Name: __________________________________________________________________________

27th Annual
Summer Agricultural Institute

June 5 - 9, 2017
SPONSORS
The Summer Agricultural Institute is a program of the University of Arizona College of Agriculture and Life Sciences Cooperative Extension.

It is funded by the Arizona Foundation for Agricultural Literacy through generous donations from individual members and organizations:

A Tumbling T Ranches
Agribusiness and Water Council of AZ
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Apple Annie’s Orchard, Inc.
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Arizona Cotton Ginners Association
Arizona Cotton Growers Association
Arizona Grain Research & Promotion Council
Arizona Grain, Inc.
Arizona Milk Producers
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Cochise Groves, LLC
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Condor Seed Production, Inc.
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Kleinman Citrus
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Lakin Milling Company
Le Smith Farms
Maricopa County Farm Bureau
Meyer Farms, LLC

Moore & Moore Cattle Ranch
Primetime Harvesting, Inc.
Rainfire Stables
Saddle Mountain Dairy
SAI Alumni 2010 & 2015, Louise Bunker
SAI Alumni 2010, Cheri Stegall
SAI Alumni 2010, Chris Krause
SAI Alumni 2011, Patricia Hellman
SAI Alumni 2013, Stormi Carlson
SAI Alumni 2013, Loren Hall
SAI Alumni 2015, Michelle Crary
SAI Alumni 2015, Teresa Scotland
SAI Alumni 2016, Terry Armstrong
SAI Alumni 2016, Sarah Bell
Santa Rita Ranch
Seeds West Inc.
Sunrise Dairy Farm
Tempe Farming Co.
The Kemper & Ethel Marley Foundation
Tingle Farms
Triple G Dairy
West Pinal NRCD
Whitewater Draw NRCD
Wuertz Farm
IN-KIND CONTRIBUTORS

In-Kind Contributors are organizations, companies, facilities or individuals that have donated resources to support the Summer Agricultural Institute. This could be in the form of providing a staff person to help on the planning committee, hosting a site visit, sponsoring a meal, covering the cost of printing or transportation, or sponsor any of the various other components of the program. Any and all program support is greatly appreciated and we’d like to take this opportunity to thank the In-Kind Contributors of the Summer Agricultural Institute Program:

Arizona Agribusiness & Equine Center, Inc.  Rousseau Farming Company
Arizona Beef Council  Triple G Dairy
Arizona Crop Improvement Association  U of A Cooperative Extension
Arizona Department of Agriculture  U of A Maricopa Agriculture Center
Arizona Milk Producers  USDA Arid-Land Agricultural Research Center
Arizona Project WET  V & P Nurseries
Arizona State Cowbelles  Whipstone Farm
Buckeye Union High School  Yavapai College Agribusiness & Science Technology Center
Dairy Council® of Arizona  Yavapai Cowbelles
Diablo Trust
Farm Family Hosts
Four Forest Restoration Initiative
Groseta Ranches
Heiden Land and Cattle
Los Cedros USA
Maricopa County Cattlewomen
Maricopa County Farm Bureau
Mortimer Family Farm
Page Springs Cellars
Pendley Apple Homestead
Perkinsville Meat Processing
Arizona Grown

An agriculture commodity is something grown on a farm or a ranch. Milk, oranges, beef and cotton are agriculture commodities. This map shows all the major commodities grown in Arizona’s 15 counties. There are 19,600 farms in our state.

Source: 2012 Arizona Agricultural Statistics Bulletin
www.nass.usda.gov/az/
Arizona’s agriculture ranks among the highest in the U.S. for several delicious products.

Arizona ranks #1 in:
- Winter Lettuce & Alfalfa Yields (tons per acre)

Arizona ranks #2 in:
- Lemons
- Spinach
- Broccoli
- Cantaloupe
- Cauliflower
- Honeydew
- Dairy Herd Size
- Milk (lbs) per cow

Arizona ranks #3 in:
- Tangerines

Arizona ranks #4 in:
- Pecans
- Oranges
- Grapefruit

Source: 2013 Arizona Farm Bureau Information
www.azfb.org
SAI 2017 - Week at a Glance

The Summer Agricultural Institute (SAI) is a highly interactive five-day tour designed to teach you about food and fiber production in Arizona and to help you incorporate that knowledge in the classroom. You will visit a variety of agricultural operations, spend an entire day at the University of Arizona's research farm, and have many opportunities to meet and talk with many people who live and work on modern day farms or ranches, or who are connected to agriculture in myriad ways.

SAI is an action-packed adventure that combines hands-on learning about agriculture with practical curriculum development. Throughout this week you will tour the following sites and hear from a variety of additional agriculture related organizations and people. This book is designed to help you make the most of your trip. Let us know how we can support your learning adventure this week.

**Monday**
- U of A Cooperative Extension, Maricopa County Welcome and Orientation
- U of A Maricopa Agriculture Center
- USDA Arid-Land Agricultural Research Center
- Los Cedros USA Arabian Horse Training

**Tuesday**
- Pendley Apple Homestead
- Page Springs Cellars
- Groseta Ranches
- Four Forest Restoration Initiative
- Diablo Trust Restoration

**Wednesday**
- Whipstone Farm
- V & P Nursery
- Yavapai Community College Agribusiness & Science Technology Center
- Perkinsville Meat Processing
- Mortimer Family Farm

**Thursday**
- Rousseau Farming Company
- Heiden Land and Cattle
- Triple G Dairy
- Farm Family Visits
- Sponsors Celebration Dinner

**Friday**
- U of A Cooperative Extension, Maricopa County Curriculum Incorporation
- Arizona Department of Agriculture Presentation
- Agriculture Organization Exhibits
Monday, June 5, 2017

7:00 am  
**Registration/continental breakfast**  
*Hosted by Dairy Council® of Arizona*  
University of Arizona Cooperative Extension, Maricopa County  

7:30  
Welcome / Introductions / Ag Quiz  

8:00  
Depart  

8:45  
**University of Arizona Maricopa Agriculture Center**  
Welcome – *Victor Jimenez*  
Insect Collection – *Naomi Pier*  
Siphon Tube Experience– *Victor Jimenez*  

*Arizona Project WET – Pamela Justice*  

10:30 am  
Depart for USDA Arid-Land Agricultural Research Center  
Sustainable Agricultural Research  
Pest Management & Biocontrol Research Unit  
Plant Physiology & Genetics Research Unit  
Water Management & Conservation Research Unit  

11:30 am  
Depart to UA MAC for Lunch - *Hosted by Arizona Foundation for Agricultural Literacy (AFAL)*  
Presentation: **Addressing Misconceptions About Agriculture and The Story of Our Food**  
*Katie Aikins, Arizona Farm Bureau*  

1:30 pm  
Insect Science (Group A, B) – *Naomi Pier*  
Plant Science (Group B, A) – *Kelly Young*  

2:30 pm  
Depart  

4:00  
**Los Cedros USA** Horse Training and Breeding Stable  
*Heidi Grigaitis*  
8700 East Black Mountain Rd. Scottsdale, Arizona 85266  

5:00  
Depart – processing time on the bus  

5:45  
**Dinner – Chili’s, Phoenix**  

6:30  
Depart – processing time on the bus  

6:45  
**Check into hotel** – Comfort Inn, Camp Verde, AZ  

*Please Note: Restrooms will be available at the following sites today:*  
UA Cooperative Extension, Maricopa Ag Center, USDA Arid-Land Research Center, Dinner, Hotel.
**Journaling Pages**

As you begin this week’s adventure, use these pages throughout the booklet to record your thoughts, comments, ideas, suggestions, etc. Think about how you may be able to use the information you are learning in your classroom and what additional resources you might need to help you impart this knowledge to your students. Throughout the week, there will be times planned for you to process your experiences and thoughts with each other in small groups and with the group as a whole. Refer back to these pages for those processing sessions - to remind yourself of your notes and to jot down ideas from your fellow teachers.

**MONDAY** - University of Arizona Cooperative Extension: Introduction, Ag Quiz

---

Maricopa Ag Center: Insect Collection and Insect Science

---

Siphon tubes:

---

Plant Science:

---

Arizona Project WET:
** * Journaling - Monday * * **

Presentation: Addressing Misconceptions About Agriculture and The Story of Our Food

USDA Arid-Land Agricultural Research Center: Sustainable Agricultural Research

Los Cedros USA

I can use what I learned today in my classroom by...

High point of the day...
Tuesday, June 6, 2017

6:30 am  A  Breakfast at hotel and checkout

7:00  Depart

8:00  B  Pendley Apple Homestead  (pg 47)
Kathy Pendley Shaw
2395 S Ash Ln., Flagstaff, AZ 86004

8:45  Depart

9:45  C  Page Springs Cellars  (pg 46)
Luke Bernard
1500 N. Page Springs Rd., Cornville, AZ 86325  www.pagespringscellars.com

11:00  Depart

11:30  D  Groseta Ranches  (pg 42)
Andy and Mary Beth Groseta
625 S. Mt. Mingus Rd., Cottonwood, AZ 86326

Lunch
Hosted by Yavapai Cowbelles  (pg 38)
Ranching – Andy and Mary Beth Groseta
Activities Development – Monica Pastor

3:00  Depart

4:15  E  Four Forest Restoration Initiative  (pg 41)
Keen’s Park, Flagstaff
Diane Vosick  www.fourforestrestorationinitiative.org
PO Box 15017 Flagstaff, AZ 86011

5:00  Depart

5:30  F  Dinner - Roux 66
Diablo Trust Presentation – Jeremy Krones  (PO Box 190 Winslow, AZ 86047)

6:45  Depart

7:15  G  Check into hotel – La Quinta Inn and Suites, Flagstaff

Please Note: Restrooms will be available at the following sites today:
Hotel, Page Springs Cellars, Groseta Ranches, Dinner Hotel.
Tuesday, June 6, 2017
** * * * Journaling - Tuesday * * * **

Pendley Apple Homestead:

_________________________________________________________________________________________________________________

_________________________________________________________________________________________________________________

_________________________________________________________________________________________________________________

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Page Springs Cellars:

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Groseta Ranches:

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Activities Development:

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I want to know more about:

_________________________________________________________________________________________________________________

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_________________________________________________________________________________________________________________
How can I adapt these activities to fit the needs of my classroom?

Four Forest Restoration Initiative:

Diablo Trust:

High Point of the Day:
Wednesday, June 7, 2017

7:00 am  **Breakfast** at hotel and checkout

7:30  **Depart** - process time on the bus

9:00  **Whipstone Farm - Farmer’s Market**  
*Cori Whipstone and Dani*  
21640 N. Juniper Ridge Rd, Paulden, AZ 86334  
[www.whipstone.com](http://www.whipstone.com)  

10:00  **Depart**

10:30  **V & P Nurseries - Horticulture**  
*Hilario Anguiano*  
3900 N Road 1 West, Chino Valley, AZ 86323  
[www.vpnurseries.com](http://www.vpnurseries.com)

11:15  **Depart**

11:30  **Yavapai College Agribusiness & Science Technology Center**  
*Justin Brereton*  
PO Box 4048 Chino Valley, AZ 86323  
[www.yc.edu/chinovalley](http://www.yc.edu/chinovalley)

1:30 pm  **Depart**

1:45  **Perkinsville Meat Processing**  
*Cyndy and Casey Perkins*  
PO Box 1674 Chino Valley, AZ 86323

2:30  **Depart**

3:30  **Mortimer Family Farm**  
*Sharla and Ashlee Mortimer*  
12907 E. State Route 169, Dewey, AZ 86327  
[www.mortimerfamilyfarms.com](http://www.mortimerfamilyfarms.com)

**Dinner:**  *Hosted by Mortimer Family Farm*

5:30  **Depart**

7:00  **Check into hotel** – Courtyard by Marriott, Phoenix

*Please Note: Restrooms will be available at the following sites today:*
  Hotel, Yavapai College, Mortimer Family Farm, Hotel.
** * ** Journaling - Wednesday * * *

Whipstone Farm:

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V & P Nurseries:

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Yavapai College Agribusiness and Science Technology Center:

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Perkinsville Meat Processing:

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** ** Journaling - Wednesday ** **

Mortimer Family Farm:

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General thoughts about Wednesday’s sites:

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How can I use this information in my classroom?

________________________________________________________________________

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________________________________________________________________________
Thursday, June 8, 2017

6:15 am  Breakfast at hotel

6:45  Depart

7:30  Rousseau Farming Company - Specialty Crops

Charlie Montgomery
PO Box 100, Tolleson, AZ 85353
www.rousseaufarming.com

8:45  Depart

9:30  Heiden Land & Cattle

Paul Heiden
PO Box 428 Buckeye, AZ 85326
www.heidencompanies.com

10:15  Depart

10:45  Triple G Dairy - Family Dairy Farm

Ben and Max Gingg
29115 W. Broadway Rd., Buckeye, AZ 85326

12:00 pm  Depart

12:30  Lunch - La Placita Café, Buckeye

1:30  Depart

1:45  Farm Family Pick-up

Spend the afternoon with a farm family.
Buckeye Union High School

5:30  Twenty-Seventh Annual Summer Agricultural Institute

Sponsors’ Celebration Dinner
Buckeye Union High School

8:00  Depart

8:45  Return to hotel - Courtyard by Marriott, Phoenix

Please Note: Restrooms will be available at the following sites today:
Hotel, Lunch, Dinner, Hotel.
Thursday, June 8, 2017
** * * Journaling - Thursday * * * **

Rousseau Farming Co.:

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Heiden Land and Cattle:

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Triple G Dairy:

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See page 25 for a journaling page for your Farm Family Visit.
**Journaling - Thursday**

Sponsors’ Celebration Dinner:


The Summer Ag Institute would like to thank all the families who hosted the Farm Family Visit and provided SAI participants an opportunity to learn about life in the agricultural community.

* * * Journaling - Thursday * * *

Farm Family Hosts:

<table>
<thead>
<tr>
<th>Dairy Name</th>
<th>Host Name</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danzeisen Dairy</td>
<td>Clayton and Gail Danzeisen</td>
<td>6829 W. Broadway Rd. Phoenix, AZ 85043-7010</td>
</tr>
<tr>
<td>Gladden Farms/Saddle Mountain Dairy</td>
<td>Danny &amp; Sheri Gladden</td>
<td>PO Box 1061 Buckeye, AZ 85326</td>
</tr>
<tr>
<td>Jason and Carolyn Hardison</td>
<td>P. O. Box 156</td>
<td>Palo Verde, AZ 85343</td>
</tr>
<tr>
<td>Hickman Family Farms</td>
<td>Sharman Hickman</td>
<td>3507 N. 110th Ave, Ste 1 Avondale, AZ 85323</td>
</tr>
<tr>
<td>Justice Brothers Ranch</td>
<td>Selwyn Justice</td>
<td>14269 W. Peoria Ave., Waddell, AZ 85355</td>
</tr>
<tr>
<td>Kerr Dairy</td>
<td>Wes and Lauren Kerr</td>
<td>28105 W. Hazen Rd., Buckeye, AZ 85326</td>
</tr>
<tr>
<td>Joel John</td>
<td>John Bros. Farm, Inc.</td>
<td>25328 W. Carter Ct. Buckeye, AZ 85326</td>
</tr>
<tr>
<td>Rovey Dairy</td>
<td>Tamara Ridge</td>
<td>7711 W Northern Ave, Glendale, AZ 85303</td>
</tr>
<tr>
<td>Rovey Farms</td>
<td>Jerry Rovey</td>
<td>4225 S. Dean Rd., Buckeye, AZ 85326</td>
</tr>
<tr>
<td>RS Farms</td>
<td>Rick &amp; Sherry Saylor</td>
<td>6404 S. Wilson Rd., Buckeye, AZ 85326</td>
</tr>
</tbody>
</table>
* * * Journaling - Thursday * * *

Who did I meet? What do they do?

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What was the most interesting?

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What do I want to learn more about?

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Reflections:

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________________________________________________________________________
Friday, June 9, 2017

7:00 am  Breakfast at hotel and checkout

8:00  Depart

8:30  University of Arizona Cooperative Extension, Maricopa County  
      Curriculum Incorporation Session  
      4341 E. Broadway, Phoenix, AZ  85040  
      Monica Pastor, U of A Agricultural Literacy Program  
      www.cals.arizona.edu/agliteracy

11:30  Arizona Department of Agriculture  
      Governmental Role in Agriculture  
      Mark Killian  
      Director, Arizona Department of Agriculture  
      www.azda.gov

11:45  Lunch  
      Hosted by Arizona Milk Producers  
      Agricultural Organization Displays

1:30 pm  Final Discussions / Evaluation / Wrap up  
         Monica Pastor, U of A Agricultural Literacy Program  
         www.cals.arizona.edu/agliteracy

2:30  Adjourn
# Friday Exhibitors

<table>
<thead>
<tr>
<th>Organization</th>
<th>Contact Person</th>
<th>Contact Info</th>
</tr>
</thead>
</table>
| Arizona Beef Council                              | Tiffany Selchow    | tnselchow@arizonabeef.org  
www.arizonabeef.org  
602-273-7163 |
| Arizona Dept. of Education, Farm to School & School Garden Program | Ashley Schimke    | www.azed.gov/health-nutrition/farm-to-school-programs/  
Ashley.Schimke@azed.gov |
| Arizona Farm Bureau Ag in the Classroom           | Katie Aikins       | www.azfb.org  
katieaikins@azfb.org  
480-635-3609 |
| Arizona Nursery Association                       | Cheryl Goar  
Kayla Colvin | cgoar@azna.org  
www.azna.org  
(480) 966-1610 |
| Association of Arizona Food Banks                 | Monique Cordova    | monique@azfoodbanks.org  
www.azfoodbanks.org |
| Central Arizona Project (CAP)                      | Vicki Campo        | vcampo@cap-az.com  
www.cap-az.com |
| Dairy Council of Arizona                          | Colleen Bergum  
Terri Verason | www.dairycouncilofaz.org  
tverason@dcaz.org |
| Hickman Family Farms                              | Sharman Hickman    | shickman@hickmanseggs.com  
www.hickmanseggs.com |
| The Phoenix Zoo Education Programs                | Liesl Pimentel  
Leslie Hawkins | www.phoenixzoo.org  
lpimentel@thephxzoo.com  
602-914-4366 |
| Shamrock Farms                                    | Christina Calio    | Christina_Calio@shamrockfoods.com  
www.shamrockfarms.net/farm-tour |
| Treasures 4 Teachers                              | Louise Bunker  
Barbara Blalock | lbunker@susd.org  
barb@treasures4teachers.org |
Overall impressions of the week:

________________________________________________________________________

________________________________________________________________________

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How this experience will improve my teaching:

________________________________________________________________________

________________________________________________________________________

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________________________________________________________________________
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# 2016 STATE AGRICULTURE OVERVIEW

**ARIZONA**

<table>
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<tr>
<th>Farms</th>
<th>Total Cash Receipts</th>
<th>$3,732,113,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Farms</td>
<td>19,600</td>
<td>Value of Crop Production</td>
</tr>
<tr>
<td>Land in Farms (acres)</td>
<td>25,900,000</td>
<td>Includes:</td>
</tr>
<tr>
<td>Average Farm Size (acres)</td>
<td>1,321</td>
<td>Food Grains</td>
</tr>
</tbody>
</table>

**Livestock Inventory**

| Cattle and Calves – All | 970,000 | Feed crops | $301,926,000 |
| Hogs and Pigs | 115,000 | Cotton | $224,486,000 |
| Sheep | 130,000 | Fruit, Tree Nuts, | $72,917,000 |
| | | Vegetables, Melons | $764,062,000 |

<table>
<thead>
<tr>
<th>Milk</th>
<th>Value of Livestock Production</th>
<th>$1,655,545,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Cows</td>
<td>196,000</td>
<td></td>
</tr>
<tr>
<td>Milk Production per Cow (lbs)</td>
<td>24,429</td>
<td></td>
</tr>
<tr>
<td>Production (lbs)</td>
<td>4,788,000,000</td>
<td></td>
</tr>
</tbody>
</table>

**Total Value of Agricultural Sector Production**

| $4,063,701,000 |

## Changes Over Time 2007 - 2016

<table>
<thead>
<tr>
<th>2007</th>
<th>2016</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Farms</td>
<td>15,637</td>
<td>19,600</td>
</tr>
<tr>
<td>Land in Farms (acres)</td>
<td>26,117,899</td>
<td>25,900,000</td>
</tr>
<tr>
<td>Average Size of Farm (acres)</td>
<td>1670</td>
<td>1,321</td>
</tr>
<tr>
<td>Cash Receipts</td>
<td>$3,234,552,000</td>
<td>$3,732,113,000</td>
</tr>
<tr>
<td>Crops</td>
<td>$1,998,911,000</td>
<td>$1,942,539,000</td>
</tr>
<tr>
<td>Livestock</td>
<td>$1,590,291,000</td>
<td>$1,655,545,000</td>
</tr>
<tr>
<td>Average Per Farm</td>
<td>$206,552</td>
<td>$186,559</td>
</tr>
</tbody>
</table>

## Other State Highlights, 2012

### Economic Characteristics

<table>
<thead>
<tr>
<th>Farm by value of sales</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $1,000</td>
<td>10,568</td>
</tr>
<tr>
<td>$1,000 to $2,499</td>
<td>2,068</td>
</tr>
<tr>
<td>$2,500 to $4,999</td>
<td>1,820</td>
</tr>
<tr>
<td>$5,000 to $9,999</td>
<td>1,501</td>
</tr>
<tr>
<td>$10,000 to $19,999</td>
<td>1,267</td>
</tr>
<tr>
<td>$20,000 to $24,999</td>
<td>236</td>
</tr>
<tr>
<td>$25,000 to $39,999</td>
<td>491</td>
</tr>
<tr>
<td>$40,000 to $49,999</td>
<td>181</td>
</tr>
<tr>
<td>$50,000 to $99,999</td>
<td>442</td>
</tr>
<tr>
<td>$100,000 to $249,999</td>
<td>649</td>
</tr>
<tr>
<td>$250,000 to $499,999</td>
<td>269</td>
</tr>
<tr>
<td>$500,000 or more</td>
<td>633</td>
</tr>
<tr>
<td>Total farm production expenses ($1,000)</td>
<td>3,256,922</td>
</tr>
<tr>
<td>Average per farm ($)</td>
<td>162,905</td>
</tr>
</tbody>
</table>

| Net cash farm income of the operations ($1,000) | 600,305 |
| Average per farm ($) | 30,012 |

### Operator Characteristics

<table>
<thead>
<tr>
<th>Principal operators by primary occupation</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming</td>
<td>13,219</td>
</tr>
<tr>
<td>Other</td>
<td>8,786</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Principal operators by sex</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>12,170</td>
</tr>
<tr>
<td>Female</td>
<td>7,835</td>
</tr>
</tbody>
</table>

Average age of principal operator | 61.1 |

<table>
<thead>
<tr>
<th>All operators by race</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian or Alaska Native</td>
<td>18,375</td>
</tr>
<tr>
<td>Asian</td>
<td>100</td>
</tr>
<tr>
<td>Black or African American</td>
<td>64</td>
</tr>
<tr>
<td>Native Hawaiian or Other Pacific Islander</td>
<td>26</td>
</tr>
<tr>
<td>White</td>
<td>13,064</td>
</tr>
<tr>
<td>More than one race</td>
<td>113</td>
</tr>
</tbody>
</table>

All operators of Spanish, Hispanic or Latino Origin | 1,161 |

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https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=ARIZONA
Arizona Agribusiness and Equine Center
High Schools

What is AAEC?
Founded in 1997, early college high school, Arizona Agribusiness and Equine Center, Inc. (AAEC) in partnership with Maricopa Community Colleges and now Yavapai Community College, is a multiple campus, independent college preparatory high school district. Each campus offers a rigorous college preparatory curriculum, and enables qualified Arizona resident students to earn college-transferable credits while completing work for their high school diploma.

AAEC Early College High Schools teach the Arizona State Standards in all core curricula and is accredited by the North Central Association of Schools and Colleges. Currently, AAEC Early College High Schools is a thriving five-campus independent public high school district specializing in a college preparatory high school program with sites connected to Mesa Community College, Paradise Valley Community College, South Mountain Community College, Estrella Mountain Community College and now Yavapai Community College.

