seasonal basis, this new information on important human pathogens associated with sheep is critical to growers and consumers alike.