<table>
<thead>
<tr>
<th>South Mountain</th>
<th>Paradise Valley</th>
<th>Red Mountain</th>
<th>Estrella Mountain</th>
<th>Prescott Valley</th>
</tr>
</thead>
</table>

AAEC has a reputation in the Valley for preparing students of various academic backgrounds and abilities for college level studies in all disciplines. Remaining true to its origins, AAEC Early College High Schools continues to offer outstanding instruction in the sciences for students interested in careers in biotechnology, veterinarian studies, equine science and agriculture-related fields. AAEC is focused on preparing students for future success. Our teachers work with industry partners to update and strengthen our curriculum. We also study labor projections to focus our offerings on professions which will be in demand in the future. Each campus is designed to provide educational choice for up to 500 high school students. The schools attract students and families from all over the Phoenix Valley who have many different interests. Alumni studies show that graduates pursue a wide variety of college majors. Independent status allows AAEC, through an open enrollment policy, to draw a wide range of students from across the city and state to its uniquely blended high school/college model.

AAEC College Preparatory High Schools Philosophy
AAEC pledges to provide all students with what they need to succeed:
- A superior academic program that meets students where they are academically and socially, and prepares them for college.
- Advanced coursework.
- Comprehensive student support services.
- Small classes and an intimate high school environment.
- An authentic college experience that allows students to enroll in college classes and participate fully in the life of the post-secondary partner.

Exceptional Faculty
AAEC Early College High Schools employ highly qualified instructors with substantial academic backgrounds as well as extensive professional experience. Our lower teacher to student ratio enables your child to have a personalized experience.
WHO ARE WE?
Congress created the Beef Promotion and Research Act, the “Beef Checkoff Program,” with passage of the 1985 Farm Bill. Ranchers approved making the Beef Checkoff Program mandatory in 1988, with 79 percent voting in favor of it.

RANCHERS ASKED THE CHECKOFF PROGRAM BE BUILT ON THESE TENETS:
- All producers and importers pay the same $1-per head.
- One-half of the money collected by state beef councils – 50 cents of every dollar- is invested through the beef council in each state.
- All national checkoff-funded programs are budgeted and evaluated by Cattlemen's Beef Board, an independent organization of 104 checkoff-paying volunteers.
- Beef Board members are nominated by fellow state producers and appointed by the U.S. Secretary of Agriculture.

RESOURCES FOR TEACHERS
The Arizona Beef Council provides materials for classroom, presentations and ranch tours with topics including nutrition, the basics of the beef industry, food safety, beef byproducts, and the Arizona Cattle Industry all for FREE! Visit www.arizonabeef.org for more information.

OTHER USEFUL CHECKOFF FUNDED WEBSITES…
- www.beeft whatsfordinner.com - Helpful cooking tips and recipes
- www.factsaboutbeef.org - Explains the story, environmental and economics of beef
- www.beefnutrition.org - All the nutrition information you need
- www.arizonabeef.com - Arizona specific information about beef and raising cattle including lesson plans
- www.arizonabeefblog.com - Stories about Arizona beef farmers and ranchers

For more educational questions or requests, please contact Tiffany Selchow at 602.273.7163 or tnselchow@arizonabeef.org
Arizona Department of Agriculture

The Arizona Department of Agriculture is a cabinet-level statewide agency with 263 employees and an annual budget of more than $22 million. Our goal is to regulate and support Arizona agriculture in a manner that encourages farming, ranching, and agribusiness while protecting consumers and natural resources. The agency consists of three main divisions: Animal Services, Environmental Services, Plant Services.

The Department also includes a State Agricultural Laboratory; a Citrus, Fruit and Vegetable Standardization and Fresh Produce Grade Inspection program; and an Agricultural Consultation and Training program.

**Plant Services Division** - Protecting Arizona’s native plants.
Ensure the public and the agriculture industry that dangerous plant infestations prevented or readily controlled. (Such pests include: gypsy moth, Mediterranean fruit fly, and imported fire ant, among others.)

**Animal Services Division**
We protect consumers from contagious and infectious disease in livestock, poultry, commercially raised fish, meat, milk, and eggs. We do this by enforcing laws concerning the movement, sale, importation, transport, slaughter, and theft of livestock. In addition, we conducting food quality and safety inspections of milk and meat products produced and processed in Arizona, and of egg and egg products produced in, or imported to, Arizona.

**Environmental Services Division**
Register and licensing feed, fertilizer, seed and pesticide companies or products in accordance with federal and state laws; Sampling for product quality to help protect the consumer; Enforce pesticide use compliance to ensure established buffer zones are adhered to, environmental concerns are met, and people are protected; Train and certify pesticide applicators and advisors. This includes the Worker Safety program, which is responsible for preventing or limiting farm workers exposure to pesticides.

**Citrus, Fruit and Vegetable Standardization**
The Citrus, Fruit, and Vegetable Standardization program monitors and enforces the quality standards for all fresh fruit and vegetables produced and marketed in Arizona. Citrus, Fruit, and Vegetable Standardization continues to support the state-wide gleaning program — a collection of wholesome food for distribution to the poor and hungry. This program gathered and distributed over 40.3 million pounds of produce in FY 2009.

**Agricultural Consultation and Training**
The Agricultural Consultation and Training (ACT) Program is an innovative compliance assistance program unique to an agricultural regulatory agency. This program embraces the ADA’s goal of encouraging farming, ranching and agribusiness, while protecting consumers and natural resources by utilizing a non-enforcement approach. ACT is not affiliated with any of ADA’s enforcement programs, allowing staff members to provide a formal means by which the regulated agricultural community may request compliance assistance without regulatory intervention. ACT serves Arizona’s diverse agricultural community through the following compliance assistance and education programs: Pesticide Safety, Air Quality, and Agricultural Conservation Education.

ACT also houses the Livestock & Crop Conservation Grant Program, Specialty Crop Block Grant Program, AZ Citrus Research Council, AZ Iceberg Lettuce Research Council, AZ Grain Research and Promotion Council, Agricultural Employment Relations Board, and the AZ Agricultural Protection Commission.

**State Agricultural Laboratory**
We provide quality agricultural and environmental laboratory analysis, identification, certification and training services to various regulatory divisions of the Department and others as provided by law. To accomplish this mission, we are divided into Biology and Chemistry.
The National FFA Organization was organized as the "Future Farmers of America" in 1928 in Kansas City, Missouri. In 1988, the official name of the organization was changed to The National FFA Organization to reflect the broadening field of agriculture, which today encompasses more than 300 careers in everything from agri-science to biotechnology to turf grass management.

FFA operates on local, state and national levels. Student members belong to chapters organized at the local school level. Agricultural education instructors serve as chapter advisors. Chapters are organized under state associations headed by an advisor and executive secretary, often employees of the state department of education. States conduct programs and host annual conventions.

Through active participation in the FFA, members learn by taking part in and conducting meetings, speaking in public, participating in contest based on occupational skills, earning awards and recognition and becoming involved in cooperative efforts and community improvement. The FFA offers opportunities for becoming productive citizens in our democracy.

FFA members believe in leadership, citizenship, and patriotism. They believe in free enterprise—freedom under the law-in making their homes, schools, and communities’ better places in which to live and work.

Members participate in regular chapter meetings, present motions, debate issues, and take part in decision making. They work hard, but they also play hard, as recreation is also a part of each year's program of activities.
Arizona Department of Education - Farm to School and School Garden Program

Farm to School is an initiative based on connecting local farmers and schools in an effort to enhance school food. Research shows that when students know where their food comes from and have the opportunity to work in a school garden, they are more likely to eat those healthful foods. The growing movement to increase access to local foods has been evident for years. Now, Arizona is coordinating its efforts to ensure that children have access to Arizona Grown products in school meals.

Benefits of the Arizona Farm to School Program include:

1. Investing in Arizona’s local ranchers and farmers thereby supporting your local economy.
2. Helping meet the needs of Child Nutrition Programs by providing access to fresh and healthy food.
3. Supports education initiatives by providing innovative learning techniques in and outside of the Classroom.

Key Components of the Arizona Farm to School Program:

1. Serving locally and/or regionally grown or produced goods in school meals and snacks.
2. Teaching science, language arts and math through the concepts of nutrition, agriculture, and food safety to enhance each district’s curriculum in these core subjects.
3. Farm tours.
4. Agriculture in the Classroom [http://azfb.org/programs/agriculture-inthe-classroom.html] and Agricultural Literacy programs [http://cals.arizona.edu/agliteracy/]
5. Seasonal menus.
6. Community involvement.

The Health and Nutrition Services Division (HNS) of the Arizona Department of Education oversees the federal child nutrition programs at the Arizona Department of Education. A function of these programs are to ensure that the health and safety needs of their direct beneficiaries are met. These programs include: National School Lunch Program and its associated programs, the Summer Food Service Program and the Child and Adult Care Food Program.

HNS helps to identify available resources that positively impact the academic success and well-being of Arizonans. In an effort to increase access to fresh and healthy foods at meals offered through child nutrition programs, HNS focuses work in farm to school and school garden development. HNS accomplishes this through grant administration, training and technical assistance and research.
Arizona Farm Bureau

Arizona Farm Bureau is a grassroots organization dedicated to preserving and improving the Agriculture industry through member involvement in education, political activities, programs and services. The Arizona Farm Bureau is Arizona’s largest farm and ranch organization with membership that represents production agriculture throughout the state of Arizona.

Farm Bureau’s purpose is to be an independent, non-governmental grassroots organization that analyzes problems and formulates action to achieve educational improvement, economic opportunity, and social advancement in order to promote the financial and overall well being of agriculture and our members. We are the "Voice of Agriculture in Arizona."

As the agriculture industry faces new challenges in the future, Farm Bureau will be there to assist our members in meeting those challenges. We will be involved in lobbying on county, state and national issues. We will be there to discuss issues of profitability, property rights, labor, water, trade, farm policy, tax issues, environmental issues and much more. We will also continue to offer value to our members by providing products and services.

We reach out to the public in many ways to teach them that their food, fiber and ornamentals come from farms and ranches, not from the store. Activities to promote agriculture to the public and the schools are also a focal point of the Farm Bureau.

Ag in the Classroom
The Arizona Farm Bureau Ag in the Classroom program strives to develop and implement curriculum and programs that are aligned to the state and core learning standards to help students and teachers be successful, while increasing agricultural awareness in K-6 classrooms and beyond.

**Free Resources for Teachers** - You take the kits or we come to your classroom
- Curriculum Kits
- Farmer/Rancher Pen Pals
- Classroom presentations
- School Field Trips
- Ag Lending Library
- Informational websites

Online Product Directory
Arizona Farm Bureau’s Fill Your Plate is an on-line direct market product directory. From apples to zucchini, and everything in between, Arizona’s farmers and ranchers will fill you up with the best knowledge of where your Arizona food comes from. Find locally grown products at www.fillyourplate.org.

Farm Bureau is local, county, state, national, and international in its scope and influence, and is non-partisan, non-sectarian, and non-secret in character. We are supported by dues-paying members, and we offer a myriad of services, discounts and benefits to our members.

Arizona has 13 active county Farm Bureaus covering all 15 counties. These are the basis of our grassroots organization. Each county Farm Bureau is an independent entity governed by local farmer and rancher volunteer leaders. All ideas, solutions, and leadership come from the members of the county Farm Bureau.

Arizona Farm Bureau
325 S. Higley Road, Suite 210, Gilbert, AZ 85296  www.azfb.org
Arizona State Cowbelles, Inc.

The Arizona State Cowbelles is a unified, professional organization made up of generations of Arizona women playing a vital role in the state’s cattle industry. The organization got its start in 1939 when a group of ranchers’ wives in the Douglas area formed a social club to cement goodwill and friendship among the wives and mothers of cattlemen in southeast Cochise County. The women named their organization “The Cowbelles.” The club immediately began doing charitable work.

Word of the unique organization spread quickly. The Wyoming State Cowbelles was formed in 1940. Texas women also asked permission to organize their own state Cowbelles. The Arizona State Cowbelles was formally organized in January, 1947, during the annual convention of the American National Cattlemen’s Association in Phoenix. Mattie Cowan, president of the original Cowbelles in Douglas, was elected the first state president. A total of 16 local Cowbelles groups have been organized around the state.

Over the years, the Cowbelles have turned their primary focus to beef promotion and public education about the nutritional value of beef and the lifestyle of ranch families. Arizona Cowbelles work hand in hand with the Arizona Beef Council to bring the message or ranching and the beef industry to their local schools, communities, and businesses.

Visit www.ArizonaCowbelles.org to find out more about the Cowbelles’ Scholarship Program or to contact the Cowbelles’ Officers and Local Presidents.
Dairy Council® of Arizona

Arizona Milk Producers

Dairy Council® of Arizona is a nonprofit nutrition education organization funded by Arizona’s milk producers and is an affiliated unit of National Dairy Council®. We strive to provide you with the latest in nutrition research and educational materials to help make your job easier. We offer a wide range of scientifically based education materials for all age groups, from pre-school through adult audiences. As a leader in nutrition education services in Arizona, we provide information on current nutrition issues such as calcium needs, osteoporosis, hypertension, weight management, lactose intolerance, dental health, and general nutrition. All Dairy Council of Arizona nutrition education materials are based on the MyPyramid Food Guidance System. Some of our materials are also available in Spanish.

No school wellness policy can be complete without incorporating nutrition education into the plan. Dairy Council of Arizona provides nutrition curriculum packages for several grade levels, as well as other nutrition education materials you can use to help you implement the best wellness policy you can. Dairy Council of Arizona is proud to provide these award winning, age-specific nutrition education materials throughout the state at no charge.

Arizona Milk Producers is the advertising and promotion arm of the organization, dedicated to promoting the benefits of milk and dairy foods to consumers. One aspect of this promotion is to highlight the importance of agriculture in the state and how dairy farmers care for their land and animals.

Arizona’s dairy farmers are committed to providing you and your family with wholesome milk and dairy products. This commitment starts on the farm with top-notch animal care and extends across the supply chain - from the milk tanker trucks to the processing plant to the grocery store - to ensure that the dairy foods you enjoy each day are as wholesome and pure as nature intended.

Dairy farmers work hard every day to bring you fresh, great tasting, milk products. Most dairies are family-owned, and as active members of their communities, farm families take pride in maintaining natural resources. That means preserving the land where they live and work, protecting the air and water they share with neighbors, and providing the best care for their cows - the life-blood of their business.

Dairy Council of Arizona
www.dairycouncilofaz.org
Diablo Trust

Learning from the land and sharing our knowledge... So there will always be a West.

An Unlikely Alliance
The Diablo Trust was initiated in 1993 at a community gathering called by two northern Arizona ranch families — the Prossers of the Bar T Bar and the Metzgers of the Flying M. The families took this unique step in response to increasing pressures on the historic uses of these century-old homesteads and the ranches associated with them.

Members of these families, who had long worked to promote healthy ranchlands, now welcomed others who shared their concern for the environment and wildlife to combine their energy, skills, dedication, and willingness to work to deal with these pressures more effectively, openly, and collaboratively.

From that "opening up" of the management of these two ranches arose a cooperative effort in which the diverse members of the Diablo Trust have worked together to create research and educational programs that are earning attention and acclaim from around the West and beyond.

Today, the Trust, open to everyone, provides a forum for the community to actively participate in a land stewardship process with monthly meetings the second Friday of every month. The results of its efforts include improved vegetation, better habitat for wildlife and livestock, and the protection of open spaces. Additionally, the ranch lands provide “hands-on” proving grounds for new, collaborative land management ideas.

Projects
Through our Diablo trust collaborative learning process, we are evaluating the effects of management, recreation, climate, fire, and time on more than 400,000 acres of private and public lands. As we learn from the land, we also work to restore it.

The ranchlands provide "hands-on" proving grounds for new, collaborative land management ideas. Project areas include rural planning; education; wildlife; community outreach; land and watershed improvement; recreation; and science and monitoring. Each project area is administered by a Diablo Trust Working Group.

In 2010, with the collaboration of state and federal agencies representatives, we created the Collaborative Resource Operational Plan (CROP). This plan documents projects implemented on Diablo Trust lands including brush management, water improvements, prescribed burns, and facilities implementation. The CROP plan and project database helps facilitate the transition of in-coming and out-going agency personnel that work closely with us.
Four Forest Restoration Initiative

What is Four Forest Restoration Initiative (4FRI)?
The Four Forest Restoration Initiative (4FRI) is a collaborative effort (among the U.S. Forest Service, citizens, conservation organizations, researchers and state agencies) to restore forest ecosystems on portions of four National Forests – Coconino, Kaibab, Apache-Sitgreaves, and Tonto – along the Mogollon Rim in northern Arizona.

Ponderosa pine forests stretch almost continuously from the south rim of the Grand Canyon, across the Mogollon Rim, to the White Mountains in eastern Arizona. Presently, forests are overgrown with thickets of young, unhealthy trees that contribute to the threat of unnaturally-severe wildfire.

Why do we need a forest restoration initiative?
Recent wildfires, increasing in size and intensity never before witnessed, provide evidence of natural ecosystems in widespread decline. While fire has always helped shape the landscape, today's fires are not those of the past; they are often hotter, more destructive and more dangerous to fight. In part, the reason for the difference is that many of today's forests have unprecedented levels of flammable materials including: dense thickets of small trees, underbrush, needles and leaves.

The vision of the 4FRI is a restored forest that supports low-intensity surface fires and functioning populations of native plants and animals. The vision includes communities that are better prepared for and protected from unnaturally-severe wildfire, and sustainable forest industries that strengthen local economies.

4FRI GOALS
• Accelerate large restoration efforts to support natural fire regimes, healthy diverse forests and rangelands, and abundant populations of native plans and animals.
• Facilitate community fire protection and preparedness.
• Enhance local economies through the use of excess trees.

Four Forest Restoration Initiative
www.fourforestrestorationinitiative.org
Groseta Ranches

Groseta Ranches was started in 1922 by Peter Groseta, Sr. in Middle Verde, Arizona. Over the past 87 years, the original 25-cow ranch has grown into a 400 cow-calf operation that is run by Andy Groseta and his son, Paul. Currently, the third, fourth & fifth generations live at the ranch headquarters, located on the banks of the Verde River in Cottonwood, Arizona. Cottonwood is 20 miles southwest of Sedona and 100 miles north of Phoenix.

Cattle on the ranch are branded with the W Dart brand which was acquired when Pete Groseta, Jr. purchased the W Dart cow outfit from the Fain family in 1948.

The ranch consists of approximately 40 sections of deeded, private leases, state trust and Forest Service lands. A set of commercial crossbred cows consisting primarily of Angus, Hereford and Charolais cows runs on these 40 sections. In addition to these cattle, a small herd of Maine, Chianina, Angus crossbred cows are kept on irrigated pasture at the ranch headquarters and are used to produce a select number of club calves for local 4-H and FFA members.

_land Management Practices_

The ranch uses a deferred rotation grazing management system. Cattle are rotated through pastures allowing a minimum of one growing season (12 months) of rest. This practice promotes healthy rangelands for the cattle and wildlife. The ranch has approximately 20 miles of pipeline to provide water to both cattle and wildlife. Water is provided by wells, springs, dirt tanks and the Verde River. At the ranch headquarters we have irrigated permanent pastures where the ranch horses are kept. Irrigation water is provided to the headquarters from the Cottonwood Ditch Association (CDA). The CDA has senior water rights on the Verde River with the first water rights being recorded on December 10, 1877.

*ranch Management Practices*

Cows calve in the spring, and are weaned and sold in the fall or held over and sold the following spring; this depends on forage conditions. The top heifers are kept as replacement heifers, bred by natural service and calve as first-calf heifers at the headquarters before being mixed in with the rest of the herd on the ranch. Despite the many challenges facing the cattle industry, Groseta Ranches continually strives to improve the quality of cattle produced, while remaining a good steward of the lands the cattle are produced on. With our large land base, our program revolves around functional, easy going, low maintenance cattle. A keen eye is kept on market demand in order to stay in tune with the trends of today’s consumers. This diligence in selection and continual improvement helps us meet the needs of commercial producing beef for today's consumer.
Los Cedros USA

From the sweet and warm heart of the arizona desert, in the beautiful city of Scottsdale, resides a place of enchantment for those who love superb performance horses. Art and functionality, perfectly blended with the surrounding desert flora, is embodied in a magnificent compound of extraordinary resources for the excellence and performance of trainers and horses.

Los Cedros USA, combined with the resident professional trainers, make this facility the ultimate home for performance horses from around the world. Trainers, breeders, owners, and horse enthusiasts are encouraged to call us about Los Cedros horse events, or call us about scheduling your own special event at this majestic and elegant facility.

Los Cedros USA is committed to be one of the finest horse training facilities in the world. Trainers working at Los Cedros are several cuts above the rest, with specialists in Arabian horses, and Hunter, Jumper, Dressage, and Western styles. With an on-site rehabilitation and exercise pool, and on-site veterinary services available, Los Cedros has it all.

Los Cedros USA transforms, when the horse training workday is done, into a world-class event site. We are strategically located in beautiful north Scottsdale Arizona, with easy access to five-star amenities and an international airport. Los Cedros USA offers a uniquely majestic and elegant place to gather for corporate or personal celebrations, seminars, dinners, and other events. The enchanting company of world-class performance horses, with the beauty of the setting sun behind the glorious Scottsdale mountains, make Los Cedros USA the perfect event oasis for your group.

Los Cedros USA, 8700 East Black Mountain Rd. Scottsdale, Arizona 85266
http://loscedros.com/
Maricopa County Farm Bureau

Maricopa County Farm Bureau (MCFB) is a grassroots membership organization dedicated to promoting and defending agriculture in a county with nearly 4 million residents. A non-profit organization governed by an elected board of directors who are local agriculture producers, MCFB concentrates its efforts on four areas: representing agriculture in local and county legislative and regulatory actions; education and communication; member benefits and developing leaders for the agriculture industry.

MCFB is one of the 13 county Farm Bureaus that make up the Arizona Farm Bureau Federation.

Maricopa County Farm Bureau is an “umbrella” organization that covers all aspects of agriculture—large and small production facilities growing crops and animals from celery and cilantro to horses and shrimp, from dairy cattle to hay and zucchini. That’s why Farm Bureau calls itself “The Voice of Agriculture.”

As part of our educational outreach, our farmers read to students during Agriculture Literacy Week in November and respond to requests for classroom presentations by a real farmer. Our farmers are also seen in various media presentations that show the real source of food, fiber, and ornamental plants.

Our Ag in the Classroom program brings presentations to your school to help your students learn about the plants and animals that provide all the food they eat, most of the clothes they wear, the materials to build their homes and the ornamental plants and trees that make their homes and properties beautiful.

MCFB originated the popular “How to Grow a Pizza” trace-back exercise that shows how many farms it takes to provide the ingredients for pizza. Schedule “How to Grow a Pizza” presentations for your school by calling MCFB at 602-437-1330.

MCFB also provided initial funding for writing and printing an accurate children’s book about Arizona agriculture entitled Arizona Agriculture: Bee’s Amazing Adventure. Call our office in early November to request a real farmer to read this book to your class during Agriculture Literacy Week! (And check your school library to see if it is available there.)

Maricopa County Farm Bureau, 4001 E. Broadway, Ste. B-9, Phoenix, AZ 85040
602-437-1330 – e-mail: mcfb@qwestoffice.net
Welcome to Mortimer Family Farms, a popular Prescott area attraction formerly known as Young’s Farm, is bringing back the rich farming history of Dewey-Humboldt. Gary Mortimer started Mortimer Nursery & Landscape Company in 1987 when he moved to the Prescott Area from Phoenix. Sharla joined the family and business in 1996. Through the years they have grown not only their business, but also their family to include four children: Ashlee, Hayden, Kayla, and Kolten.

In 2003 they moved to Ash Creek Ranch where they raise Black Angus Cattle. Since then their love of farming has flourished and readied them to revitalize and bring back to life one of Arizona’s most recognizable premier farms located at the corners of Highway 69 & 169 in Dewey-Humboldt.

Made famous for our Sweet Summer Corn, we also grow a variety of other seasonal vegetables on our 300 acre farm made available in our Farm Store. Mortimer Family Farms is growing a variety of produce that will be available seasonally in our farm store.

Vegetables include: Sweet Corn, Pumpkins, Squash, Onions, and more! Our nursery also has trees, shrubs, flowers, landscape materials, and gardening supplies available for all your gardening needs.

2011 was very successful with many excited visitors to the farm. They enjoyed a Spring Festival, Corn Festival, Pumpkin Festival, and Christmas Event. The Mortimer’s will do their best to continue many of the traditions you have enjoyed in the past.

- Re-opening of the Farm Store, On-Site Nursery, and Seasonal Vegetable Stand
- The fields will be brimming with Sweet Corn, Summer Vegetables, and Pumpkins
- Sweet Corn Festival in August
- Pumpkin Festival every weekend in October
- Huge Corn Maze
- A beautiful shady park near the river is now available for private weddings and events.

Thank you for your continued support of Mortimer Nursery & Landscape Company. It is because of the many years of community support and fantastic customer service staff, Mortimer Family Farms is becoming a reality!
Page Springs Cellars is a family owned vineyard and winery crafting fine Arizona Wines tucked into the volcanic landscape overlooking pristine Oak Creek. Page Springs Cellars Arizona winery offers delicious Rhône style wines, gourmet food selections and breathtaking views.

Come visit the tasting room just 15 minutes south of Sedona and experience a true taste of Arizona. Whether you are a novice or aficionado, experienced staff can suggest tasting flights from the extensive wine menu to delight your palate.

The Estate Vineyard was planted in the spring of 2004. Nestled along the banks of Sedona’s famous Oak Creek and on the lower flanks of House Mountain volcano, this site is truly unique. The specific soils contribute character to the grapes. And Page Springs has a climate very similar to the Mediterranean, which is critical for the development of flavors and other grape components that are critical to making fine wine.

Shop for local crafts and artwork, t-shirts, caps and locally produced products, or ask us to pack you a picnic basket! Enjoy the view from the scenic deck beside the cooling waters of Oak Creek and catch a glimpse of the local residents: herons, hawks, bald eagles, ducks, hummingbirds, raccoons, river otters and javelinas. Or for the ultimate in relaxation or for car-weary muscles, try a chair or table massage on the vineyard.
Pendley Apple Homestead

Apples and Rangers Unite

*by Hank Vincent, Park Ranger*

The apple orchard at Slide Rock State Park has graced the property since 1912, when Frank Pendley established his first plantings. Apples were the primary cash crop of the Pendley family homestead. The homestead property became Slide Rock State Park in 1987.

For over a decade, orchard maintenance has been contracted out. In the spring of 2007 State Parks reacquired responsibility. The longevity of the historic trees and the quality of up coming harvests greatly depend upon ranger interaction. There are just over three hundred apple trees that require unwavering care and attention.

Winter in Oak Creek Canyon has brought freezing temperatures and taken the leaves from deciduous trees. With the apple trees entering dormancy, pruning has begun. Important objectives in pruning are: remove dead wood, admit sunlight and allow aeration, promote quality fruit, and shaping the trees for easier harvest and to allow passage. Cutting is done with loppers, handsaws and chainsaw. Three legged aluminum ladders are used to access high sections of tree. Each cut leads to the completion of a tree. Completion of each tree leads to a well-trained orchard.

Early spring brings blossoms and bud growth. Apple flowers are small, white with pink high lights and have an exquisite sweet aroma. With assistance from bees, other insects and wind the flowers are cross-pollinated. After fertilization, the petals will drop and apples will begin to take shape.

Spring is a fragile time for apples. A late freeze can kill the blossoms. This is also when the codling moth lays its eggs in the tree. The eggs hatch and become worms. The worms will eat the fruit and seeds. The codling moth needs to be monitored using pheromone traps. The trees must be sprayed with insecticide when moths are in greater numbers to prevent further infestation. As the apples grow thinning needs to occur. Thinning is the removal of excess fruit to improve size and quality of what is left on the tree.

During the long hot days of Arizona summer, fruit trees need irrigating. Electric pumps bring water from Oak Creek. Long aluminum pipe with sprinklers are set up to deliver water to each section of the orchard. With the trees well watered and thinned, the apples will continue to mature. Branches sagging under the weight of fruit need to be propped up with cull lumber. Harvest is both a laborious and rewarding time in an orchard. Picking usually starts in late August or early September. Indications of maturity are size, color, firmness and of course taste. Prematurely picked apples are chalky and bland. The familiar crisp crunch and classic sweetness of an apple is a most pleasing suggestion to pick. Caution must be taken while picking. Apples bruise easily. The fruit is sorted and boxed then taken to cold storage.

Slide Rock still employs the “Apple Packing Shed” built by Frank Pendley. The Pendley family used the shed to sort, polish, package and store their harvests. Harvest is celebrated with the Slide Rock Apple Festival. Activities include a pick your own apple program, games, entertainment, vendors and display booths. With a sigh of relief orchard clean up and preparations for next year’s crop begin. As ranger efforts continue, experience and training will expand the relationship between apple and human. These efforts enhance visitors’ experience and preserve historic integrity.

*From: www.azstateparks.com/Parks/SLRO/feature.html*

Pendley Apple Homestead

2395 S Ash Ln Flagstaff, AZ 86004

http://azstateparks.com/Parks/SLRO/history.html
The Rousseau family has farmed in Arizona for four generations, dating back to the late 1800’s. Bill Rousseau was primarily involved in the cattle business with a feed lot in West Phoenix that he operated until 1982. His oldest son, Will, after graduating with a Bachelor of Science in Agronomy from the University of Arizona in 1979, worked with Bill for three years while starting his own farming operation. By 1986, Will was farming 1700 acres of row crops before experimenting with 40 acres of carrots. That same year the youngest son, David, another University of Arizona grad ('83) returned after three years with the Farm Credit System to help form the Rousseau Farming Company partnership.

Founded in 1986, Rousseau Farming Company is a privately-held grower/shipper of vegetables and melons. It is one of the Arizona’s fastest growing produce companies. The company, with headquarters and growing fields in Tolleson, AZ, and additional farms in Scottsdale, employs a staff of approximately 500.

Today, the operation consists of over 10,000 acres, of which over 70 percent is vegetable production with the core crops being carrots, broccoli, onions, cantaloupe and watermelons. Rousseau Farming Company grows all these crops on a separate organic farm as well. The operation is vertically integrated with its own harvesting equipment, trucking, cooling, icing, processing and shipping facilities.

Will Rousseau has been active in the Arizona agriculture community and was elected to the Western Growers Board of Directors in 1993 and has served continuously since.
Dairy cows are treated like queens on Arizona dairy farms and Triple G Dairy is no exception - it’s a high tech cow spa.

Owned and operated by the Gingg family, Triple G embodies four generations of dairy farming. Conrad Gingg grew up in the dairy business on his family’s dairy farm in California. His sons, Ben and K.C., run Triple G along with Ben’s children, Connie and Max who are part of the day to day operation of the dairy.

Cow comfort is an obvious priority at the facility as sophisticated computer controlled fans and misters adjust the atmosphere to keep the cows cool, while side curtains help keep the cool air inside. The milking parlor contains two state of the art milking carousels that each have 48 stalls and the cows even have a shaded walkway to get to the milking parlor. Triple G milks 3700 cows 3 times each day and combined with the young stock, the facility houses about 8000 animals.

Sustainability is also important for Triple G. Much of the feed is grown on the family’s 4000 acre farming operation and feed storage and mixing takes place right there on the grounds. A new methane collection system is in place and plans are in the works to actually generate their own power using the methane. Environmental issues are a key element as the family works to protect the soil and water to provide a good home for their cows, their families and their communities.
U of A Cooperative Extension

**Cooperative Extension** plays a unique role in both urban and rural areas of the state. Extension provides practical information and education to help people make their lives better. Outreach efforts translate relevant University of Arizona research into effective practices people can put to immediate use in their homes and businesses.

Programs are conducted by the University of Arizona College of Agriculture and Life Sciences Cooperative Extension faculty in each county office and by campus-based Extension Specialists. Faculty members – Extension Agents – form partnerships with community groups and with trained volunteers to *bring the university to the people.*

Cooperative Extension programs address key quality of life issues pertaining to Animals; Environment & Natural Resources; Family, Youth & Community; Marketing, Trade & Economics; Nutrition, Food Safety & Health; and Plants.

**Creating a Better Environment for Families and Consumers:** Healthy people are better able to contribute to a robust economy. Cooperative Extension programs are designed to strengthen families, promote healthy lifestyles and wise financial decisions and develop community leaders. Programs are offered at community centers, churches, and other venues to reach diverse audiences.

**4-H Youth Development:** Youth ages 5-19 can be involved in more than 100 educational projects that are offered through 4-H. 4-H uses experiential learn-by-doing projects, meetings, community service and a variety of educational experiences to teach life skills while having fun. 4-H is young people and adults growing together to become informed, educated citizens.

**Agriculture and Natural Resources:** Extension promotes environmental stewardship through Horticulture, Field Crops, Turfgrass and Invasive Species programs. The Water Sustainability programs create quality interactive learning experiences to promote responsible water stewardship, including conservation.

**Cooperative Extension** has offices across the state, in counties and on Indian Reservations, that can be accessed through the web site cals.arizona.edu/extension. These offices are located in:

- Apache (St. Johns)
- Cochise (Willcox & Sierra Vista)
- Coconino (Flagstaff)
- Gila (Payson & Globe)
- Graham (Solomon)
- Greenlee (Duncan)
- La Paz (Parker)
- Maricopa (Phoenix)
- Mohave (Kingman)
- Navajo (Holbrook)
- Pima (Tucson & Sahuarita)
- Pinal (Casa Grande)
- Santa Cruz (Nogales)
- Yavapai (Prescott & Cottonwood)
- Yuma (Yuma)
- Colorado River Indian Tribes (Parker)
- Hopi Tribe (Keams Canyon)
- Navajo Nation (Window Rock & Shiprock)
- Hualapai Nation (Peach Springs)
- San Carlos Apache (San Carlos)
U of A Maricopa Agriculture Center

As one of the major centers of the Arizona Agricultural Experiment Station, the Maricopa Agricultural Center strives to be at the forefront of disciplinary field investigations, to develop, deliver and service the best appropriate integrated agricultural technologies for all problems faced by Arizona consumers and producers, and to provide assistance to all scientists conducting their research and educational outreach programs. The Center not only provides facilities and support for extension outreach programs, but also provides support and facilities for teaching University classes and Ag-Literacy to all age groups.

MAC Farm Ag-Ventures is an Ag-Literacy outreach program that emanates from the University of Arizona's Maricopa Agricultural Center. Program outreach primarily focuses on youth grades K-6. In the past year 9000 youth and adults have experienced an Ag-Venture program which carries out ag related educational experiences both at the MAC Farm as well as an outreach to teachers and students in school settings throughout Arizona. All programs are in line with Arizona educational guidelines.

Nutrition Ag-Ventures - (September-October, March-May)
In this “food comes from the farm series”, students learn how many farms it takes to make a pizza. As pizza is the most popular item of choice among today’s youth, students learn about how plants grow and all the work it takes to bring healthy, nutritious food to the table. Classroom activities are provided to help further the Ag-Literacy experience.

Amazing Corn Festival - (October, November)
For thousands of years, corn has been a major staple in our diets. We have grown, ground, and gobbled it down! Students participate in a variety of educational activities ranging from harvesting, grinding and tasting corn products to corn art.

Desert Ag-Ventures - (January, February)
During the months of January and February, a special series titled 'Desert Ag-Ventures' opens up to let seniors and winter visitors learn about arid land agriculture. Most of the world’s agriculture takes place in arid environments, so this is a great opportunity for adults from around our nation and Canada to learn about and experience Arizona’s agriculture in a fun way.

Water & Science Ag-Ventures - (February)
Junior high school and high students participate in a cooperative effort with U.S. Water Lab research scientists, community supporters and MAC to learn about the science and technologies being applied in agriculture today. In addition to experiencing various rotating workshop presenters, students also get an opportunity to learn about aquaculture in addition to trying their hand at using siphon tubes in the fields.

Garden Ag-Ventures - (March, April, May)
Vegetables are an important part of our diet. Elementary students learn about nutrition, growing techniques, effects of weather, insects, & have the chance to harvest vegetables (depending on harvest conditions.)

For program reservations contact Victor Jimenez at (520) 568-2273 or vjimenez@ag.arizona.edu.
The U.S. Arid-Land Agricultural Research Center integrates the former Western Cotton Research Laboratory and the U.S. Water Conservation Laboratory on a 20-acre site at the University of Arizona, Maricopa Agricultural Center. The 97,000 ft2 research center houses 26 research scientists and over 90 research and administrative support personnel. The mission of the research center is to develop sustainable agricultural systems, protect natural resources, and support rural communities in arid and semi-arid regions through interdisciplinary research. Research topics include crop management, integrated pest management, irrigation technology, remote sensing, water reuse, crop breeding and physiology, and global climate change. The facility opened in February 2006.

Water Management and Conservation Research
Irrigated agriculture is the major user of water in the western United States. While water is considered a renewable resource, it is often in short supply or of poor quality. Increasing demands are being made on limited water supplies by agriculture, cities, and industries. Thus, the objectives of the Water Management and Conservation Research Unit are to develop management strategies and physical hardware needed to attain the most efficient use of irrigation water, to protect groundwater in areas where agricultural practices would have the potential for degrading water quality, and to reuse wastewater.

Research Projects:
- Water Management in Arid Irrigated Agriculture
- Remote Sensing for Crop and Water Management in Arid Irrigated Agriculture
- Reuse of Treated Municipal Waste Water for Irrigation

Plant Physiology and Genetic Research Unit
The mission of the Plant Physiology and Genetic Research Unit is to increase the productivity, profitability and sustainability of agriculture in arid environments by developing new germplasm for both traditional and alternative crops and by improving plant responses to abiotic stresses and to changes in the global environment. Research is conducted under three major projects:
- Physiological and Genetic Basis of Cotton Acclimation to Abiotic Stress
- Commercialization of New Industrial Crop Germplasm and Cropping Systems
- Predicting Impacts of Climate Change on Agricultural Systems and Developing Potentials For Adaptation

Pest Management and Biological Control Research Unit
The mission of the Pest Management and Biocontrol Research unit is to develop unique and improved biological, behavioral, cultural, and genetic based methods to reduce losses by insects and mites affecting crops in arid land production areas of the U.S. The goals are economically, socially and environmentally acceptable pest population suppression technologies based on the use of behavioral chemicals, genetics, cultural practices, biological control, sampling and decision aids, modeling and population dynamics of pests and their natural enemies. Emphasis is placed on development of fully integrated, ecologically-based management strategies in a changing agricultural environment that includes recognition of the agriculture-urban interface.
We are a wholesale plant nursery located in Queen Creek, just southeast of Phoenix, Arizona. Since 1978 we have been growing sub-tropical and drought tolerant varieties from the desert and sub-tropical regions of the world, including many Arizona native plants, as well as vines, trees, shrubs, perennials, succulents, ornamental grasses and grass-like plants.

V&P is constantly looking and developing new and unique cultivars through horticultural techniques and new ideas. We are progressing well in technology of plant sciences – the latest addition being a plant tissue culture laboratory. As we continue to grow, V&P Nurseries is always striving to improve in plant quality and customer satisfaction.

As a wholesale nursery we do not sell directly to the public, but we do sell to many contractors, landscape architects, chain retailers and independent retailers.

**History**

V&P Nurseries started in Demetrios Vlachos' backyard in the 1970's, growing Caesalpinia pulcherrima, the Mexican Bird of Paradise. The nursery started on less than half an acre as a family endeavor. They now have one main site in Queen Creek with 300 acres and one satellite location for further backup and direct-ship of bulk items. In 28 years the operation has expanded to over 300 acres of production and 200 varieties of plants.

Dealing with retailers, Demetrios learned early that you can't survive on just the plants you like. He started out with the Red Bird of Paradise and moved on to other drought tolerant and native plants. The Red Birds were a big hit, but some of the other native varieties were slow to take off. He started to grow other sub-tropical varieties from the desert and sub-tropical regions of the world. V&P is now growing a combination of sub-tropical plants and drought tolerant plants.
Whipstone Farm

We are a family farm located in Paulden, Arizona, about 30 miles north of Prescott. We started selling produce door-to-door in 1995 when our large garden produced more food than our family could eat. We have grown every year since then and now have 15 acres in production. We grow over 100 varieties of vegetables and flowers.

We farm with our heart and health in mind. We do not use any synthetic fertilizer or chemical pesticides. We enjoy growing food for our community not only as a means of providing healthy sustenance, but also as a way to bring people together. We welcome you to come out and see our farm, to learn about where your food comes from and meet the folks who grow it.

Farmers markets are a great way to find and purchase local, fresh products. You get the best of what’s in season and you can talk directly to the farmers who grow it. Farmers markets are also a great community meeting place with lots of educational opportunities. You can find our produce and flowers every week at the Prescott, Flagstaff and Chino Valley Farmers Markets.

The Whipstone Farm Community Supported Agriculture (CSA) is a subscription program where members pay up front for the season, and in return receive a weekly distribution of fresh, locally grown produce. The subscription program helps to support our farm operations; members share the risks and rewards of the harvest with us.
The Chino Valley Agribusiness & Science Technology Center houses courses in Agribusiness Technology, Animal Care & Management, Production Horticulture, Canine Care & Handling, Therapy & Service Dog Team Skills, Equine Practitioner, Electrical Utility Technology, and offers general education classes, including English, math and science.

YC’s Chino Valley Agribusiness & Science Technology Center programs offer students hands-on experience by putting them to work in state-of-the-art learning facilities. Thus, allowing students to learn in a real-world environment and preparing them for careers in specialized industries.

The main campus building is an award-winning “green” facility; Silver LEED (Leadership in Energy and Environmental Design) certification from the U.S. Green Building Council and the first community college in the nation to receive this award. This building minimizes environmental impact and takes advantages of the site upon which it is built with xeriscape landscaping, rainwater harvesting, solar water heating, a geothermal heat pump system, and energy management control system and other features.

The Chino Valley Agribusiness & Science Technology Center also includes computer commons, science lab, construction shop, exercise room, testing services, student support services, academic advising, career coaching and so much MORE!
1. America’s Heartland Episode 502: *Making the Move segment* (5:45) America’s Heartland
   http://www.americasheartland.org/episodes/episode_502/makin_the_move.htm

2. America’s Heartland Episodes (c. 26:00 each) America’s Heartland**
   http://www.americasheartland.org/episodes

3. America Revealed: Food Machine* (53:12) PBS
   http://www.pbs.org/america-revealed/episode/1

4. Arizona Dairy Videos* (*lengths vary*) Dairy Council of Arizona
   http://www.youtube.com/user/AzMilkProducers or http://www.youtube.com/user/AzMilkProducers

5. Arizona Water Story: *Segment 1* CAP & SRP Available for Checkout

6. City Slicker: The Udder Story* (8:16) Arizona Farm Bureau
   http://www.youtube.com/user/azfb#p/search/0/-omcc9ZHeg4

7. Desert Durum: Gem of the Southwest (c. 14:00) University of Arizona Provided

8. Dirty Jobs* (27:53) Hickman’s Family Farms
   http://www.hickmanseggs.com/videos.html

9. Feeding America 1) *The Rust Invasion* (7:49) 2) *Hidden Danger* (5:13) 4) *The Robot Farm*
   (3:30) USDA, CREES
   http://www.csrees.usda.gov/newsroom/partners/partners_17.html

10. Modern Marvels: Harvesting* (c. 50:00) The History Channel Available for Checkout

11. The SRP Legacy (c. 9:55) Available from Salt River Project,

12. Temple Grandin (c. 1:46:00) HBO Available where movies are sold

13. Ten Things Kids Want to Know About Agriculture* (c. 22:00) America Farm Bureau Federation

14. Today in Arizona Agriculture* (8:34) Arizona Farm Bureau
    http://www.youtube.com/user/azfb#p/search/1/YD1xsNBxjB8


16. Welcome to Harmony Farm* (5:14) Arizona Farm Bureau www.azfb.org or
    www.phoenixzoo.com/harmonyfarm

* We plan to watch this on the bus.
** Various segments from this series may be shown.
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Summer Agricultural Institute

News Articles
Making STEM Relevant Through Agriculture

"All science comes from agriculture. Biology, zoology, botany—it all comes from agriculture," asserts John Cole, an agriculture science teacher at Columbia High School in Lake City, Florida. "I feel like agriculture science is a foundation course for all science...If we had not learned to grow things...we would not have science like we know it today.

Cole’s agriscience classes incorporate history (the origins of agriculture) and math (calculating acreage, fertilizer use, and growth rate). He says the hands-on aspects of agriculture also help him demonstrate that "science is not boring." Working in the school greenhouse and garden gives students a chance to "take what they learn [from a book and] apply to it to a real-world situation. It allows them to learn better and retain it better.”

Cole is not alone in these views. Many educators, whether they teach agriculture science as a separate course or integrate it into other science courses, contend that agricultural science is essential and particularly applicable to project-based learning.

Denise Scribner uses agriculture in her ecology, biology, and forensic science course at Eisenhower High School in Goddard, Kansas. Forensic science is a particularly “neat way to look at agriculture,” she says. "I like to integrate [agriculture] with other sciences. Many schools have separate classes [for agriscience], but by integrating it, I can share our agricultural heritage in a variety of ways.

“Agriculture has always been a significant factor in the sustainability and development of human society. Unfortunately, the important role of agriculture as a foundation for secure and durable civilization is not always apparent to those outside of agriculture.

Before taking my classes [in which] I apply ‘real-world’ concepts of agriculture into my lessons, my students saw it only in terms of narrow stereotypes: a farmer, a cow, a tractor,” Scribner says. “My students represent the future leaders of society, the people we will depend on to support, regulate, and advocate for agriculture. That is why I expose them to trending issues like sustainable farming, natural resources, and energy.”

When it comes to agriculture and science, technology, engineering, and math (STEM), "if you’re involved in it, you’re going to be applying it,” says Matthew Eddy, agriscience teacher at Southeast Polk High School in Pleasant Hill, Iowa, where he uses the Curriculum for Agricultural Science Education (www.caselarning.org). Eddy says the curriculum is a “very hands-on, project-integrated program...I’m usually there helping them figure things out; it’s not lecture-based by any means.”

When comparing students’ reactions to being told they would be designing their own hydroponic systems versus finding out they would be studying statistics and probabilities (concepts applied in hydroponic design), Eddy laughs, noting a lack of enthusiasm for statistics and probabilities. However, he adds, “once you get the connection between what you’re learning in science and where it’s applicable, that’s where students start to become engaged.”

“Since agriculture is the basis of our community and state economy, I decided to bring it into my classroom,” explains Stacey Balbach, Wisconsin farmer and grades 9–12 STEM lead teacher at Cuba City High School.

“I integrate it at every moment I can, and with the NGSS [Next Generation Science Standards], it is so easy to do. For example, I was beginning a unit on DNA in my biology class, and I had my students grind up some soybeans from [my] field. We isolated DNA from the soybeans. That was an exploratory activity that included making qualitative and quantitative observations from an experiment and asking questions,” she adds. "Other examples are in chemistry: Polymers—soybeans and wax; colloids—milk; mixtures—butter; homogeneous and heterogeneous materials (food science). In Chemistry II: [I] isolate the set of genes that are in GMOs [genetically modified organisms], and discuss GMOs, fractional distillation of ethanol.”

Brian Shmaefsky, professor of biology at Lone Star College-Kingwood in Kingwood, Texas, teaches agriscience as part of a year-long freshman environmental science course. "I wouldn’t do [environmental science] without agriculture,” he says. The majority of his students come from urban areas, and he says, "urban kids have every misconception under the sun [about farming]. They find alternative agriculture interesting. The rural kids are not used to looking at sustainability. We have a lot of pollution issues” from highway runoffs that his students are studying on a test farm.

“Agriculture makes a more natural integration of science then just biology, chemistry, or physics,” Shmaefsky says. "The materials I use in life science and Earth science provide a relevance to the learning about environmental interactions, genetic challenges and innovations, and green technologies,” states Sue Meggers, seventh- and eighth-grade science instructor at Interstate 35 Secondary School in Truro, Iowa. "We have a three-acre prairie and 12-acre corn/bean test plot that we use for hands-on diversity, soil quality, water quality, and sustainability studies. This hits home since we live in rural Iowa, and helps the ‘bedroom’ community kids understand the value of agriculture and ecology as a harmonious unit. Engagement is tenfold better when we do these hands-on, real-world activities.

“Agriscience supports the NGSS standards regarding humans and Earth changes; water cycle/quality; life science ideas regarding genetics, sustainability, evolution; [and] physical science regarding the chemistry of life,” she adds. Meggers finds agriscience resources through state extension services, the U.S. Geological Survey, Environmental Protection Agency, and the National FFA, among others.

“For our sustainable future, we need to give our students the experience and concepts for the farming of the future (based upon sound science) that can be applied at the local level,” maintains Wayne Oelfke, grades 6–12 agriculture instructor and FFA advisor at Fort White High School in Fort White, Florida. Oelfke has always integrated science into his agriculture courses, and he has begun working with science teachers on lessons on decomposition and soil quality. "Agriscience research and problem solving are a part of our curriculum...we start with ‘what’s the problem’ and go through the whole thing.” He says students have designed experiments to investigate ways to grow crops while reducing water use and to identify the most beneficial nitrogen fertilizer with the lowest leach rate.

“Agriscience and sustainability should be integrated,” he exclaims, "I love agriscience being a method, a delivery vehicle for STEM!”
Great jobs news for the “college of solutions to the world’s most pressing problems”

It seems that everywhere we turn we are hearing "Henny Penny," sky is falling, doom and gloom stories about the future. Some news has a basis in fact, but many stories are driven by other agendas.

We can choose to spiral down in response to these reports or we can chose to spiral up. We can build a science- and fact-based future. We can choose a future in which our environmental, social and economic sustainability are not at odds but are linked to each other as three fundamental components of a self-reinforcing virtuous cycle. We can do this in Arizona and in the US and for the world.

And of course CALS is the college at the epicenter of the greatest opportunities.


Ian L. Maw, Ph.D., vice president of food, agriculture, and natural resources of the Association of Public and Land-Grant Universities, has analyzed the BLS data for some of the occupations for which we have undergraduate and graduate programs.

The data is telling. The BLS report shows that overall job growth is projected to be approximately 10% for the decade. For the occupation categories that Dr. Maw analyzed, however, workforce growth is substantially greater. This news is particularly timely as the college is working hard to get our new Veterinary Medical & Surgical Program established. The report shows that the US will need 44% more veterinarians in 2022 than it had in 2012.

With veterinary careers, and all of the careers listed here, we believe that Arizona’s students should have an opportunity equal to those of students in other states. Arizona’s economy should not be left out of the economic growth opportunity predicted for the rest of the US.
One of the Best Fields for New College Graduates? Agriculture.

Nearly 60,000 High-Skilled Agriculture Job Openings Expected Annually in U.S., Yet Only 35,000 Graduates Available to Fill Them

WASHINGTON, May 11, 2015 – Agriculture Secretary Tom Vilsack today announced a new report showing tremendous demand for recent college graduates with a degree in agricultural programs with an estimated 57,900 high-skilled job openings annually in the food, agriculture, renewable natural resources, and environment fields in the United States. According to an employment outlook report released today by USDA's National Institute of Food and Agriculture (NIFA) and Purdue University, there is an average of 35,400 new U.S. graduates with a bachelor's degree or higher in agriculture related fields, 22,500 short of the jobs available annually.

"There is incredible opportunity for highly-skilled jobs in agriculture," said Secretary Vilsack. "Those receiving degrees in agricultural fields can expect to have ample career opportunities. Not only will those who study agriculture be likely to get well-paying jobs upon graduation, they will also have the satisfaction of working in a field that addresses some of the world's most pressing challenges. These jobs will only become more important as we continue to develop solutions to feed more than 9 billion people by 2050."

The report projects almost half of the job opportunities will be in management and business. Another 27 percent will be in science, technology, engineering, and mathematics (STEM) areas. Jobs in food and biomaterials production will make up 15 percent, and 12 percent of the openings will be in education, communication, and governmental services. The report also shows that women make up more than half of the food, agriculture, renewable natural resources, and environment higher education graduates in the United States.

Other highlights of the report include:

- While most employers prefer to hire graduates of food, agriculture, renewable natural resources, and environment programs, graduates from these programs only fill about 60 percent of the expected annual openings. Even as enrollments in these programs increase and the job market becomes somewhat more competitive, good employment opportunities for the next five years are expected.
- Growth in job opportunities will be uneven. Employers in some areas will struggle to find enough graduates to fill jobs. In a few areas, employers will find an oversupply of job seekers.
- Expect to see a strong employment market for e-commerce managers and marketing agents, ecosystem managers, agricultural science and business educators, crop advisors, and pest control specialists.
- Job opportunities in STEM areas are expected to grow. Expect the strongest job market for plant scientists, food scientists, sustainable biomaterials specialists, water resources scientists and engineers, precision agriculture specialists, and veterinarians.

The report, Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment, United States, 2015–2020, is the eighth in a series of five-year projections initiated by USDA in 1980. The report was produced by Purdue University with grant support.
USDA is an equal opportunity provider and employer. To file a complaint of discrimination, write: USDA, Office of the Assistant Secretary for Civil Rights, Office of Adjudication, 1400 Independence Ave., SW, Washington, DC 20250-9410 or call (866) 632-9992 (Toll-free Customer Service), (800) 877-8339 (Local or Federal relay), (866) 377-8642 (Relay voice users).

_Agriculture Jobs Requiring Bachelor's Degree or Higher_

- Management and Business: 46%
- STEM areas: 12%
- Food and Biomaterials production: 15%
- Education, Communication, & Governmental services: 27%

Employment Opportunities for College Graduates
in Food, Agriculture, Renewable Natural Resources, and the Environment
United States, 2015–2020

Employment Opportunities

During the next five years, U.S. college graduates will find good employment opportunities if they have expertise in food, agriculture, renewable natural resources, or the environment. Between 2015 and 2020, we expect to see 57,900 average annual openings for graduates with bachelor’s or higher degrees in those areas.

According to our projections, almost half of the opportunities will be in management and business. Another 27% will be in science, technology, engineering, and mathematics (STEM). Jobs in sustainable food and biomaterials production will make up 15%, while 12% of the openings will be in education, communication, and governmental services.

The projections in this report are based on data from several sources. The Bureau of Labor Statistics forecasts a 10.8% increase in the U.S. labor force between 2012 and 2022 due to job growth and openings from retirement or other replacements. We expect employment opportunities in food, agriculture, renewable natural resources, and environment occupations to grow more than 5% between 2015 and 2020 for college graduates with bachelor’s or higher degrees.

Graduates

An average of 35,400 new U.S. graduates with expertise in food, agriculture, renewable natural resources, or the environment are expected to fill 61% of the expected 57,900 average annual openings. Most employers prefer to hire graduates with this expertise. However, because we anticipate more annual job openings than can be filled by these graduates, employers will need to look to other areas such as biology, business administration, engineering, education, communication, and consumer sciences to fill the remaining 39% of openings.

College graduates with expertise in food, agriculture, renewable natural resources, and the environment are essential to our ability to address the U.S. priorities of food security, sustainable energy, and environmental quality. Graduates in these professional specialties not only are expected to provide answers and leadership to meet these growing challenges in the United States, but they also must exert global leadership in providing sustainable food systems, adequate water resources, and renewable energy in a world of population growth and climate change.

Look to graduates of food, agriculture, renewable natural resources, and environment higher education programs if you are seeking to hire female graduates with STEM degrees. While other U.S. higher education programs have encountered challenges enrolling women in STEM specialties, women make up more than half of the food, agriculture, renewable natural resources, and environment higher education graduates.

Many food, agriculture, renewable natural resources, and environment graduates will have interests, skills, and experiences that lead them to employment in other industries. This will further widen the gap between numbers of graduates with expertise in these areas and the growing number of employment opportunities.
MANAGEMENT AND BUSINESS

Between 2015 and 2020, expect an average of 26,700 annual job openings in management and business in the United States for new college graduates with expertise in food, agriculture, renewable natural resources, and the environment. This represents almost half of the annual job openings. Graduates with the best prospects have a strong background in life sciences and business, excellent communication skills, and work experience.

Selected Occupations

- Sales and Service Representative
- Forest Products Manager
- Land Use Manager
- Farm Labor Specialist
- Forest Ecosystem Manager
- E-commerce Specialist
- Financial Analyst
- Agricultural Economist
- Agricultural Loan Officer
- Landscape Contractor
- Marketing Specialist
- Grain Merchandiser

SCIENCE AND ENGINEERING

Food, agriculture, renewable natural resources, and environment higher education programs will continue to produce a growing number of graduates in science, technology, engineering, and mathematics (STEM) disciplines in the next five years. About half of these graduates will be women. Expect 15,500 annual job openings in these areas as demand for these graduates grows in many areas.

Selected Occupations

- Food Scientist
- Veterinarian
- Biological Engineer
- Environmental Scientist
- Insect Biologist
- Fisheries Biologist
- Plant Scientist
- Watershed Scientist
- Dietitian
- Irrigation Engineer
- Animal Scientist
- Soil Scientist

FOOD AND BIOMATERIALS PRODUCTION

Expect 8,500 annual job openings in food and biomaterials production between 2015 and 2020. More individuals filling these jobs will have bachelor's degrees, but production experiences will still be very important. Some growing job opportunities will be available in production of fresh and locally grown foods, poultry and swine production, crop production, forest management, and precision agriculture.

Selected Occupations

- Farmer
- Rancher
- Poultry Production Manager
- Range Manager
- Precision Agricultural Specialist
- Fruit and Vegetable Grower
- Forest Manager
- Crop Management Consultant
- Organic Crops Grower
- Viticulturist
- Swine Production Manager
- Aquaculturist

EDUCATION, COMMUNICATION, AND GOVERNMENTAL SERVICES

Anticipate 7,200 annual job openings in education, communication, and governmental services in the next five years for graduates with expertise in food, agriculture, renewable natural resources, and the environment. Graduates will find opportunities in agriscience education at all levels, government service, forest recreation, and agritourism. They will also find opportunities in marketing, event planning, and public relations.

Selected Occupations

- High School Agriscience Teacher
- Rural Development Specialist
- Plant and Animal Inspector
- Agricultural Extension Educator
- Farm Services Agent
- Natural Resources Conservation Specialist
- Technical Writer
- Social Media Specialist
- Outdoor Recreation Manager
- Environmental Science Teacher
- Food and Agricultural Science Editor
- Event and Meeting Planner

Project Consultants: Antoine J. Alston, North Carolina Agricultural and Technical State University; Kirby Barrick, University of Florida; Richard A. Cavaletto, California Polytechnic State University–San Luis Obispo; Cameron Faustman, University of Connecticut; John C. Foltz, University of Idaho; Michael C. Gaul, Iowa State University; Terry L. Sharik, Michigan Technological University; Susan Sumner, Virginia Tech University

For more details, log on to: https://www.purdue.edu/usda/employment

Authors: Allan D. Goecker, Purdue University; Ella Smith, U.S. Food and Drug Administration; J. Marcos Fernandez, Purdue University; Ray Ali, U.S. Department of Agriculture, NIFA; Rebecca Theller, Purdue University

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8 Reasons Why Ag Careers are Needed More than Ever
By: Alyssa Schwarck, AgCareers.com Marketing Intern

While agriculture is a multi-billion dollar industry that directly affects everyone in the world each day, employers still struggle to find qualified candidates that are enthusiastic about the industry and need. According to the USDA, “between 2010 and 2015 there will be more jobs available in ag and food systems, renewable energy, and the environment than qualified graduates to fill them.” With the industry booming but college students being left uninformed about the importance of agricultural careers, the numbers need to increase. Here are 8 reasons that agriculture is needed now more than ever and to choose an agricultural career:

1. **Population is Increasing**
   By 2050 the world’s population is projected to hit 9 billion people. To be able to feed and clothe the world, the population is going to rely heavily on agriculture. With that comes the need for new technology, hard workers, creative minds, and college graduates that are ready to get into the workforce and support this ever-changing industry.

2. **“New” Generation of Agriculture**
   Baby boomers are in the primary agricultural leadership roles, but they are retiring at vast rates, leaving many positions un-filled. Employers are having difficulties finding the right talent to put into these positions and 60% of them are shifting their focus to recruiting college graduates.

3. **Job Diversity**
   Within the last 20 years, agriculture has expanded and become so diverse, giving job seekers a wide variety of careers to choose from. There are significant jobs in production, economics, marketing, agribusiness, technology, sales, finance, microbiology, communications, and much more. In 2013, there were 52,862 jobs posted on AgCareers.com containing differentiated career opportunities in every aspect of the agricultural industry!

4. **Shortage of College Graduates in Agriculture**
   The truth of the matter is, there just are not enough people going into an agricultural related program of study causing a shortage of qualified job seekers. According to the AgCareers.com Enrollment and Employment Outlook Survey, less than 1% of college students are in an agricultural major. In 2013 there were 56,000+ career opportunities in the industry but only 29,000 graduates were trained to fill them.

5. **Industry Growth**
   Since the industry is growing at such a fast pace, there is high demand for qualified job seekers in every aspect of agriculture. The U.S. Department of Labor projects significant growth in selected food, renewable energy, and environmental jobs from now and throughout 2018. Even more, the Agribusiness HR Review shows that 60% of employers are planning to do more college recruiting within the next 1-5 years.

6. **Technology Advancements**
Agricultural technologies are constantly evolving to help improve productivity. With the new technology, comes a need for job seekers with the right education to be able to work with and develop the technology that will continue to shape the industry.

7. **Increased Salary**
   To remain competitive and to secure the best talent in the industry, employers have been consistently increasing salaries. They have also offered better benefit packages to retain employees. Furthermore, qualified talent is being promoted now faster than any other generation has before.

8. **Rewarding**
   Working in an agricultural related field is rewarding. You get the peace of mind knowing that you are making a positive impact on those around you. People that have careers in agriculture are passionate about what they do and want to see the industry be successful and prosperous. It’s rewarding to know that by working in an ag-related career, you are making a difference. Plus, the industry is an easy sector to network and make lasting connections with others in your field.

It is undeniable that the agriculture industry is one of the smartest career paths to take. Whether you are looking for a company that you fit in with, a competitive salary, or you want to make a difference, the agricultural sector has such a wide variety of jobs to choose from that it is easy to find what suits you best. It’s a growing field that needs new and talented employees to be ready to fill positions and be the next generation of agriculture.

*This article was first published in the* **2014-2015 AgCareers.com Ag & Food Employer Guide.**

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I am Demetrios Vlachos. I came to the United States in the 1950’s to go to school at ASU where I studied horticulture. While I went to school one of my jobs was an assistant horticulturist at the Botanical Gardens. I did a lot of the planting and rockwork along the pathways. I enjoyed it very much.

After I graduated I didn’t go into the horticulture business right away. First I went into electronics then I taught at a high school. Eventually I found my way and started my own nursery business, V&P Nursery.

It is a family owned business. We started out in our backyard with a quarter of an acre. I had my wife and my son Niko going out and collecting tomato and coffee cans from the restaurants and schools to use for the pots. For three or four summers we grew plants in our backyard. Eventually we got a few contractors and some retailers. We grew and we purchased our first piece of land. That is when I met our attorney Charlie Davis and we’ve been with him ever since.

Over the last 30 plus years, V&P Nurseries has grown to about 240 acres out in Queen Creek and another 40 acres out in Chino. Our customers are Home Depot, Lowes, contractors and Mom and Pop nurseries.

We mostly grow ornamental plants for landscape from bushes to large trees. 99% of our material we grow ourselves. We cultivate 6 to 8 million plants in 200 to 300 different varieties.

Back then we didn’t realize that we’d get to where we are now. We’re still not a huge company but we’ve certainly grown from where we were. We’ve been able to develop some great partnerships with Home Depot, Lowe’s, and Costco and they’ve asked us to expand with them. As we expand our company we will continue our relationship with Davis Miles McGuire Gardner.
Arizona honey bees are making a comeback

Arizona was once a hotbed of the honeybee industry, a place where bees were so plentiful they were sent by the truckload to states such as California, North Dakota and Washington to pollinate cherries, apples and almonds.

Up until the mid-1990s, more than 20,000 beekeepers kept honeybees in Arizona. That number has dwindled to about 5,600 beekeepers today, a result of a ravaged honeybee population. Mites, pesticides, drought, disease and a devastating phenomenon called colony collapse disorder have all left deep marks.

But nothing has dealt a blow as nearly fatal as the emergence 30 years ago of the Africanized bee, a small, ferocious foe that strikes fear in Arizonans' hearts and sent beekeepers packing to the far reaches of the state and beyond.

Arizona beekeepers have learned to take extraordinary steps to prevent the still prevalent African bee from taking over their backyard hives. The aggressive Africanized bee enters hives occupied by gentle European bees and takes over by killing the queen and rapidly repopulating.

Despite the challenges, the industry is making somewhat of a comeback in Arizona, say the men and women who nurture hives in their backyards. Beekeepers, people as industrious as their charges, have developed an array of solutions to help keep Arizona buzzing.

The mite is all but gone, and careful, hardworking beekeepers can prevent their hives from becoming Africanized, often with the help of Italian or other gentle queen bees.

"You have to be on your toes to combat them," Dowdy says of the aggressive Africanized bees who have taken over many of the hives of European bees in Arizona. Preventive measures include adding new European queens to hives and moving hives to areas with no water. (Photo: Mark Henle/The Republic)

"We've solved a lot of the problems," said Virl Dowdy, 79, considered by many to be the dean of Arizona beekeepers.

Such a comeback is good for Arizona, as beekeeping can be lucrative and funnel more money back into the local economy. On a larger, ecological scale, beekeeping is also good for the planet. Without bees, there is no pollination. Without pollination, plants and flowers will become extinct, too.
The African bee, also called the Killer bee, arrived in Arizona about 1993, experts say. It's not so much a freak of nature as a freak of overzealous breeding, a Brazil laboratory experiment gone awry when some queens escaped. Africanized queens mate three times more often than their European counterparts -- they even mate in the air -- and will repopulate a hive, rendering it useless as beekeepers can't harvest the honey without getting attacked. Africanized bees are also unusable for pollinating crops for profit.

The first Arizona fatality involving the aggressive bees was in 1995, when African bees fatally stung an 88-year-old Apache Junction woman. The most recent fatality was Oct. 8, when 800,000 killer bees in Douglas killed one man and injured three others. By the mid-1990s, African bees had terrified Arizonans and dominated many a hive. The state's last bee inspector declared the entire state Africanized. "The African bee scared everybody out," beekeeper David Meyer of Phoenix said. "A lot of cities had knee jerk reactions and banned bees." Beekeepers moved their hives to less populous places like Klondike, Wilcox, Buckeye, and even California and Oregon.

"This used to be one of the largest producing bee states," said Scott Clark, who owns the Beesville Bee Farm in Phoenix and makes Wild Flower Honey. "When Africanized bees came, we lost places to keep bees."

Arizona beekeepers ship bees to farms for profit

Before the near death knell, Arizona bees were shipped off by the plane and truckload to pollinate crops in other states, then shipped back to their Arizona owners. "Most beekeepers produced more bees than honey," said Clark. "That was the big income." It's still income, according to Dowdy and some others, but on a smaller scale.

Central California almond farmers now pay $200 per hive to pollinate crops starting in February. Less lucrative opportunities are available in Oregon, Washington, Utah, Washington, Idaho and North Dakota.

"One million hives go to Central California to pollinate almonds," said Meyer, who owns Mican-Meyer Farms. "About once a year, a semi-trailer (carrying bees) tips over, and bees get out. That's what that is."

The bees come back to their Arizona owners, then go on to pollinate another crop, Meyer said. Beekeepers get about $75 per hive from Yuma-area cotton and melon farmers, Meyer said.

Italian queens help hives

To prevent African bees from taking over hives, Dowdy said, Arizona beekeepers must regularly re-queen their hives with expensive European queens. "You have to be on your toes to combat them," Dowdy, who has kept bees for 40 years, said of African bees. Dowdy moves his hives to areas with no natural or irrigated water, because African bees are unlikely to be drawn there. Then Dowdy hauls in his own water. "Otherwise, African bees will take over (the hives)," Dowdy said.

Variations of this practice are becoming the norm in Arizona, but beekeepers acknowledge buying the imported queens is expensive. "It's a real hit to the bottom line," Meyer said.

Colony Collapse Disorder

But there is something else occurring called Colony Collapse Disorder, a phenomenon in which all the bees in a hive disappear.

Research from the Harvard School of Public Health supports a popular theory that a certain class of insecticides, neonicotinoids, seems to be the blame.

Colony Collapse Disorder is one of many challenges beekeepers in Arizona are grappling with. Beekeepers in the state have developed support systems and groups that allow them to exchange information and ideas.
At a recent monthly meeting of the Beekeepers Association of Central America, about 50 Phoenix-area beekeepers gathered to share tips and gain inspiration about their shared interest. The group's swelling attendance reflects the growing health of Arizona's honeybees, and the topics discussed reflect the intricacies of keeping bees.

A young man's earnest voice cut through the crowd. The bees of his third hive -- his biggest, strongest -- had begun to die. Instead of leaving the hive and flying off, they dropped dead to the ground. But it's the biggest and the strongest bees that forage the farthest, several of the old-timers responded. Chances are, they foraged to a field that had been sprayed with pesticide or herbicide. "When you aerial spray everything, because you have now planted a crop that is resistant to herbicide, that is not a good thing," Meyer said.

**Bees another canary in the coal mine**

Bees are an essential part of the world food supply. Nearly 80 percent of all commercial crops are pollinated by bees, according to most estimates. "If the bee disappeared off the surface of the globe, then man would have only four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man," Albert Einstein is quoted as saying.

In "Silent Spring," published in 1963, author Rachel Carlson wrote about the impact of synthetic pesticides on insects and the food chain. In China, there are so few bee hives that instead of using bees to pollinate crops, some farmers use workers wielding pipe cleaners. "But hand pollinators do not make beeswax," said beekeeper Diane Campoy of Laveen. "Hand pollinators do not make honey. We need bees."

In Arizona today, more people who come across swarms or hives of unwanted bees are asking to have them removed without harm, Meyer said. "Bees get such a bad rap," Campoy said. "But when you think about it, bees are the only insects that actually feed man." On Alice Avenue between Central and 7th Avenues, Dave Krause's obvious affection for bees has proved contagious. Several neighbors have joined him in keeping backyard hives. Central Phoenix's plentiful water supply and mature and varied vegetation are a bee mecca.

"I love handling bees, even Africanized bees," said Krause, 73. "It does take a special person to work with bees. You have to have a determination, and a mentor." He was sitting with his mentor, Dowdy, in Dowdy's old-fashioned country kitchen in Central Phoenix, when the phone rang. It was a backyard beekeeper. Dowd receives about a dozen such calls a day.

"Here in Arizona we've solved a lot of the problems," said Dowdy. "I think China could learn a little from us."

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**About the writer**

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Rubber is a substance usually made from petroleum or from the Asian rubber tree plant. But rubber can also be produced from a domestic plant called “guayule.” Guayule is a woody desert shrub cultivated in the southwestern United States as a source of natural rubber (latex), organic resins, and high-energy biofuel feedstock.

Agricultural Research Service (ARS) chemist Colleen McMahan and her colleagues molecular biologists Grisel Ponciano, Niu Dong, and Dante Placido and technician Trinh Huynh, in Albany, California, developed improved guayule for rubber production. Last year, they delivered more than 3,000 experimental guayule plants to research partner Bridgestone Americas in Eloy, Arizona, for field testing.

In 2013, Bridgestone Americas and ARS’s Bioproducts Research Unit entered into a research agreement to evaluate ARS’s genetically improved guayule. “The genetic modification increased rubber content dramatically in the lab, and we have seen that in the greenhouse as well,” says McMahan. Their work with Bridgestone has allowed them to evaluate the plants and test them in the field.

But a long-term goal is to supplement current guayule germplasm collections with plants that have important traits such as drought and disease resistance. The team needed to find guayule types that weren’t already in ARS’s collection.

“Three years ago, a separate project with Cornell University was initiated to DNA fingerprint all known guayule germplasm in public seed collections that breeders rely on to create new types,” says McMahan. “In the process, we searched for new—and old—sources to add to the collection,” because this isn’t the first time guayule has been used as a rubber source.
During World War II, Manzanar, California, was the site of a Japanese-American internment camp where guayule plants were selected, bred, cultivated, and processed into natural rubber to aid in the war effort. Manzanar is now a National Park Service Historic Site.

“Turns out Manzanar National Park had plants and was willing to donate seed from those plants,” says McMahan. She also collected seed from guayule plants at the home of a former Manzanar guayule breeder, Frank Kageyama.

These guayule plants looked very different (silver-green lacy leaves) from most other guayule breeding lines (larger, deep-green leaves). The plants grown from the Manzanar seeds are still under evaluation by ARS and Cornell and may provide an important source of genetic diversity in the germplasm.

In the meantime, the genetic improvement program continued. In 2016, the ARS experimental guayule plants were ready for delivery to Bridgestone America’s 180-acre facility in Eloy, where the focus is on developing guayule as a domestic source of natural rubber.

“We packed close to 3,200 plants in tissue culture,” explains Huynh. “These plants have unique DNA modifications that may translate into increased rubber and biomass. The plants are being grown and evaluated in Bridgestone America’s greenhouse and field in Eloy.”

Since the route to Eloy isn’t far from Manzanar, McMahan and team members returned to make a special delivery. “The curators of the museum asked us to provide some of the plants we had grown from the donated seed, so we delivered 33 legacy plants for planting in their interpretive garden.”

And for part of that trip, those plants carrying the history of the Manzanar guayule breeding program rode alongside plants that may carry the future of commercial U.S. rubber production.

By Sharon Durham, ARS Office of Communications.

Source: https://agreemag.ars.usda.gov/2017/mar/guayule
Spider venom: An insecticide whose time has come?

Biopesticide maker Vestaron says fruit and vegetable farmers are ready for its novel pest chemistry

By Melody M. Bomgardner

When it comes to solving difficult insect problems, it helps to consult an expert. For example, you could ask Hadronyche versuta, the Blue Mountains funnel-web spider. It has a few tried-and-true tools for killing: a funnel-shaped web to hide in, really large fangs, and venom laced with the powerful insecticide versutoxin.

“It has a well-earned, fearsome reputation,” says John Sorenson, chief executive officer of the biobased pesticide firm Vestaron. Like seemingly all things super venomous, the spider comes from Australia—specifically, the coastal range of New South Wales.

A farmer or gardener could travel to eastern Australia, gather up some Hadronyche, and milk them to obtain their insect-killing venom. But that’s not very practical. So for years scientists have been working out how to make a pesticide based on, or inspired by, the spider’s powerful weapon. After successful registration with the Environmental Protection Agency in 2014, Vestaron is about to introduce its first product, which is based on a peptide in versutoxin. The insecticide, called Spear T, is effective against thrips, whiteflies, and spider mites in greenhouse settings. “Those three are the trifecta—the FBI most wanted—of greenhouse pests,” Sorenson says. Getting to launch has not been easy or quick. Vestaron was founded in 2001 with the more ominous-sounding name Venomix. That was before the time when pesticides based on biological, rather than synthetic, compounds were considered sexy. Since then, major agrochemical companies have invested in biopesticides and acquired biobased chemical firms with the hope of providing more options to farmers. The marquee deal was Bayer’s 2012 acquisition of AgraQuest for $425 million. But even after a few decades of trying, convincing growers to adopt new pest control methods for their high-value fruit and vegetable crops is challenging. Early entrants were pricey and gave inconsistent results. To succeed, Vestaron will have to build a track record of efficacy, compete on price, and get visibility for its product in a marketplace crowded with bigger players. “It’s actually easier to develop a product than establish it on the market,” warns Duane Ewing, an agricultural products consultant who was one of the cofounders of AgraQuest. “This is not for the fainthearted.” In 2016, the North American biopesticide market was worth $1.2 billion, only about 8% of total pesticide sales, according to Arun Ramesh, an analyst at the market research firm Frost & Sullivan. Bioinsecticides claimed 30% of that slice. Although biopesticide sales in
general are growing by 11.5% annually, he says, bioinsecticides are stuck at 2% growth because of lingering farmer skepticism about their efficacy.

Even among biopesticides, Spear T is unusual. Most are used to kill fungal diseases, not insects. That’s not surprising, because until now biopesticides have all come from soil bacteria, and bacterial chemical defenses are designed mainly to combat other microbes. Even the most famous biological insect killer, *Bacillus thuringiensis*, or Bt, is a protein made by a microbe. And spider venom presented a web of challenges, Sorenson says. When scientists first attempted to identify and characterize venom peptides, they didn’t have the necessary molecular biology tools. When that problem was solved, no one knew how to manufacture the peptides. And the peptides—large molecules the size of insulin—did not look like they would be bioavailable, except via spider bite. Vestaron’s active ingredient came out of research by Glenn King, a professor of chemistry and structural biology at the University of Queensland. King found a variety of disulfide-rich peptides in venom. Some are used for defense against other spiders or mammals, and others are tuned to kill insect prey. All of them work by disrupting ion channels of the victim’s nervous system. “The genius of Glenn’s work is that he looked at the minor components that had broad insecticidal activity but not mammalian activity,” Sorenson says. The peptide at the heart of Spear T is called GS-omega/kappa-Hxtx-Hv1a. As an active ingredient, the peptide did not look very promising at first; its structure violated most of the rules said to define a good insecticide. It has a large molecular weight, is hydrophilic, and has many hydrogen donors. But surprisingly, tests showed that it kills some insects on contact.

The peptide blocks two ion channels in the insect nervous system—a voltage-gated calcium channel and a calcium-activated potassium channel. Both modes of action differ from the way Bt toxin and many other pesticides work. That means growers can use the peptide with other products to prevent the emergence of resistant insects. “It’s a magnificent partner for rotation with other agricultural chemicals,” Sorenson claims. Vestaron scientists inserted the gene responsible for producing the peptide into yeast so it can be manufactured in large quantities via sugar fermentation. Last August, the company contracted Capua Bioservices to make its products in Italy.

Also in August, Vestaron’s venture investors put an additional $18 million into the company. With the help of the funding, it is gearing up for distribution of Spear T and finalizing two follow-on products for release later this year and in 2018. The new versions will be combined with Bt to control caterpillars and the Colorado potato beetle.

Sorenson says the first Vestaron products will be price-competitive with “top-tier synthetic chemicals.” But they can also play a different role than most synthetics because of their low toxicity to nonpest species, he says. After application, farm or greenhouse workers need wait only four hours rather than days to resume working. And Spear products can be applied right up until harvest. Ewing, the consultant, sees more growth ahead for biological insect control. Even agchem companies wedded to synthetics are introducing products that mimic biological compounds to decrease damage to mammals and beneficial insects. “They’re not like parathion where you spray and kill everything for 30 days,” he says. Vestaron, meanwhile, is screening synthetic mimics that share the insecticidal and toxicity characteristics of spider venom peptides. And it hopes to grow its market by inserting venom peptide genes into corn, cotton, and soybeans.

But for now, Sorenson is pleased to introduce a product he calls extraordinary. “It’s the first peptide product of this kind ever to be commercialized,” he says.

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The Voice

The Mystery of the One Percent

Posted by Julie Murphree on Thu, Apr 20, 2017@05:00 AM

By Julie Murphree, Arizona Farm Bureau Communication and Organization Director: Recently, a random statistic was thrown out that claimed Arizona imports 99% of the food that goes to our neighborhood groceries, restaurants and homes. The 1 percent claim of what’s home-grown then served and sold in the state is a powerful statistic to use against our current Arizona food system, if it were true.

With a quick query to our cadre of researchers and scientists at the University of Arizona, our land-grant university, the mystery of the 1% was debunked in a matter of days.

According to Ashley Kerna, an Economic Impact Analyst at the University of Arizona’s Cooperative Extension and Department of Agricultural and Resource Economics, approximately 30% of Arizona household spending on raw agricultural food products comes from Arizona farm and ranches.

Approximately 30% of Arizona household spending on raw agricultural food products comes from Arizona farm and ranches; an estimated 18% of Arizona household spending on processed food products comes from Arizona processing facilities.

“Obviously, consumers for the most part do not buy these products directly from farms and ranches,” said George Frisvold, Ph.D., economic professor and extension specialist for the University of Arizona’s College of Agriculture and Life Sciences, who regularly works with Kerna on economic studies. “The purchases are

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made at food stores and restaurants, often as raw ingredients consumed in processed food.”

Even for processed foods, an estimated 18% of Arizona household spending on processed food products comes from Arizona processing facilities. While these processing facilities may not necessarily be using Arizona ingredients, there are certainly food products that are produced and processed in-state that fulfill a portion of Arizona’s household demand.

These figures are a far cry from the 1% claimed by some random statistic.

So, how did the U of A team get to this? The Input-Output model Kerna and Frisvold use, IMPLAN, has data on trade flows between more than 5,400 industries and to households of different income categories. Trade flows describe the movement of goods and services between Arizona and the outside world, generating what is known as Regional Purchase Coefficients (RPCs) for all commodities. An RPC is the proportion of local demand that is supplied by local producers. The IMPLAN trade flow data is based on national statistics from the Department of Commerce (Bureau of Economic Analysis) and Census Bureau. The U of A team used the IMPLAN trade flow data to calculate RPCs for both on-farm products and for processed foods.

These RPCs are estimated based on household demands, not industry demands. So the RPCs presented here are estimates of the proportion of local household demand for agricultural commodities and processed food products that are supplied locally (i.e., by the region to itself). In this case “locally” means within Arizona.

RPCs are higher for individual items that Arizona specializes in such as vegetables and melons, beef, fluid milk and tortillas. It is lower for things we do not produce much (or any) of such as sugar, chocolate, breakfast cereal, seafood and poultry.

Added Kerna, “The trick was ‘getting under the hood’ of the model to figure out how much of what is produced on-farm or on-ranch ends up in Arizona households.”

It seems to me we’ve lost a sense of maximizing on the benefits of trade economics. As Frisvold and others pointed out, Arizona trades agricultural commodities with the other 49 states and globally, with countries all around the world. This means Arizona’s $17.1 billion agriculture industry exports commodities where we have a comparative advantage in production and imports commodities from other areas that have different comparative advantages.

Do we really want other states saying, “Why are we buying all this lettuce from Arizona, that’s a bad thing?” If you go to a Phoenix grocery store, the lettuce, and leafy greens in the winter are going to come from Yuma; the eggs and milk, and much of the other dairy products will come from Arizona; tortillas too.

The chicken, pork, and fish will come from out of state, as will coffee, apples, bananas, rice and potatoes. In summer and fall, lettuce will come from California. We live in a global economy with complex international supply chains. Some of the “imported” clothing you and I purchase in Arizona stores is made out of Arizona-grown cotton. (I’ve always wondered if I ever wore the actual cotton fibers my parents’ grew for 45 years in their Arizona cotton fields; certainly from one of our Arizona cotton farmers.)

As our U of A team correctly points out, many items coming from outside the state are processed foods. Arizona’s food manufacturing industries are not as large as other states that specialize in corn and wheat. The food processing sector has been growing though. Milk and dairy product production in particular are important.

And back to Arizona cotton: virtually all our cotton is exported, but much of it returns to the United States as clothing and household goods. Edible commodities are marketed in state, across the country, and globally. We need agriculture trade and we need it to function as robustly as this recent U of A economic analysis reflects.

And the origins of the one percent? It’s a mystery.

Editor’s Note: The Economic Impact Analyst (EIA) team formed over four years ago within the Cooperative Extension System (CES) in an effort to address the many issues and needs the agriculture industry has to quantitatively document the impacts of agriculture in Arizona and our CES programs. Collectively, the EIA group is providing to the CES the capacity to address questions and issues just like what we queried them about regarding the percentage of Arizona agriculture going to Arizona families. The EIA team does so in a technically correct manner, based on appropriate economic methods, providing valuable and accurate information in a timely manner.

Tags: Arizona agriculture
Agriculture in 2050: Recalibrating Targets for Sustainable Intensification

MITCHELL C. HUNTER, RICHARD G. SMITH, MEAGAN E. SCHIPANSKI, LESLEY W. ATWOOD, AND DAVID A. MORTENSEN

The prevailing discourse on the future of agriculture is rife with the assertion that food production must increase dramatically—potentially doubling by 2050—to meet surging demand. Many authors also call for agriculture to become more environmentally sustainable, but with little urgency and few quantitative targets. The result is an imbalanced narrative that heavily privileges production over conservation. This imbalance persists despite calls in the growing sustainable intensification (SI) literature to treat food production and environmental protection as equal parts of agriculture’s grand challenge (Robertson and Swinton 2005, Garnett et al. 2013, Pretty and Bharucha 2014, Rockström et al. 2017).

We aim to rebalance this narrative by laying out quantitative and compelling SI targets for both production and the environment. These goals will clarify the scope of the challenges that agriculture must face in the coming decades, focus research and policy on achieving specific outcomes, and ensure that SI efforts lead to measurable environmental improvements.

Our targets are based on the following standards: (a) SI production goals should aim to meet projected global food demand while recognizing that factors beyond aggregate production also affect hunger and malnutrition (FAO et al. 2015, Schipanski et al. 2016), and (b) SI environmental goals should aim to restore and maintain ecosystem functioning in both managed and natural systems (Neufeldt et al. 2013, Rockström et al. 2017).

Many authors call for production increases of 60%–100% by 2050, based on two recent food-demand projections (Tilman et al. 2011, Alexandratos and Bruinsma 2012). These goals appear clear and compelling, but they exaggerate the scale of the production increase needed by 2050 because they misinterpret the underlying projections and ignore recent production gains. Moreover, the projections are often simplified into a goal of doubling yields, which serves as an urgent rallying cry for research, policy, and industry (Monsanto 2008, Foley et al. 2011, Tilman et al. 2011, Ray et al. 2013, Long et al. 2015, Buckley 2016). This, in turn, fosters a produce-at-all-costs mentality, which may exacerbate existing environmental challenges by increasing the use of fertilizers, pesticides, irrigation, and tillage.

In contrast, current SI environmental targets are unclear and unlikely to inspire action. Most authors agree that uncultivated land should not be converted for crop production (e.g., Garnett et al. 2013, Pretty and Bharucha 2014). Beyond this, however, stated goals diverge. They range from the basic—not “increasing agriculture’s environmental footprint” (Buckley 2016)—to the more aggressive—“major reductions in environmental impact” (Garnett et al. 2013). Some sustainability goals would even result in increased environmental degradation, such as when marginal reductions in per-unit impacts are coupled with doubled output (Monsanto 2008).

Our analysis shows that, largely because of recent production gains, an increase of approximately 25%–70% above...
Food-demand projections

Food demand in 2050 is projected to rise as the global population crests 9.7 billion people (UN 2015) and greater wealth drives up per-capita consumption, especially of resource-intensive animal products (Alexandratos and Bruinsma 2012). Public and scientific discourse on the subject focuses primarily on two studies (Tilman et al. 2011, Alexandratos and Bruinsma 2012). First, Alexandratos and Bruinsma (2012) of the United Nations (UN) Food and Agriculture
Organization (FAO) projected a 60% increase in demand from a 2005/2007 baseline using a price-weighted index of food commodities. Second, Tilman and colleagues (2011) projected that demand for calories and protein from human-edible crops will increase by 100% and 110%, respectively, from a 2005 baseline. Both of these projections account for crops used as animal feed and, to a limited extent, as biofuel feedstock.

These projections are complex and are commonly misinterpreted. First, the FAO projection of a 60% increase is frequently misquoted as a 70% increase when authors cite an earlier FAO report (Alexandratos 2006). Second, the price-weighted basis of the FAO figures implies a larger increase in crop demand than is actually projected on a mass basis: For example, FAO projects only a 46% increase in cereals demand (Alexandratos and Bruinsma 2012). Most importantly, authors often ignore the base year of the projections (Foley et al. 2011, Ray et al. 2013, Long et al. 2015, Daryanto et al. 2016), implying that the projected increase must occur from today’s production levels. For both of these projections, the base year is now a decade past, and production has increased substantially in this time (table S1). This error is particularly misleading when authors explicitly graph 2050 demand as a doubling from current levels (e.g., Long et al. 2015).

We use global demand for cereals as a proxy for total crop demand to illustrate the production increase needed by 2050. Cereals are the world’s dominant crops. In 2013, they were grown on 47% of global cropland and provided 63% and 56% of calories and protein, respectively, from human-edible crops (table S3; FAO 2016). Of course, ending hunger and malnutrition will require multiple crop types, including pulses, roots, vegetables, and fruits, many of which will need to be produced and marketed locally. Our focus on aggregate global cereal demand does not imply that meeting this demand would ensure global food security. Instead, our updated projections are intended to illustrate agriculture’s big-picture production challenge.

We build and update approximations of the FAO (Alexandratos and Bruinsma 2012) and Tilman and colleagues’ (2011) projections. The FAO projected cereals demand in 2050 directly (Alexandratos and Bruinsma 2012). Tilman and colleagues (2011) did not, so we approximate their projection with a simple doubling of demand from a 2005 baseline. We also linearly transform both estimates to account for differences between the original projections’ assumed 2050 population and the latest United Nations analysis (UN 2015). We use the most recent FAOSTAT data (FAO 2016), from 2014, as the baseline for our projections. All data and projections are available in the supplemental materials.

Our updates to the FAO (Alexandratos and Bruinsma 2012) and Tilman and colleagues’ (2011) projections indicate that production of cereals must only increase 26% and 68% from 2014 levels, respectively, to meet 2050 demand (figure 1a, table S1). Rapid production growth in recent years has made substantial progress toward the original projected increases of 46% and 100%. Cereal production increased 24% from 2005 to 2014 because of both yield improvements and the expansion of cropped area (supplemental tables S1 and S5; FAO 2016). The production of oilcrops—which account for most of the remaining calories and protein from human-edible crops—increased even more, by 39% (supplemental tables S2 and S4; FAO 2016). Projected 2050 demand for oilcrops is 46% higher than 2014 production levels based on the FAO projection and 50% higher based on a doubling from 2005 (table S2).

The discrepancy between the two cereal demand projections—26% versus 68%—is largely due to differences in model assumptions. The FAO (Alexandratos and Bruinsma 2012) assumed a lower rate of annual GDP growth than Tilman and colleagues (2011): 2.1% as compared with 2.5%. The FAO also adjusted its projection to account for potential saturation of meat consumption in the largest developing country, China, and cultural factors limiting the growth of meat consumption in the second largest, India (Alexandratos and Bruinsma 2012).

The two projections have drastically different implications for the future of crop production. Under the FAO projection, the rate of average annual cereal yield growth could fall gradually over the next 35 years and still meet demand using only existing cropland. To double from a 2005 baseline, in contrast, cereal yields would have to grow continually at a compound annual rate of over 1.5%, which has not been achieved consistently since the mid-1980s (figure 2). Doubling yields by 2050 from a recent baseline—the increase implied when authors do not specify the base year for doubling—would require an even higher annual yield growth rate of 1.9% per year.
Sustaining these rates of average annual yield growth until 2050, if it is even possible, would require widespread intensification of fertilizer, pesticide, and irrigation regimes. This level of intensification would almost certainly increase agriculture’s impact on water quality, aquifers, wildlife, and the climate (Robertson and Swinton 2005, Foley et al. 2011, West et al. 2014). SI production goals should therefore be stated carefully to avoid furthering a production-at-all-costs approach to agriculture. Goals should reflect the updated projection that production must increase approximately 25%–70% from recent levels to meet demand in 2050. Calls for doubling current production by 2050 should be avoided.

**Environmental goals**

In contrast to the literature on food demand, there has been little discussion of specific environmental goals for agriculture in 2050 or of the sector’s trajectory toward such goals. Instead, the prevailing discourse often focuses on increasing efficiency or improving general “sustainability,” which gives the impression that marginal environmental improvements are sufficient (Petersen and Snapp 2015). To illustrate the true scope of agriculture’s environmental challenges, we analyze the sector’s performance against quantitative targets that have been proposed to achieve specific environmental outcomes: mitigating climate change and limiting eutrophication in the Gulf of Mexico.

Agricultural production activities directly contribute 11%–13% of the world’s total anthropogenic greenhouse gas (GHG) emissions (IPCC 2014). Indirect emissions from land-use change in agriculture and forestry contribute another 12% (IPCC 2014). To avoid the worst impacts of climate change, Foley and colleagues (2011) called for an 80% reduction in agricultural GHG emissions. Since direct agricultural GHG emissions have been steadily climbing, achieving this level of reduction by 2050 would require an abrupt shift in emissions trajectory (figure 1b, table S3).

Losses of agricultural nutrients to waterways contribute to hypoxic “dead zones” downstream, threatening marine life and fisheries in coastal regions throughout the world. The hypoxic zone in the northern Gulf of Mexico is fed by the Mississippi–Atchafalaya River Basin system in the central United States, where riverine nitrogen (N) and phosphorus (P) are primarily from agricultural sources. The second largest in the world, this dead zone reached 22,000 square kilometers (km²) in 2002 and averages 13,650 km² per year (EPA 2016). In 2001, an intergovernmental task force set a goal to reduce the average size of the dead zone to 5000 km² by 2015, which would require reducing annual N and P loading to a level 45% below the 1980–1996 average (MRCGMWNTF 2001, 2008). This goal was not met, and the task force recently extended the deadline to 2035 (MRCGMWNTF 2015). As figure 1c shows, P loading has been increasing, and meeting the 45% reduction goal would require a significant shift in trajectory (see also table S3). We illustrate this goal using P data because the trends for total N and reactive N are diverging and the Gulf Hypoxia Task Force goal applies only to total N. Because total N has been declining more rapidly than reactive N, using total N would indicate greater progress toward the goal than has actually been made.

These two examples show that agriculture still faces large environmental challenges, but they are not meant to imply that the sector has not made any progress. Indeed, US agriculture has improved in important areas, including by cutting sheet, rill, and wind erosion by 43% between 1982 and 2007 (USDA 2011) and by beginning to reduce N losses in the Midwest (McLsaac et al. 2016). However, both US and global data on concerns ranging from biodiversity loss and land conversion to irrigation-water withdrawals—in addition to GHG emissions and nutrient pollution—indicate that agriculture leaves a large and growing footprint (Foley et al. 2011, West et al. 2014, Haacker et al. 2015). Clearly, environmental sustainability cannot play second fiddle to intensification; efforts to increase food production and reduce aggregate environmental impacts must go hand in hand.

**Agriculture’s path to 2050**

Meeting food demand while maintaining functioning ecosystems will require a recalibrated SI strategy, in which up-to-date production goals are coupled with quantitative environmental targets. Research and policy should pivot to align with this strategy, both in the United States and globally. Here, we focus on the US context.

The research enterprise led by the National Science Foundation and the US Department of Agriculture (USDA) should prioritize efforts to identify and meet quantitative production and environmental goals. First, research is needed to specify targets in both categories. There is a particularly urgent need to quantify the reductions in pollution and land degradation that must be achieved to sustain functioning ecosystems at multiple scales (Neufeldt et al. 2013, Rockström et al. 2017). These goals will need to be refined periodically as new information becomes available, given the uncertainty of long-term projections.

Second, applied agricultural research should focus on developing production systems that can simultaneously meet both production and environmental targets while helping farmers adapt to a range of emerging challenges, such as mounting water shortages (Falkenmark 2013, Elliott et al. 2014), pesticide resistance (Mortensen et al. 2012), yield plateaus (Grassini et al. 2013, Ray et al. 2013), and the changing climate (Challinor et al. 2014). The technical challenge of such a fundamental transformation in production systems is daunting, and meeting both sets of goals will require navigating complex trade-offs (Robertson and Swinton 2005, Neufeldt et al. 2013, Davis et al. 2016). However, establishing clear targets will help researchers focus on these long-term challenges.

Achieving both production and environmental goals will require shifts in US agricultural policy. Current policy heavily favors production, including through crop insurance and revenue- and price-based subsidy payments for commodity
crops. These programs carry only minimal environmental requirements, which provide limited protection against erosion and the loss of some wetlands and grasslands, but fail to target nutrient loss, air quality, GHG emissions, and other concerns. Conservation incentive programs help producers implement many environmentally beneficial practices, but they are not structured to produce maximum benefits. Moreover, many environmental regulations currently exempt agricultural activities. To bring US policy in line with future needs, producers who receive subsidies should be required to meet more stringent environmental standards, conservation programs should be reformed to tie payments to quantified outcomes (Winston and Hunter 2011), and effective regulatory backstops should be instituted to control the most environmentally damaging practices. Quantitative targets can help guide these policy efforts and promote effective collaborations among researchers, farmers, government agencies, and civil-society groups. The Danish government's pesticide strategy, which aims to reduce pesticide loads by 40%, is one promising example of using quantitative targets to collaboratively set agroenvironmental policy (DME 2013).

The goals of sustainable intensification extend beyond aggregate production and environmental performance. Additional policy efforts are needed to manage food demand by reducing food waste (West et al. 2014) and shifting diets (Davis et al. 2016). We must also halt cropland expansion (Cunningham et al. 2013) and ensure that the world's poorest people have secure access to nutritious food (FAO et al. 2015). Total land in agriculture has risen since 2005 in Africa, South America, and Asia (supplemental table S6; FAO 2016), indicating continued land conversion at the expense of native ecosystems, and conversion continues in the United States as well (Lark et al. 2015). Approximately 795 million people are hungry today, despite adequate global food production, because poverty, lack of infrastructure, poor governance, natural disasters, and political unrest restrict food access (FAO et al. 2015). These problems must be addressed even as production increases and pollution plummets.

Conclusions
We call on researchers, policymakers, and farmers to embrace this recalibrated vision of sustainable intensification. Time is short: The annual cycle of planting and harvest gives farmers fewer than 35 chances to transform their production systems by midcentury. Scientists also face a limited number of opportunities to develop and test new production and conservation strategies. As a group of young agricultural scientists (and one senior scientist), this is the challenge of our careers. By the time our generation retires, agriculture's 2050 goals must be met.

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Supplemental material
Supplementary data are available at BIOSCI online.

References cited
——. 2016. FAOSTAT Database. FAO. (1 December 2016; www.fao.org/faostat)
Monsanto. 2008. Monsanto Will Undertake Three-Point Commitment to
McIsaac GF, David MB, Gertner GZ. 2016. Illinois river nitrate–nitrogen con-
Lark TJ, Salmon JM, Gibbs HK. 2015. Cropland expansion outpaces
[IPES-Food] International Panel of Experts on Sustainable Food Systems.
[IAASTD] International Assessment of Agricultural Knowledge, Science,
———. 2015. Agriculture and Food Research Initiative Competitive Grants
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U.S. Farmers, Who Once Fed the World, Are Overtaken by New Powers

GREENVILLE, Ill.—On a pancake-flat stretch of land not far from the Mississippi River, Illinois farmer Jerry Gaffner thumbs through weather forecasts and crop reports on his tablet computer, searching for clues about when to market his soybean crop.

The data streaming in isn’t from Illinois or even the American Midwest. It is from half a world away in Brazil, where farmers are harvesting what’s expected to be a record soybean crop. With 43% of the export market—up from just 12% 30 years ago—Brazil can sway global prices with a weather hiccup or transportation snarl, spurring U.S. farmers to sell crops and capture profits, or to bunker grain and hold off until prices improve.

Mr. Gaffner pays close attention to South American conditions because of the new reality facing U.S. farmers: America’s agricultural dominance has eroded.

Brazil overtook the U.S. as the world’s biggest soybean exporter in 2012-13, according to the U.S. Department of Agriculture. It’s projected to be the second-largest corn exporter, on the heels of the U.S., this season. As of the last crop year, Russia now beats America in shipments of wheat.

It’s a reversal for a country that has long identified as the world’s bread basket. America’s share of global corn, soybean and wheat exports has shrunk by more than half since the mid-1970s, the USDA says. In soybeans, the most exported U.S. crop, U.S. supplies make up about 40% of world exports, down from more than 70% three decades ago.

Other countries’ rising share of global trade and their bin-busting harvests have helped fuel a multiyear downturn in crop prices that is pushing some U.S. farmers out of business.

“We’re going to have to learn the table manners of sitting at a bigger table,” says Mr. Gaffner, whose soybeans often make their way down the Mississippi to be shipped overseas from New Orleans ports. For U.S. farmers, he says, “that’s hard for our psyche.”

American farmers’ fates are inextricably tied to the broader economy. Farmers produce three-quarters of the nation’s food. U.S. agricultural exports in 2015, the latest year for which data is available, generated more than $300 billion in economic output and directly supported more than one million jobs, according to the USDA.

Agriculture is among the few U.S. industries that exports more goods than it imports, helping to narrow the
nation’s overall trade deficit, which last year hit its largest point since 2012, the Commerce Department says.

U.S. taxpayers are tied to farming through the billions spent each year by the government to help insure farmers against crop shortfalls or lost income. For the 12 years ending in 2027, the USDA is expected to spend nearly $87 billion to help protect farmers, according to estimates from the Congressional Budget Office.

Rural communities likely will bear the brunt of the continued pressure on farmers, as job losses and lower farmland values cut the tax base for schools and other public services.

Anxiety over the U.S. role in agricultural trade has grown in recent months amid moves by President Donald Trump to withdraw the U.S. from the Trans-Pacific Partnership, which was backed by many farm groups, and potential changes to the North American Free Trade Agreement, which they say helped develop exports to Canada and Mexico.

Russia over the past decade boosted its wheat harvests by 61%, the USDA forecasts. Corn acreage has nearly tripled in Russia, and more than doubled in Ukraine. Brazil & Argentina have also ramped up output of the grain.

Foreign farm powers in South America and Eastern Europe owe some of their grain-market victories to favorable exchange rates—a strong dollar, the currency used for global trade, means foreign grain priced in local currencies can reap bigger profits.

Other countries have structured trade policy to benefit their farm sectors and have invested in infrastructure such as barge terminals and railroad networks to cut transport costs. In the U.S., about one-third of the corn crop is used for fuel production, and conservation programs have removed land from farming.

The shift has benefited global food security. Having multiple, strong exporters of grain around the world can help prevent supply disruptions due to weather or trade, farm economists say.

Also part of the silver lining: booming international revenue for U.S. companies such as Monsanto Co., Deere & Co. and Mosaic Co., who sell genetically engineered seeds, satellite-guided tractors and fertilizer to farms outside America. In some cases, U.S. companies design products and seeds specifically for foreign markets.

Bruno Gilioli, who grows soybeans near the heart of Brazil’s vast grain belt, is running out of room to store his huge crops. A concrete shelter the size of a football field holds less than half of this year’s harvest; the rest has been squeezed into nearby storage bins or trucked to a far-off grain elevator.

“The past five years have been very good for us,” he says. Using high-tech machinery and the advanced seeds and chemicals common on U.S. farms, Mr. Gilioli, 37, has pulled record yields from his 5,000 acres in Brazil’s Goiás state.

“Inside the farm, it looks just like the U.S.,” says Mr. Gilioli, who wears an Iowa State Cyclones hat, Levi’s T-shirt and Wrangler bluejeans. Mr. Gilioli lived on a farm in Iowa for a year as an exchange student and has made four visits to tour farms across the Midwest.

He plans to trade in a still-shiny 3-year-old Case IH harvesting combine for a newer model. Brazil’s agricultural growth-spurt began about four decades ago, as farmers were lured north to its sweeping savanna, known as the cerrado, by the promise of cheap land and climbing soybean demand and prices.

The region stretches over 500 million acres, an area three times the size of Texas and nearly 50% bigger than...
all the land in the U.S. used to grow crops.

Armed with soil treatments like lime and fertilizer, settlers brought huge tracts of scrubland—once considered ill-suited for growing crops—into cultivation. Farm operations can dwarf U.S. counterparts in size, including some with multiple parcels that when added up are larger than Yosemite National Park.

Farmers have been aided by Brazil’s lower land costs, macroeconomic reforms and a year-round growing season, which allows them to stack soybean and corn crops back to back.

Low crop prices are hurting farmers in Brazil, but other financial factors have worked in their favor in recent years. Farmers are typically paid in dollars for their grain, but pay about 38% of their expenses in reais, which dropped sharply against the dollar in 2015.

As a result, when crop prices fall, Brazilian farmers can book profits for longer than U.S. farmers, according to J.P. Morgan analysts. Soybean futures currently trade around $9.50 a bushel.

Brazil has less-developed infrastructure. Heavy rains routinely trap trucks shuttling soybeans single-file down poor roads in the country’s north, requiring bulldozers to wrench them from the mud. Earlier this year, wet weather hobbled transport on BR-163, a key agricultural thoroughfare, stranding ships at Brazil’s northern ports for weeks before forcing some to reroute south to collect soybeans, according to Michael Cordonnier, president of Soybean and Corn Advisor Inc., an Illinois-based agricultural consulting firm.

Still, Mr. Cordonnier predicts Brazil will grow into an ever more powerful agricultural player. “They have the weather, the know-how and the area,” he says.

U.S. companies have helped develop the sector. Global grain giants Cargill Inc., Bunge Ltd. and Louis Dreyfus Commodities dotted the countryside with soybean processing plants in the 1970s and ‘80s, and built export terminals at the country’s ports. Some grain companies offered financing to farmers.

Equipment manufacturers such as Deere and CNH Industrial NV since 2000 have set up Brazilian factories and assembly lines to roll out tractors. Minnesota-based Mosaic agreed to buy most of Brazilian miner Vale SA’s fertilizer business for $2.5 billion last year to produce in the country.

After Brazil gave farmers the green light to grow genetically modified crops in 2003, seed giants Monsanto and DuPont Co. ramped up production and research there. In 2013, Monsanto introduced a soybean gene designed to repel pests common to Brazilian fields, their first biotech seed specifically designed for the Latin American market.

The world’s largest seed company by sales now generates about 11% of its revenue from Brazil. It plans to roll out a new genetically engineered soybean by 2021 to resist a wider range of bugs that bedevil crops in South America, says Leonardo Bastos, who leads Monsanto’s product management in South America.

Back in Illinois, the largest soybean-producing state in the U.S., Mr. Gaffner is adapting his operation to ensure his farm, in the family since the 1930s, survives the worst slump in decades. He is focused on keeping costs down on his 1,000 acres.

He buys 10-year-old farm machinery and keeps the equipment running. He uses GPS technology to avoid blanketing fertile areas of fields with unneeded nutrients. Similar systems help measure the exact number of seeds he needs to plant per row.
“That’s enabled us to stay ahead of the financial distress,” says Mr. Gaffner, 51. He considered trying his hand at farming in Brazil two decades ago but ultimately decided against it.

He has also built an array of steel storage bins behind his family’s farmhouse. With profit margins so tight, and price shifts so rapid, Mr. Gaffner says the space provides flexibility to stash crops until prices turn favorable.

He has had to spend more money for extra herbicides to fight palmer amaranth and waterhemp, weeds that have developed resistance to a herbicide, widely used with the genetically engineered seeds that revolutionized farming in the 1990s.

Seed costs are higher. The price of soybean seeds for U.S. farmers has more than quadrupled in the past 20 years, according to USDA data. Some farmers are settling for older, cheaper versions of seeds, though they may not produce as many beans.

“That’s not going to be a good thing for us in competition with other countries,” says Tommy Young, an Arkansas farmer who represents his state on the U.S. Grains Council, an export-focused body for U.S. farmers.

Income in the U.S. farm sector will decline for a fourth year this year, falling to $62.3 billion, half of the record $123 billion farmers earned in 2013, the USDA projects. The last time income fell four years in a row was in the mid-1970s.

U.S. growers are adding soybean acres, wagering that robust demand from China and other importers will make soybeans more profitable than corn. The USDA projects a record 89.5 million U.S. acres will be planted with soybeans and that U.S. exports will expand modestly over the next decade. Soybeans mostly are processed into meal to feed livestock and poultry, as well as into oil used in cooking and food products like margarine.

Farmers could also dedicate more fields to specialized soybeans, tailored to yield healthier oils for processed foods, which can fetch a higher price. “Twenty years from now we may not be focused on squeezing more bushels out of each acre but on growing a more nutrient-dense crop,” says Jim Sutter, chief executive of the U.S. Soybean Export Council.

Over all, U.S. farmland has shrunk by 12%, or 46 million acres, since 1982, partly due to urban development. In contrast, in Brazil, about 150 million more acres in the cerrado could eventually come under the plow, as farmers convert more pasture into fields for crops, according to the USDA. Brazil’s agricultural expansion has drawn criticism for deforestation, though over the past decade, farmers have boosted production largely by converting pasture land and increasing crop yields, instead of knocking down rain forest, according to the Nature Conservancy, a conservation group that has worked with grain companies.

Mr. Gilioli says his family farm has grown 10-fold since the late 1990s, when his father bought the first 500 acres with proceeds from the sale of his seed business, and he may expand further.

“It’s easy to open new land,” Mr. Gilioli says, gesturing toward a wide expanse of pasture land from the cab of his Ford pickup truck. “In two or three years, that will all be soybeans.”
Co-packers should be concerned, along with distributors, farmers and even, heck, grain elevator operators. Their worlds are incrementally turning upside down. And it doesn’t seem that they’re ready for it.

“Meet Your New Boss,” read the cover of *Successful Farming* magazine in February of this year. “Millennials are driving the new food and ag economy.”

Though Millennial foodies are often thought of in the context of hipster restaurants, a craving for avocado toast, or a passion for *LaCroix*, shifting purchasing habits—driven by the 50 percent of U.S. Millennials who claim to be foodies (FYI, that’s one-eighth of the entire U.S. population)—are inevitably beginning to reverberate further up the supply chain. It’s no longer just a chef’s challenge to write a menu with kimchi and kale; it’s now the farmer’s job to grow what the consumers are demanding, which often means, rethinking the system they’ve long worked within.

Suddenly, the goal for restaurateurs and food entrepreneurs is not to supply food that’s cheap and chock full of sugar, salt, and fat. Instead, they’re challenged to supply customers with organic, fair trade, vegan, gluten-free, and just plain nutritious foods at a price point that’s...
manageable. And it turns out that’s not what the food supply chain is set up for. Slowly but surely, Millennial demands are putting pressure on an archaic food system set in its ways.

“Today’s consumer preferences are shifting quickly. We want local, nutrient-dense food, without any commercial pesticides, herbicides, and fungicides, and so we flock to these new businesses, driving double-digit yearly growth in the organic food industry, according to the USDA, while the rest of the food industry languishes,” writes Andrea Hayley for Epoch Times, referring to rising sales at disruptive new concepts like Blue Apron and Sweetgreen, and falling sales within “Big Food.”

A recent survey by the Organic Trade Association (OTA) finds that parents in the 18-to 34-year-old age range are now the biggest group of organic buyers in America. Overall, almost 45 percent of Americans say they actively seek organic products.

“The Millennial consumer and head of household is changing the landscape of our food industry,” says Laura Batcha, CEO and Executive Director of the OTA. “Our survey shows that Millennial parents seek out organic because they are more aware of the benefits of organic, that they place a greater value on knowing how their food was grown and produced, and that they are deeply committed to supporting a food system that sustains and nurtures the environment.” Ultimately, it’s a completely new set of evaluations when it comes to what we eat, a significant shift away from the last few decades of buyers flockin to frozen and sometimes indestructible packaged goods pandered as the ultimate, cheap convenience.

The U.S. organic market posted record sales in 2015, skyrocketing to $43.3 billion, up 11 percent from 2014. Globally, organic, functional, allergen-free and better-for-you foods sales just might reach $1 trillion in 2017, according to Euromonitor International. Havas anticipates the gluten-free market to grow 68 percent in the next five years, Paleo to grow 364 percent, vegetarian and vegan markets to grow 86 percent and raw to grow 101 percent. Food is the new social currency, and beyond that, now viewed as a mechanism for managing personal and planetary health. People are placing their food dollars where their personal values are.

Yet, “a majority of American farmland is dominated by industrial agriculture—the system of chemically intensive food production developed in the decades after World War II, featuring enormous single-crop farms and animal production facilities,” states Union of Concerned Scientists. Corn, soybeans, wheat, and hay account for 85 percent of the nation’s farmable land—not the organic greens, berries and legumes these young eaters have a hankering for. Interest in local, sustainable, and organic products far exceeds the available supply. Imports of organics are up to compensate for the difference. Of course, prices on these items are also high, as the basic model of supply/demand economics plays out. the current supply chain to create a new map of sourcing, distributing and selling the goods.


Source: USDA Economic Research Service


See more details:
Today, food entrepreneurs looking for organic, traceable, sustainable goods are left, in large part, to their own devices, unable to source their ingredients through the same supply chains that bigger food manufacturers draw from. They’re looking beyond demanded by their food-loving and food-educated customers.

One solution exemplified by several successful food startups is to go directly to farmers. Dig Inn, an organic, veggie-focused fast food restaurant chain works with farms of varying sizes—from as small as 10 acres to as large as 500 acres—around the country to supply the local, sustainably grown produce. “We serve seasonal American food, mostly vegetables, from farmers and partners as close to home as possible,” the company website reads. “We’re disrupting the food system,” they state, by working directly with farmers and producers that align with their values and mission. Blue Apron is another startup that goes direct to farmers, along with Sweetgreen.

Even the big guys are rewriting the rules. Dannon, one of the largest yogurt companies on Earth, has had to create their own supply chain for the release of non-GMO yogurts in the U.S., unable to source directly from their usual marketplace, instead forging relationships directly with dairy farmers. Costco has opened its own chicken farms, to ensure antibiotic-free, cage-free birds. “The move is part of Costco’s plan to have more control over its own supply chain,” writes Lucinda Shen for Fortune.

Shen’s observation points to another area of tension, beyond supply: traceability, transparency, and control. Transparency—an offering the food and beverage trend firm Hartman Group notes as “paramount” when appealing to Millennial buyers—in the current system, where ingredients can bounce along a chain from farmer to manufacturer to distributor to retailer, sometimes with additional steps in between, is often a near-impossible task. (This has been proven by stories of horse meat, pink slime, pork bung, glass, e coli and other contaminants or unexpected ingredients that are difficult to track back to their sources).

Working directly with farmers allows for greater clarity on when an item is being harvested, from what kind of soil, by whom, how it’s cleaned and packaged and delivered. It also provides the opportunity for collaboration.

“Ultimately, our business is well positioned to support farmers,” Adam Eskin, founder and CEO of Dig Inn told me, “as we both benefit from a relationship that is tight-knit, with constant communication—a true partnership. Rather than cut in and out during a growing season, we support crops in their entirety, which means farmers can predict sales and be profitable off their land. Going direct to farmers improves the flavor, quality, and performance of our food. We also have the added bonus of being able to chat with a grower, make changes, and implement within a few days from harvest. The current conventional system is ill-equipped to be as hyper-responsive as we can be.”

These direct-to-farmer relationships also provide a cost benefit to the retailer and farmer, as they essentially nix the middle men. A 2011 study done by the United States Department of Agriculture Economic Research Service shows only 11.6 percent of the dollar goes back to the farmer, with food distributors and processing taking most of the profit. “Price is still a major barrier,” says Nick Green, co-CEO of Thrive Market, of getting organic, sustainable goods to their customers. Think of Thrive Market as Whole Foods meets Costco: “Buy healthy food from top-selling, organic brands at wholesale prices. Shop for gluten-free, non-GMO, non-toxic products for a wide range of diets,” their company tagline boasts. “To make Thrive’s products accessible, we need to get natural and organic products at or below the price of the conventional equivalent. And sometimes we’re able to do that, but sometimes we haven’t been able to,” says Green.

To maneuver their way around the price issues, Thrive Market has begun to launch their own products. “If there’s a product that we’re not able to get at a price that’s affordable to people,” explains Gunnar Lovelace, Thrive Market’s founder, “we’ll go up the supply chain, work directly with a supplier or co-packer and do Thrive Market branded coconut oil, for example. We can get products for 50 percent off what you’d usually pay for the conventional equivalent.” Thrive Market’s system cuts the distributors and processors out of the equation.

“The big challenge is we’re dealing with an archaic distribution system,” notes Lovelace. “We’ve got the farmer, transportation, manufacturer, distributor, broker, retailer. It’s a super obsolete 20th-century distribution model.” To solve for it, Thrive Market is “completely disintermediating the supply chain, and vertically integrating and
“The big challenge is we’re dealing with an archaic distribution system,” notes Lovelace. “We’ve got the farmer, transportation, manufacturer, distributor, broker, retailer. It’s a super obsolete 20th-century distribution model.” To solve for it, Thrive Market is “completely disintermediating the supply chain, and vertically integrating and collapsing that pricing in a way that allows us to pass along savings to our members,” Lovelace states. This model works in additional security and income for the farmer, on top of Thrive Market’s own savings and elevated product offerings.

Small farmers—like those idyllic images you often see of the young, organic, fair trade farmer in the Hudson Valley or hills of Vermont—are often separated from the conventional supply chain. They can find it difficult to find labor, transportation and distribution networks that support local, seasonal farming. Direct-to-farmer relationships provide stability to those who are practicing sustainable farming methods. But the buyers need to be willing to bend to nature’s whim and see the benefits of investing in sustainable agriculture, instead of efficient and cheap agriculture.

“We’re proud of the partnership we have with Dannon,” says Ken McCarty of McCarty Family Farms, a farmer partner with Dannon since 2011. “It’s uncommon in the dairy industry to have such a close working relationship with a milk buyer. Not only does it give us reliability in the market, it gives us reliability for our families and our community. And it encourages all of Dannon’s farmer partners to convert to practices that better serve our natural resources and environment.”

Thrive Market, Dig Inn and Sweetgreen are all also vocal about the reduction in food waste, greater diversity in crop selection, the reduction of produce’s carbon footprint and water use that all accompany this farmer-retailer relationship.

Slowly, these changes are pushing the supply chain to think more critically about their measures of “success.” Is it really just quantity, or should quality—nutrition, freshness, sustainability—start to become a part of the equation? “If we don’t change the way that food is packaged or produced or distributed or marketed—just to be stark about it—we’re going to be in serious trouble as a species,” Lovelace clearly outlines, as he discusses the sustainability shortcomings of today’s agriculture system.

The only question remains: When are those who are driving the traditional supply chain going to look up and take note?
The vegetable technology gap

Washington spends millions on crop research. Why doesn’t more go toward the foods we’re actually supposed to eat?

By Helena Bottemiller Evich
Politico.com/theagenda
03/08/17 07:33 AM EST

In the great quest to get Americans eating healthier, spinach is an unusual success story. We’re consuming four times as much fresh spinach as we were four decades ago, as a vegetable once derided as choke-it-down “good for you” has become a mainstay of home cooking and upscale restaurants. But the spinach boom wasn’t driven by changing tastes, or the cartoon exhortations of Popeye. It was driven by technology.

Spinach, like many vegetables, is finicky. If you packaged it in the same airtight bags used for potato chips, the leaves would start to break down before they made it from California’s Central Valley to a supermarket in Chicago. It wasn’t until scientists came up with a special bag—one that controls how much oxygen and carbon dioxide can seep in and out—that pre-washed, ready-to-eat spinach became something that a shopper could grab in the produce section and dump straight into a salad bowl or smoothie. Spinach, and leafy greens in general, have become so convenient that Americans are actually eating more of them—an impressive feat considering just one in 10 Americans eats the recommended servings of fruits and vegetables each day.

As the country seeks solutions to the obesity epidemic, there’s been plenty of debate about how to get people to eat better. Do we need to improve access to healthy foods? Teach cooking? Tax sugary drinks? But there’s one thing that’s often left out of the conversation: technology.

It might seem strange to think about vegetables as a technology, but they are. The average supermarket produce aisle represents decades, if not centuries, of agricultural research and development. But in the United States, big-league commodity crops like corn and soy, as well as meat, gobble up most of the agricultural research investment from both the public and private sectors. The U.S. Department of Agriculture’s dietary guidelines tell us to fill half our plate with fruits and vegetables to maintain a healthy diet, but its research priorities are far different. So-called “specialty crops”—the government’s name for the category that includes, essentially, all fruits, vegetables and nuts—received just 15 percent of the federal research budget over much of the past three decades.
“There’s nothing more important we can do to improve the health of this country than to invest billions and billions into researching the fruits and vegetables that we’re encouraging people to eat,” said Sam Kass, the former White House chef and food policy guru under the Obama administration who now works with food tech startups.

Agricultural research is fundamental to improving how we raise, grow, harvest, process and ship everything that we eat. It took millions of dollars of public and private research and years of experimenting with limp leafy greens before breathable salad packaging came onto the scene. Consumers no longer have to wash sand and dirt off their greens, remove tough stems and ribs or chop them into bite-sized portions. The same types of technologies have also helped bring us baby carrot packs with dips, sliced apples in McDonald’s Happy Meals and ready-to-eat kale salad kits. The enormous logistical and technological challenges facing so many of the foods that nutritionists tell us to eat make research especially critical for produce, which as a sector is still relatively inefficient. Apples bruise. Berries don’t all ripen at once. Cilantro wilts. Cherries can split and crack if it rains at the wrong time—a problem that can be so expensive, some growers hire helicopters to fly over their crop to dry the delicate fruit. Many of these crops still rely on increasingly expensive (and oftentimes undocumented) labor to pick them by hand. And water. They need lots of water.

Specialty crops remain special—just 3 percent of cropland is dedicated to growing them—though they make up roughly a quarter of the value of crops grown in the U.S. because they demand higher prices. This lopsided dynamic means that specialty crops have historically received very little federal research investment compared to their value. It also means the country simply doesn’t have a food system that supplies what we’re told to eat. In 2007, there were about 8.5 million acres of specialty crops in a sea of more than 300 million acres of everything else.

“If Americans were to actually go ahead and jump into consuming the amount of fruits and vegetables recommended, we’d be hard-pressed to meet that demand,” said Sonny Ramaswamy, director of the USDA’s National Institute for Food and Agriculture, which coordinates a large part of the government’s agricultural research portfolio. “There’s an incredible amount of innovation that we need, all the way from the farm to the table.”

The imbalance is no accident: In a sense, it’s built into the mission of the USDA itself, which frustrates both vegetable growers and nutrition advocates. But there are signs it’s starting to change—if slowly.

THE ROAD TO packaged salad isn’t just an example of how research pays off: It shows just how long the process can be, and how much commitment it requires. It began in the late 1920s when a young Berkeley grad named Bruce Church bought a field of head lettuce in Salinas, California, and devised a plan to ship it, packed in ice, by rail across the United States. According to local lore in the

Salinas Valley, children as far away as Maine would greet the rail cars excitedly, shouting: "The icebergs are coming! The icebergs are coming!" The name stuck. After World War II, a handful of USDA scientists stationed in Fresno, California, set out to learn more about how to best handle, store and ship fruits and vegetables. They obsessively measured temperatures, shelf life, spoilage and the rate at which different crops respire—or breathe—which is one way of measuring how fast something will rot.

“They’re still alive!” explained Gene Lester, national program leader for the Agricultural Research Service’s food science and technology division. “You’re eating a lettuce leaf or a kale leaf, or a string bean, or an apple—they’re still alive. There’s still CO2 and oxygen exchanging in those organisms, and that’s what’s keeps them healthy for us.”

In 1954, researchers published a roundup of everything they’d learned in a massive book, known as AH-66. That tome served as a base of knowledge that preceded major advances in produce innovation for decades afterward. “That was kind of a bible for us,” said Jim Lugg, a longtime agriculture scientist who in many ways is the grandfather of modern salad technology. “The problems weren’t really with growing the crops, it was with shipping them and keeping them fresh.” Lugg, who’s now 83 years old, still consults in the industry (and, for the record, still eats lots of salad).

In 1963, Lugg signed on to lead the research division of Bruce Church Inc., which teamed up with a subsidiary of refrigerator-maker Whirlpool—a partnership based largely on the hope that they might be able to figure out how to get lettuce from Salinas to the East Coast before it turned brown. After a lot of experimentation, they figured out how to manipulate the atmosphere inside the vehicles in which they shipped the lettuce so that it was more hospitable, providing the right balance of CO2 and oxygen in refrigerated rail cars and containers—a hack that took the shelf life of the lettuce from three or four days to 14, as long as the lettuce was kept cold.

“We’ve put it to sleep,” Lugg explained. “It’s sleeping! It’s not breathing at its normal rate.”

Bruce Church Inc. eventually morphed into Fresh Express, which in 1989 introduced what is believed to be the first pre-washed, bagged salad in grocery stores nationwide. That first mix, packaged in breathable bags, was chopped iceberg lettuce, with bits of shredded carrots and purple cabbage, a combo that meant home cooks could serve a multi-ingredient salad without chopping a single vegetable. “We saw a way to really improve the customer experience with lettuce,” Lugg said.

Lugg recalled serving on a board that helped advise the government on investing in specialty crop research in the 1990s. “I don’t think they were spending very much,” he says. (USDA couldn’t provide an estimate.) “The then-head of [the Agricultural Research Service] was very defensive about all the problems they had getting money and that they had to spend money for things like corn and ethanol and cotton.”

He’d sometimes give Ed Knipling, the then-head of ARS, a hard time about the disparity. “He would point out how much they spent on this crop or this crop, and we’d say ‘Well, how much did you spend on lettuce?’”

SO WHY DOESN’T the nation spend more on better lettuce? The answer lies partly in the history of the U.S. Department of Agriculture itself. On one hand, the department, founded by Abraham Lincoln, is dedicated to promoting and boosting American agriculture as an industry. That means investing in the
massive commodity crops that largely fuel American farming, giving us the cheapest, most abundant food supply in the history of the world. But the department is also tasked with encouraging healthy eating—it’s the agency that gives Americans nutrition advice—and these two major goals can at times be directly at odds.

Public health advocates have long lamented that the USDA’s nutrition advice doesn’t align with how the institution actually spends its money, and they often point to crop subsidies as the most glaring example. Between 2008 and 2012, for example, fruits and vegetables and other specialty crops got just under one-half of 1 percent of all the subsidies that were doled out. A full 80 percent of those payments went to supporting grains used in all manner of foods, to feed livestock and to fuel our cars, and oils, like what we use to fry potato chips.

The disparity is something that frustrates Rep. Chellie Pingree, a Democrat from Maine, who also happens to be an organic farmer. When the congresswoman speaks at food conferences, she often shows a side-by-side graphic comparing MyPlate, the government’s nutrition guide, and a plate representation of crop subsidies.

“Vegetables are called specialty crops! Don’t ask me to explain why,” Pingree said as she unveiled her graphic at TedxManhattan back in 2014. The room full of foodies gasped and mumbled disapprovingly.

The idea that junk food is cheaper than produce because of farm subsidies is so often repeated by food movement leaders like Michael Pollan that almost everyone assumes that it’s true. But the reality is more nuanced.

Subsidies on their own don’t explain why processed foods are cheaper than produce, calorie for calorie. Fruits and vegetables, first and foremost, are highly perishable, which makes everything about growing, harvesting, storing and shipping them infinitely more complicated and expensive. Many of these crops also take a ton of labor to maintain and harvest. Economists who’ve crunched the numbers have found that removing agricultural subsidies would have little effect on consumers’ food prices, in part because the cost of commodities like corn and soybeans represent just a tiny share of the cost of the food sold in the grocery store.

The U.S. has simply gotten much better at growing corn than lettuce. Today, we get about six times as much corn out of one acre of land as we did in the 1920s, when Bruce Church started his lettuce farm. Iceberg lettuce yields, on the other hand, have only doubled in that time. The USDA didn’t start tracking such data for most of the darker leafy greens until the 1990s.

Even if subsidies did make fruits and vegetables dramatically cheaper, it’s far from clear that everyone would start eating their broccoli. The price of produce isn’t the only cost to eating fruits and vegetables; many consumers also lack the time or the skills to prepare and cook their perishables. And increasing fruit and vegetable consumption is hard to keep up as Americans eat more of their food on the go, away from home and prepare far fewer traditional meals on their own.

Moreover, the produce industry doesn’t want to be subsidized like Big Corn or Big Soy. When industry leaders come to Capitol Hill, they have been clear that they didn’t want traditional subsidies, like price supports, said Glenda Humiston, vice president of agriculture and natural resources at the University of California. “They want help with the infrastructure to do their jobs better,” she says, including more funding for research labs and data collection that can help industry solve problems on the ground.
Reducing the need for labor is one of the top priorities for the industry, especially with the Trump administration’s rhetoric and recent crackdown on undocumented workers. Labor alone can account for half a farm’s costs and labor shortages are already preventing the expansion of acreage of specialty crops in many regions. Farmers can be hesitant to invest in growing, watering and raising a crop if there’s uncertainty about having enough workers to harvest it.

“Growers and shippers are going to have to find ways to mechanize, or we’re not going to be able to harvest our products, and we’re talking about delicate products,” said Steve Church, CEO of Church Brothers Farms, a major grower in Salinas.

“The biggest issue we have here is labor,” Church added. “No question in my mind.”

Today, the government is funding research at Washington State University and other universities to design robots that can gently harvest apples and even see or smell when the fruit is ripe—a potential leap for the kind of mechanization that has so far eluded much of the produce industry.

USDA researchers are also working on a system that drastically cuts down on the need to sort fruit. The prototype is an elaborate, six-armed machine that goes into the field with apple pickers. The apples are fed onto a conveyor belt that uses an infrared system to detect blemishes and even grade the fruit on the spot.

Other research is focusing on improving flavor. In Florida, researchers have cracked the code to make tomatoes taste better, an innovation that could help reverse decades of breeding tomatoes for durability and thick skin that has left the fruit tasteless and watery. The tomatoes, which also have more lycopene, an important nutrient and anti oxidant, have begun being marketed in Florida under the name Tasti-Lee. The company that commercialized the technology says nearly 94 million pounds of the tastier tomato have been sold so far.

“We first of all had to have a stable supply. We had to figure out how to get tomatoes from the West Coast to the East Coast,” says a USDA scientist, permitted to speak on background. “But now we can focus on the whole flavor component.”

Making tomatoes tastier is only the beginning. “Understanding this pathway, it’s not unique to just tomatoes, but you can use this as a model for citrus, or peppers or apples or anything else,” the scientist said.
THOUGH SPECIALTY CROPS have lagged behind their shelf-stable brethren for much of the past century, the needs of the produce industry haven’t gone totally unheard in the halls of Washington. The idea that these smaller crops might deserve more attention began to gain some traction in the early 2000s, when California growers became increasingly angry that their state was the No. 1 agriculture state based on value, largely due to high-dollar specialty crops, but they were coming up around 16th in terms of USDA research funding coming into the state.

In 2006, there was also a renewed interest in investing in research after a deadly E. coli outbreak linked to packaged spinach rocked the entire produce industry—and consumer confidence. Three people died, and 276 people were hospitalized. The disaster fueled an intense food-safety push across Salinas Valley and the rest of the produce industry. It also helped energize a diverse coalition of growers that had started to organize to ask Washington for a greater share of spending in the farm bill, the law that every five years sets the agenda for the Agriculture Department. They demanded that more money be invested in food safety and other types of research. Producers of commodities like dairy and grains were less than pleased to have another group vying for a part of the federal pie, according to congressional aides.

“It was a hell of a fight,” said Humiston.

But Big Produce’s political push has paid off. In 2008, the farm bill for the first time included a section dedicated to specialty crops. There’s now a $72 million fund to promote various specialty crop projects, like building hoop houses to extend the growing season. Fruit and vegetable farmers are also starting to get access to the same government-subsidized insurance policies that other commodities have enjoyed for years. But the biggest growth for specialty crops in recent years has been in research spending.

The USDA now dedicates some $400 million to studying specialty crops each year—a big increase, though still a modest fraction of the nearly $3 billion the government invests in agricultural research each year. That pot of money is spread among USDA’s in-house research, land grant universities and other public research institutions. The USDA couldn’t provide specialty crop research estimates from before 2008.

The Obama administration and its intense focus on healthy eating was also a boon to the specialty crop sector. The administration not only backed allocating more money to the crops, but it also promoted more fruits and vegetables in school meal programs that serve 30 million children each day, and in the Women, Infants and Children program, which provides nutritional support for half of all babies born in the United States.

While much of the new federal boost for produce investment is motivated more by the industry’s business needs than any push to combat the nation’s crippling obesity epidemic, public health advocates with little political clout are thrilled to see the needle moving, however it happens.

“If what we want is for people to eat fruits and vegetables, we have to make it easier, we have to make it taste better,” said Marion Nestle, a food studies professor at New York University and author of the popular blog Food Politics.

“It’s about time produce got some attention.”
Here's Why We Haven't Quite Figured Out How to Feed Billions More People

Solving the world’s looming food crisis will require big investments in agricultural research, yet public support for that is lagging.

By Dennis Dimick, National Geographic News

PUBLISHED OCTOBER 04, 2014

When famine loomed in Mexico and southern Asia in the mid-20th century, agricultural crop researchers saved the day. Scientists at Mexico’s International Maize and Wheat Improvement Center (CIMMYT) and the Philippines’s International Rice Research Institute (IRRI) came up with new, high-yielding varieties of wheat and rice that raised harvests and kept starvation at bay.

That major advancement in crop production—financed with money from governments and the Rockefeller and Ford Foundations—increased yields of cereal grains by using improved crop seeds, irrigation systems, synthetic fertilizer, and pesticides. Led by American agronomist Norman Borlaug, this movement became known as the Green Revolution.

Most increases in agricultural production during the past half century have come from innovation: boosting crop and livestock yields on land that already was being used for agriculture. Studies indicate that this growth in productivity has stemmed largely from investments in agricultural research.

But yield improvements have slowed during the past 20 years, and public spending on agricultural research in developed nations such as the United States and those in Europe has flattened. That’s a daunting combination at a time when the world’s population is soaring toward 11 billion by 2100 and when several parts of the world—from California’s Central Valley to Brazil’s southern region around São
Paolo—are suffering through history-making droughts that have emptied reservoirs and damaged crops. More than 400,000 acres of food-growing lands have been left fallow in California.

A 2012 report in Science based on U.S. Department of Agriculture (USDA) data indicated that a decline in public support for agricultural research may be a factor in faltering yields and rising food prices. At the same time, investment in privately funded agricultural research—the kind that spawned patented pesticide-resistant genetically modified crops—has dominated the agricultural research landscape. The lesson: Biotechnology and better seeds provide a key piece of the puzzle in meeting future food demand, but alone cannot solve the challenge of feeding the world.

**Calls for Revitalizing Agriculture Research**

Worried about this decline in basic research and the flattening of yield growth, scientists and research groups are calling for renewed emphasis on—and financing of—publicly funded agricultural research. Donald Kennedy, editor emeritus of Science, wrote in the magazine's October 3 issue that "for decades the agricultural sector has suffered from neglect. If we want to combat new strains of pests that destroy crops, find new crop varieties enriched in nutritional value, improve yields, develop resistance to disease and drought, and provide environmentally sensitive cultivation practices, then agricultural research must be a priority. Why isn't it?"

"Over the past 35 years," he continued, "new ventures in U.S. public investment in agriculture research and development confronted a steady decline. At the same time, great advances in biochemistry, cell and molecular biology, and genetics were being made through increased funding to other agencies (besides USDA) for competitive-merit based research grants."

Kennedy also said that because of the regional or commodity-based "formula" method in which agricultural grants are allocated to the USDA, "agricultural research is now in a deficit position with respect to the infrastructure, human capital, and policies needed to address the challenges of food security."

Former USDA Secretary Dan Glickman, an advocate of increased public funding for agricultural research, recently was named chairman of the new Foundation for Food and Agricultural Research, which Congress has funded with $200 million for making research grants. Those grants must be matched with non-government money as the foundation's projects are identified. Congress's move represents a healthy contribution, but it also shows that the U.S. government's investment in the future of our food
Supply remains a tiny fraction of the public financial support for health and medical research. The National Institutes of Health receives almost $30 billion annually for its research grant-making, 150 times more than the funding for the Foundation on Food and Agricultural Research.

The vital role of agricultural research in improving harvests and farmer prosperity dominated discussions last month at the first-ever gathering of CGIAR, a consortium of the world’s top agricultural researchers. During a panel discussion that focused on the role of staple crops in meeting future food needs, Tim Searchinger of the World Resources Institute starkly framed the looming challenge.

Searchinger said that to meet the projected demand for food, unless we cut down all the world’s remaining forests—which obviously is not a good idea—we must increase harvest on current farmland by one-third more than harvest were increased during the Green Revolution period of the 1940s through the 1960s. CGIAR is leading a renewed emphasis on agricultural research, and late last year announced $1 billion in new funding for research at its 15 centers.

Targeting Africa, Asia, and "Leverage Points"

Getting higher yields of corn and soybean from U.S. farms to feed more meat animals is not the problem. The main challenge for agricultural research is to get usable knowledge to farmers in places such as sub-Saharan Africa and southern Asia, so they can raise enough food for themselves and others, make money, and protect the land and water on their farms.

National Geographic Emerging Explorer Jerry Glover is working to achieve that in Africa by exploring integration of perennial legumes such as pigeon peas and groundnuts—plants that generate their own nitrogen fertilizer—into farmers’ fields as a way to improve soil health and increase yields of food crops planted alongside the legumes. Glover’s work at the U.S. Agency for International Development is part of Feed the Future, a U.S. government program designed to improve the harvests, and lives, of smallholder farmers.
Meeting the challenge of growing more food will also require targeting areas where additional research investment can be particularly effective in increasing productivity and protecting the environment.

Paul West and researchers at the University of Minnesota, in a July study in Science, identified "leverage points" in six countries that would allow enough food to be grown for three billion more people without trashing the planet. This study builds on an earlier study published in Nature, "Solutions for a Cultivated Planet," that proposed a five-step plan for feeding the world in decades ahead while minimizing damage to the planet. National Geographic magazine featured this study in the article “Feeding Nine Billion” in the May 2014 issue, written by lead researcher Jonathan Foley.

Getting Knowledge "That Works"

Tim Folger writes in “The Next Green Revolution” in the October 2014 issue of National Geographic that the main challenge agricultural researchers face in helping farmers is not in creating low-tech or high-tech solutions to problems, but in providing appropriate knowledge "that works" and is useful to farmers on the land they farm.

Before we can better educate farmers about improved agricultural methods, we must identify what those methods should be. This is where low-profile, long-term agricultural research activities come in, projects and studies that create knowledge that help lead to successful harvests and prosperous farms.

Examples include more research into fruit, vegetable, crop, and livestock production; designing mobile phone networks to share market and production information; creative initiatives to capture and store water and irrigate fields; crop storage methods that trim the waste from harvests and protect grain from insects and rodents; solar-powered lighting; new and improved roads; and the creation of local purchasing cooperatives, financing strategies, and group markets to boost farmers' capital and revenue.

A new Green Revolution likely will hinge less on the kind of big research breakthroughs that defined the original Green Revolution and more on incremental examples like these that can work together and add up to better harvests and better lives for farmers.

Bruce Campbell, a CGIAR researcher, tells of Mary Ogello, a Kenyan farmer who was able to triple and quadruple her corn and sorghum harvests after researchers helped her access information about the start of rainy season and the likelihood of flood and drought on her land. Such thinking is part of a new approach called climate-smart agriculture that seeks to help farmers respond to climate change while reducing greenhouse gas emissions from agriculture that drive climate change.

Rice bowls used for three meals a day by Chinese factory workers speak to our ever-rising need for food: By 2050 we’ll have to grow enough food for more than 9.6 billion people, and by 2100 enough for a projected 11 billion.

PHOTOGRAPH BY JOHN STANMEYER, VII
A Rising Sense of Urgency

Food prices rose dramatically in late 2007 because of rising demand for grain-fed meat, faltering regional harvests, and increased diversion of corn crops for ethanol. Higher prices were good for farmers who sold crops, but around the world the rising prices hurt the least well-off who must buy food. There were reports suggesting that high food prices helped to fuel the social unrest of the Arab Spring in 2010 and 2011, but this remains a matter of debate. Regardless, despite projected ample grain harvests and lower prices this year, food prices globally have remained above 2010 levels ever since because of population and income growth, higher demand for food and grain-fed meat, extreme weather events affecting crops, and diversion of crops for biofuels.

The era of cheap food seems to be past, and as has been the case for a half century, food supplies and prices will be influenced by the effectiveness of agricultural research. When Norman Borlaug worked to develop high-yield "Green Revolution" wheat varieties more than 50 years ago, he was driven by a sense of urgency. We could all benefit by adopting his sense of urgency in making agricultural research a priority once again.

Dennis Dimick has degrees in agriculture and agriculture journalism from Oregon State University and the University of Wisconsin, and is National Geographic's executive editor for environment. You can follow him on Twitter, Instagram, and flickr.

Accessed 4/21/15

Largest Forest Service Restoration Initiative Reaches Milestone

USDA Office of Communications sent this bulletin at 04/20/2015 10:30 AM EDT

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Release No. 0102.15

Contact:
Office of Communications (202) 720-4623

Largest Forest Service Restoration Initiative Reaches Milestone

Joined by More than 30 Citizen Groups

WASHINGTON, April 20, 2015 – U.S. Forest Service Chief Tom Tidwell said today that the Four Forest Restoration Initiative (4FRI), the largest landscape-scale restoration initiative of its kind, has reached a pivotal milestone towards achieving accelerated forest restoration on more than 500,000 acres of the Coconino and Kaibab National Forests and grasslands in Arizona. Coconino National Forest Supervisor Earl Stewart and Kaibab National Forest Supervisor Mike Williams signed the final decision document for the project's first Environmental Impact Statement on April 17th.

"The Forest Service is accelerating the restoration and management of our national forests, despite budgetary challenges, using innovative and collaborative strategies to work across large landscapes," said USDA Under Secretary for Natural Resources and the Environment Robert Bonnie, "The 4FRI project is one of the best examples of this approach, and we appreciate the hard work and participation of the many employees and partners who have worked to achieve this milestone."

"This is exceptional work of Forest Service employees and citizens who joined together to support this historic endeavor," said Tidwell. "This restoration work will contribute significantly to our efforts to sustain healthy, resilient landscapes. Support from these citizen groups will ensure we maintain this momentum for the long haul. That's what it will take to make a difference."

More than 30 stakeholder groups contributed significantly to the development of this phase of work, which also reflects public comments and input received throughout the process. Additional 4FRI restoration projects have already been and are being implemented across the Apache-Sitgreaves, Coconino, Tonto, and Kaibab National Forests.
Forests. To date, approximately 300,000 acres have received some sort of restoration treatment as part of the initiative.

Chief Tidwell said signing the final "record of decision" for this phase of the restoration project is the result of four national forests and stakeholder groups joining together over five years to work on the largest landscape-scale restoration project ever analyzed in Forest Service history. This decision approves various restoration activities on over 586,000 acres of the Coconino and Kaibab National Forests including thinning; prescribed burning; watershed and road maintenance; grassland, spring, and stream channel restoration; and habitat improvements.

The 4FRI collaborative effort was started to restore forests ecosystems that support natural fire regimes, reduce the threat of destructive wildfire to nearby communities, and support sustainable forest industries that strengthen local economies.

4FRI represents unprecedented stakeholder engagement and participation. The 4FRI Stakeholders Group consists of individuals and groups representing local, county, and state governments; environmental groups, organizations, and institutions; and industry representatives. Their commitment to seeing these forests restored, and their continual engagement and participation throughout this process has been invaluable.

Restoring the health and resilience of our forests generates important values as well as economic benefits. 4FRI, and dozens of similar efforts, will help maintain a robust forest industry with benefits flowing not only to local communities but also to the Forest Service itself as the agency relies on local forest contractors and mills to provide the workforce to undertake a variety of restoration activities.

For additional information on the Four Forest Restoration Initiative visit www.fs.usda.gov/4fri.

The mission of the Forest Service, part of the U.S. Department of Agriculture, is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations. The agency manages 193 million acres of public land, provides assistance to state and private landowners, and maintains the largest forestry research organization in the world. Public lands the Forest Service manages contribute more than $13 billion to the economy each year through visitor spending alone. Those same lands provide 20 percent of the Nation's clean water supply, a value estimated at $7.2 billion per year. The agency has either a direct or indirect role in stewardship of about 80 percent of the 850 million forested acres within the U.S., of which 100 million acres are urban forests where most Americans live.

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Restoration of Ponderosa Pine Forests to Presettlement Conditions

February 2005
Ecological restoration seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability. . . . Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International 2004).

In the southwestern United States, most ponderosa pine forests have been degraded during the last 150 years; many areas are now dominated by dense thickets of small trees and have lost their once diverse understory. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-intensity surface fires—often after first thinning dense stands—and reestablishing productive understory plant communities. The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of southwestern ponderosa pine forests. By allowing natural processes such as fire to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

Every restoration project needs to be site specific, but the detailed experience of field practitioners may help guide practitioners elsewhere. The Working Papers series presents findings and management recommendations from research and observations by the ERI and its partner organizations.

This publication would not have been possible without significant funding from the USDA Forest Service. The views and conclusions contained in this document are those of the authors and should not be interpreted as representing the opinions or policies of the U.S. Government. Mention of trade names or commercial products does not constitute their endorsement by the U.S. Government.

For More Information

For more information about forest restoration, contact the ERI at 928-523-7182 or www.eri.nau.edu.

Written by Peter Friederici
Illustrations by Andrew Sanchez-Meador
Series Editor Peter Friederici
Cover: Gus Pearson Natural Area, Coconino National Forest, Arizona.


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**Treatment Type**

Emulation of the forest structure prevalent before the landscape-level disturbances that followed Euro-American settlement.

**Treatment Objectives**

To emulate the forest structure characteristic of the period immediately preceding Euro-American settlement in order to return forest conditions to their natural range of variability. This greatly reduces risks of stand-replacing fire, allows frequent ground fire to be safely reintroduced in order to regulate forest structure, and promotes the growth of understory plants that fuel such fires and support wildlife.

**Steps**

**Oversory Trees:**

- All living trees that existed at the time of local Euro-American settlement are identified and left standing. Depending on the location, area, and resources available, this may be assessed through increment boring, size, or the presence of yellow bark.
- All indicators of trees standing at the time of settlement that are no longer present as living trees—including snags, downed logs, stumps, and stump holes—are identified. Read more about this in Working Paper 7: Establishing Reference Conditions for Southwestern Ponderosa Pine Forests.
- Younger trees to replace the trees that have fallen, burned, or decayed since settlement are selected. "Extra" trees are left standing—that is, each missing tree is replaced with more than one— to compensate for possible mortality after treatment, and because most of the replacements are much smaller than the large trees that were removed or have died. In tests these trees have been chosen according to several different replacement rates, depending on local conditions, social considerations, wildlife needs, wildfire hazards, and other factors:
  - 1.5/3 (full restoration). If the replacement trees are over 16 inches in diameter, 1.5 trees are left standing for each presettlement indicator. If they are smaller, 3 trees are left standing for each indicator.
  - 2/4 (modified restoration). If the replacement trees are over 16 inches in diameter, 2 trees are left standing for each presettlement indicator. If they are smaller, 4 trees are left standing for each indicator.
  - 3/6 (minimal restoration). If the replacement trees are over 16 inches in diameter, 3 trees are left standing for each presettlement indicator. If they are smaller, 6 trees are left standing for each indicator.
- Replacement trees are chosen from within 60 feet of indicators, though a smaller distance (15 or 30 feet) can result in a more desirable clumping pattern among the remaining trees. Where possible, replacements should include the largest and healthiest postsettlement trees, and/or clumped trees, especially those with interlocking canopies.

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**Treatment Options**

This Working Paper is one of a series that describes the planning and implementation of restoration treatments in southwestern ponderosa pine forests. It presents the best scientifically based knowledge currently available about treatment types and effects. But this Working Paper is not a prescription. Restoration decisions need to be made with close attention to local conditions—there is no “one size fits all” approach, and specific prescriptions must be determined according to project objectives. Use this publication as an aid in making informed decisions about how to restore more natural conditions, and greater health, to the southwestern ponderosa pine forests.
Restoration of Ponderosa Pine Forests to Presettlement Conditions

This treatment and variations on it have been implemented at a variety of locations, including:

- Gus Pearson Natural Area, near Flagstaff
- Fort Valley, near Flagstaff
- Mount Trumbull area, in the Grand Canyon–Parashant National Monument
- Other national forest sites in Arizona
- San Juan National Forest, Colorado
- Lincoln and Cibola national forests, New Mexico

Fire:
- Prescribed burns are conducted after thinning.
- Slash can be treated by gathering it into piles for burning prior to broadcast burning.
- It is also possible to scatter slash throughout a treatment area and leave it to settle before burning; some practitioners have tried compacting it with a small tractor before burning to reduce flame heights (Jerman et al. 2004).
- Ground fires should recur on the site in years to come, at intervals that reflect the site’s “range of natural variability”—often from 2 to 12 years in many parts of the Southwest (Swetnam and Baisan 1996; Landres et al. 1999).
- Raking thick duff about a foot away from the trunks of remaining large trees—especially large trees—before fire may be necessary in order to prevent excessive bark scorch or root mortality (see Working Paper 3: Protecting Old Trees from Prescribed Fire). Particular caution is needed on lava soils, which may make trees especially susceptible to fire damage (Fulé et al. 2002).

Understory Vegetation:
- Treatment of understory vegetation varies. In some cases it may make sense to reseed treated areas with native plants after burning. Seeding can increase species richness, but also poses the risk of introducing invasive species and nonnative genotypes (Springer and Laughlin 2004). Whether it is necessary depends on such variables as the existing understory, distance from seed sources, and contents of the soil seed bank.
- In many places control of invasive plants may be necessary, and in all cases it is prudent to minimize their spread. Read how to do this in Working Paper 8: Controlling Invasive Species as Part of Restoration Treatments.

Where It’s Been Done
This treatment and variations on it have been implemented at a variety of locations, including:

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References


Table 1. Difference in selected ecological parameters between control areas and areas thinned to three different tree densities.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONTROL</th>
<th>1.5/3</th>
<th>2/4</th>
<th>3/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree vigor and health</td>
<td>Often declining due to heavy competition for water, light, and nutrients</td>
<td>Improved for at least seven years after initial thinning (Kolb et al. 2001; Wallin et al. 2004); some danger of mortality during intense prescribed fire (Jerman et al. 2004)</td>
<td>Likely to improve due to reduced competition; some danger of mortality during intense prescribed fire (Jerman et al. 2004)</td>
<td>Likely to improve due to reduced competition; some danger of mortality during intense prescribed fire (Jerman et al. 2004)</td>
</tr>
<tr>
<td>Herbaceous vegetation</td>
<td>Often low in richness and cover, due to tree density and heavy deposits of fallen needles</td>
<td>Both native and nonnative species increase in richness and cover (Abella and Covington 2004; Huffman and Moore 2004; Moore and Deiter 1992)</td>
<td>Response intermediate between 1/3/3 and control treatments (Abella and Covington 2004)</td>
<td>Response similar to 2/4 thinning (Abella and Covington 2004)</td>
</tr>
<tr>
<td>Fuel loading</td>
<td>Heavy crown fuels and &quot;ladder fuels&quot;; little herbaceous growth, but heavy loading of pine needles</td>
<td>Very light loading of crown fuels; vigorous herbaceous regrowth should promote surface fires (Fulé et al. 2001; Waltz et al. 2003)</td>
<td>Light loading of crown fuels; vigorous herbaceous regrowth should promote surface fires (Fulé et al. 2001)</td>
<td>Intermediate loading of crown fuels; some herbaceous regrowth should promote surface fires (Fulé et al. 2001)</td>
</tr>
<tr>
<td>Fire behavior</td>
<td>Can be extremely high susceptibility to crown fire (Fulé et al. 2001)</td>
<td>Very low likelihood of crown fire (Fulé et al. 2001)</td>
<td>Moderate likelihood of crown fire (Fulé et al. 2001)</td>
<td>Likelihood of crown fire intermediate between 2/4 treatment and control (Fulé et al. 2001)</td>
</tr>
<tr>
<td>Hydrology</td>
<td>Stand-replacing wildfire can cause severe erosion and downstream sedimentation (Baker 2003)</td>
<td>Water outflow slightly higher than in control areas (Kaye et al. 1999)</td>
<td>Not measured</td>
<td>Not measured</td>
</tr>
<tr>
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Tree health is enhanced by this treatment, as remaining pines in areas with a 1.5/3 prescription have shown increased resin flow, canopy growth, and water and nutrient uptake (Ferney et al. 1998; Stone et al. 1999; Kolb et al. 2001; Wallin et al. 2004). Windthrow and wind breakage of remaining pines may increase slightly in treated areas, but only a few trees have died from these causes in the areas monitored (Kolb et al. 2001).

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In general, the productivity of the understory increases after dramatic tree thinning (Abella and Covington 2004; Huffman and Moore 2004; Moore and Deiter 1992). This response has been measured at several restoration sites, including the Gus Pearson Natural Area and Fort Valley area (Korb and Springer 2003). In Fort Valley, this treatment resulted in higher species richness, diversity, and cover on treated than untreated sites, though the degree to which understory vegetation responds to increased levels of light, water, and nutrients is significantly affected by year-to-year variability in climate (Korb et al. 2003). Because of the high degree of annual variability, it is important to conduct long-term monitoring that can accurately assess treatment impacts over time (Korb et al. 2003).

The response of specific understory plants to this level of thinning and prescribed burning is also dependent on the seed bank present in the soil. At Mount Trumbull, application of a native seed mix increased the richness and cover of native plants, especially grasses (Springer and Laughlin 2004). Seeding, though, has the potential to introduce invasive species and new, nonlocal genotypes of native species, and needs to be done carefully, with seed that is certified weed-free.

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The degree of thinning associated with this treatment can substantially reduce overall fuel loads, separate tree crowns, and increase the average base height of crowns. This results in a large decrease in crown fire potential. At Fort Valley a computer model predicted that under dry conditions a 28-mile-per-hour wind would result in a crown fire in an untreated stand, but 55-mile-per-hour winds would be needed to fuel a crown fire in stands treated with a 1.5/3 prescription (Fulé et al. 2001). Crown fire potential is reduced less in stands treated with a 1/3/3 prescription (Fulé et al. 2001).

Fire probability of posttreatment stands is most appropriate.
Logging slash represents a significant fire hazard in treated areas. The burning of slash piles can harm soil health and potentially promote the spread of invasive species (Korb and Springer 2003), but these effects can be ameliorated with seed or soil amendments (Korb et al. 2004). When it is scattered and consumed during a broadcast burn, slash can increase prescribed fire intensity to hazardous levels, resulting in substantial tree mortality due to crown scorch (Jerman et al. 2004). The intensity of future broadcast burns after the initial prescribed burn should be lower, as less woody fuel will be available.

Soils and Hydrology:
Thinning followed by prescribed burning frees water and nutrients for use by remaining trees and understory plants. Thinning in a 1.5/3 treatment area at Gus Pearson Natural Area increased summer soil temperatures (Kaye and Hart 1998b). Subsequent prescribed burning removed organic matter from the forest floor and released nitrogen and phosphorus that could be used for plant growth (Kaye and Hart 1998a). Water outflow has been slightly higher in treated than in control areas (Kaye et al. 1999).

Wildlife:
Wildlife responses to this treatment vary depending on species, tree replacement rate, treatment area size, the condition of forest stands around the treatment area, time since treatment, and many other factors (Chambers and Germaine 2003). Relatively little monitoring of wildlife responses to restoration thinning has been done, but among the most apparent responses seen in areas monitored so far is a marked increase in butterfly use of thinned and burned areas in 1.5/3 treatment areas at Mount Trumbull, probably because of increased light levels (Waltz and Covington 2004; Meyer et al. 2001). Other studies have found an increase in fledging success among western tanagers, plumbeous vireos, and western bluebirds in treated areas at Mount Trumbull, though the bluebird fledglings also had a higher rate of parasitism by nest parasites (Battin 2003; Germaine and Germaine 2002). Mule deer tended to use a combination of thinned and unthinned areas (Chambers and Germaine 2003). Wild turkey roosting behavior was not noticeably affected by treatments, and turkeys did use thinned areas for foraging (Martin et al. in press).

Social Issues:
Aesthetically, these treatments can represent a profound alteration of the forest landscape. The dramatic reduction in tree density may result in significant social concerns about thinning, but site appearance improves within a few years as stumps decay, charred wood disintegrates, and understory vegetation recovers. In the Fort Valley area social considerations were among those that led to the development of the 2/4 and 3/6 replacement rates.

Costs
Restoration costs vary widely, but researchers at the ERI estimate as a very rough guideline that it costs anywhere from $250 to $1,000 per acre to conduct the thinning work for a 1.5/3 restoration treatment. Prescriptions leaving more replacement trees may require additional thinning in a few more years. Prescribed burning of slash piles, and subsequent broadcast burning, also presents costs. In Fort Valley, slash pile and broadcast burning cost an average of $250 per acre. At Mount Trumbull, treatment costs have totaled about $700 per acre, not including the cost of native seed for understory regeneration at $80 to $150 per acre. Whether treatment costs can be offset in whole or in part by the value of wood removed varies with local conditions.

Discussion
This treatment strives to use the self-sustaining conditions present before Euro-American settlement as a template for future conditions. It aims to create a forest structure that allows ecological processes, especially low-severity fire, to shape the ecosystem into the future. As a result, stand-replacing fire and severe bark beetle outbreaks should be rare in treated stands in the future. It is important to emphasize the key role that fire must play in future maintenance: without regular fires, thinned stands are likely to once again become dense with small trees.

The degree of thinning chosen has a number of important consequences. A lighter degree of thinning, such as that represented by the 2/4 or 3/6 replacement rates, may be more socially acceptable in some places. Managers may also choose to retain more trees in some areas in order to provide habitat for wildlife species that might find 1.5/3 stands too open—or to provide options for future timber harvests. However, retaining more trees provides less protection against crown fires than using the 1.5/3 replacement rate. In addition, retaining more trees may necessitate a future entry to thin more trees, with associated impacts on soils and the potential for spreading invasive species.

The degree of thinning, and the selection of specific trees for retention, also affects how “clumpy” the resulting stand will be. Choosing replacement trees from a radius of 60 feet around presettlement evidence indicators generally allows for the retention of larger trees, but because the replacement trees can be more widely spread the resulting stand often consists of rather evenly spaced trees rather than clumps. Choosing replacements closer to presettlement evidence signs can create a stand with a mosaic of small clumps and openings that is believed to be characteristic of presettlement forest stands in many areas (White 1985).

Current conditions play an important role in making decisions about thinning intensity: a thinned stand with some remnant old “yellow” pines will look unlike one that lacks large, old trees, and may play a different ecological role. As always, local conditions and objectives should dictate replacement rates and thinning methods.

Figure 1. Simulation depicting results of this thinning treatment, with a 1.5/3 replacement rate, as implemented at the Gus Pearson Natural Area.

Restoration of Ponderosa Pine Forests to Presettlement Conditions
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Table 1. Difference in selected ecological parameters between control areas and areas thinned to three different tree densities.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>CONTROL</th>
<th>1.5/3</th>
<th>2/4</th>
<th>3/6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree vigor and health</td>
<td>Often declining due to heavy competition for water, light, and nutrients</td>
<td>Improved for at least seven years after initial thinning (Kolb et al. 2001; Wallin et al. 2004); some danger of mortality during intense prescribed fire (Jerman et al. 2004)</td>
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<td>Herbaceous vegetation</td>
<td>Often low in richness and cover, due to tree density and heavy deposits of fallen needles</td>
<td>Both native and nonnative species increase in richness and cover (Abella and Covington 2004; Huffman and Moore 2004; Moore and Deiter 1992)</td>
<td>Response intermediate between 1.5/3 and control treatments (Abella and Covington 2004)</td>
<td>Response similar to 2/4 thinning (Abella and Covington 2004)</td>
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<td>Fuel loading</td>
<td>Heavy crown fuels and &quot;ladder fuels&quot;; little herbaceous growth, but heavy loading of pine needles</td>
<td>Very light loading of crown fuels; vigorous herbaceous regrowth should promote surface fires (Fulé et al. 2001; Waltz et al. 2003)</td>
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<td>Fire behavior</td>
<td>Can be extremely high susceptibility to crown fire (Fulé et al. 2001)</td>
<td>Very low likelihood of crown fire (Fulé et al. 2001)</td>
<td>Moderate likelihood of crown fire (Fulé et al. 2001)</td>
<td>Likelihood of crown fire intermediate between 2/4 treatment and control (Fulé et al. 2001)</td>
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<td>Hydrology</td>
<td>Stand-replacing wildfire can cause severe erosion and downstream sedimentation (Baker 2003)</td>
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• Trees that are neither of presettlement age or designated replacements are removed using either manual or mechanical means. Choice of equipment can have a great impact on ecological impacts such as soil compaction, which can be minimized through careful planning. Read more about this in Working Paper 5: Limiting Damage to Forest Soils During Restoration. In most cases deciduous trees such as Gambel oak and aspen are left standing while shade-tolerant conifers such as white fir and Douglas-fir are removed, but this may vary depending upon local conditions and project objectives.

Fire:
• Prescribed burns are conducted after thinning.
• Slash can be treated by gathering it into piles for burning prior to broadcast burning.
• It is also possible to scatter slash throughout a treatment area and leave it to settle before burning; some practitioners have tried compacting it with a small tractor before burning to reduce flame heights (Jerman et al. 2004).
• Ground fires should recur on the site in years to come, at intervals that reflect the site’s “range of natural variability”—often from 2 to 12 years in many parts of the Southwest (Swetnam and Baisan 1996; Landres et al. 1999).
• Raking thick duff about a foot away from the trunks of remaining large trees—especially large trees—before fire may be necessary in order to prevent excessive bark scorch or root mortality (see Working Paper 3: Protecting Old Trees from Prescribed Fire). Particular caution is needed on lava soils, which may make trees especially susceptible to fire damage (Fulé et al. 2002).

Understory Vegetation:
• Treatment of understory vegetation varies. In some cases it may make sense to reseed treated areas with native plants after burning. Seeding can increase species richness, but also poses the risk of introducing invasive species and nonnative genotypes (Springer and Laughlin 2004). Whether it is necessary depends on such variables as the existing understory, distance from seed sources, and contents of the soil seed bank.
• In many places control of invasive plants may be necessary, and in all cases it is prudent to minimize their spread. Read how to do this in Working Paper 8: Controlling Invasive Species as Part of Restoration Treatments.

Where It’s Been Done
This treatment and variations on it have been implemented at a variety of locations, including:
• Gus Pearson Natural Area, near Flagstaff
• Fort Valley, near Flagstaff
• Mount Trumbull area, in the Grand Canyon–Parashant National Monument
• Other national forest sites in Arizona
• San Juan National Forest, Colorado
• Lincoln and Cibola national forests, New Mexico

References


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**Treatment Type**

Emulation of the forest structure prevalent before the landscape-level disturbances that followed Euro-American settlement.

**Treatment Objectives**

To emulate the forest structure characteristic of the period immediately preceding Euro-American settlement in order to return forest conditions to their natural range of variability. This greatly reduces risks of stand-replacing fire, allows frequent ground fire to be safely reintroduced in order to regulate forest structure, and promotes the growth of understory plants that fuel such fires and support wildlife.

**Steps**

**Oversery Trees:**

- All living trees that existed at the time of local Euro-American settlement are identified and left standing. Depending on the location, area, and resources available, this may be assessed through increment boring, size, or the presence of yellow bark.

- All indicators of trees standing at the time of settlement that are no longer present as living trees—including snags, downed logs, stumps, and stump holes—are identified. Read more about this in Working Paper 7: Establishing Reference Conditions for Southwestern Ponderosa Pine Forests.

- Younger trees to replace the trees that have fallen, burned, or decayed since settlement are selected. “Extra” trees are left standing—that is, each missing tree is replaced with more than one—to compensate for possible mortality after treatment, and because most of the replacements are much smaller than the large trees that were removed or have died. In tests these trees have been chosen according to several different replacement rates, depending on local conditions, social considerations, wildlife needs, wildfire hazards, and other factors:
  - 1.5/3 (full restoration). If the replacement trees are over 16 inches in diameter, 1.5 trees are left standing for each presettlement indicator. If they are smaller, 3 trees are left standing for each indicator.
  - 2/4 (modified restoration). If the replacement trees are over 16 inches in diameter, 2 trees are left standing for each presettlement indicator. If they are smaller, 4 trees are left standing for each indicator.
  - 3/6 (minimal restoration). If the replacement trees are over 16 inches in diameter, 3 trees are left standing for each presettlement indicator. If they are smaller, 6 trees are left standing for each indicator.

- Replacement trees are chosen from within 60 feet of indicators, though a smaller distance (15 or 30 feet) can result in a more desirable clumping pattern among the remaining trees. Where possible, replacements should include the largest and healthiest postsettlement trees, and/or clumped trees, especially those with interlocking canopies.
Small Molecule Could Play Role in Food Security

UA researchers have pioneered a new approach that could save millions of tons of crops each year from contamination with aflatoxin, a major threat to health and food security especially in developing parts of the world.

By Daniel Stolte | University Communications | March 10, 2017

Researchers at the University of Arizona have found a promising way to prevent the loss of millions of tons of crops to a fungus each year, offering the potential to dramatically improve food security, especially in developing countries. The team’s approach uses transgenic corn plants that produce small RNA molecules that prevent fungi from producing aflatoxin, highly toxic substances that can render an entire harvest unsafe for human consumption even in small amounts.

Although extensive field testing will have to precede widespread application of the new technique in agricultural settings around the world, the results of the study, published in Science Advances, showed that transgenic corn plants infected with the fungus suppressed toxin levels below detectable limits.

Crops all over the world are susceptible to infection by fungi of various Aspergillus species, a fungus that produces secondary metabolites known as aflatoxins. These compounds have been implicated in stunting children’s growth, increasing the risk for liver cancer, and making people more susceptible to diseases such as HIV and malaria.

Unlike in the U.S., where crops intended for human consumption are tested for aflatoxin and incinerated once levels approach 20 parts per billion (equivalent to one drop of water in a 22,000-gallon pool), no testing is available in many developing parts of the world, especially in Africa, where millions of people...
depend on consuming what they harvest. There, toxin levels up to 100,000 parts per billion have been measured, says study leader Monica Schmidt, an assistant professor in the UA's School of Plant Sciences and a member of the UA's BIOS Institute.

"Aflatoxin is one of the most potent toxins on the planet," Schmidt said. "Usually it won't kill a person outright, but it can make you very sick."

Funded by the Bill and Melinda Gates Foundation, Schmidt and her team set out to study whether a naturally occurring biological mechanism called RNA interference could be used as a weapon against the Aspergillus toxin. That approach, called Host-Induced Gene Silencing, or HIGS, builds on previous work by other researchers who discovered that during the infectious process, the host plant and the fungus exchange small nucleic acid molecules.

"When I read about this in the literature, I thought, 'Why can't we make a Trojan horse to shut off that toxin?'" said Schmidt, who has been working on this project for years. "We introduced an engineered DNA construct into the corn that passes the RNA into the fungus when it infects the corn plant."

The modified corn plants carry a genetic blueprint for small RNA molecules, each only about 20 base pairs long, only in the edible kernels, not the whole plant.

"The corn is constantly producing that RNA during the entire development of the kernel," Schmidt explained. "When the kernels come in contact with the fungus, the RNA moves over into the fungus."

Once inside the fungal cells, the hairpin-shaped RNA molecules pair up with corresponding target sequences of the fungus' own RNA that code for an enzyme needed for toxin production, in a process called RNA interference. This causes the toxin production to shut down, but does not in any other way impact the fungus, which continues to grow and live on the corn, albeit harmlessly.

The HIGS approach has a distinctive advantage over existing efforts to keep aflatoxin out of the human food chain, because it prevents the fungus from making toxin in the first place while the crop is growing in the field, as opposed to protecting crops only after they have been harvested and stored. Such approaches include solar-powered fans that suck out air from storage facilities or sealing crops in huge storage bags creating airless conditions so fungus cannot grow.

Another strategy, pioneered by study co-author Peter Cotty, a research plant pathologist with the U.S. Department of Agriculture and the UA's School of Plant Sciences, has explored spraying
crop plants with strains of Aspergillus that do not produce aflatoxin, thereby preventing their pathogenic kin from establishing themselves on the plants.

Other researchers have tried breeding varieties of corn that express antifungal proteins, but because not many antifungal proteins are known to begin with, those efforts have had limited success, Schmidt said.

HIGS holds great promise because it is highly specific and targeted in its effect, Schmidt explained, and could potentially be applied to other crops as well. Schmidt is collaborating with Tech Launch Arizona, the office of the UA that commercializes inventions stemming from research, to bring the technology to the marketplace. A patent has been filed.

In their experiments, the team infected corn plants with Aspergillus and let them grow for one month. While untreated control plants were found to harbor toxin levels between 1,000 and 10,000 per billion, toxin levels were undetectable in the transgenic plants.

"The detection limit is not zero, but low enough for the corn to be safe to eat," Schmidt said.

The team took the project a step further and investigated overall gene expression in kernels to see if the transgenic corn plants come with undesired side effects. This involved co-author Rod Wing's laboratory, also of the UA's School of Plant Sciences, to compare thousands of RNA transcripts between the nontransgenic control kernels and transgenic kernels. The team did not find a single significant difference in terms of differential gene expression between the transgenic and the non-transgenic kernels, according to Schmidt.

"This corn plant would be like any other," she said. "The only trait that sets it apart is its ability to shut down the toxin production. It shouldn't have any other effects, but obviously, a lot of downstream testing will be required before it could be grown in the fields."

Schmidt and her team chose the open access journal Science Advances specifically because "we want anyone with an internet connection to be able to access our results, especially in Africa, where aflatoxin is such a big challenge to food security."

The other authors on the study, which is published here (http://advances.sciencemag.org/content/3/3/e1602382), are Dhiraj Thakare, a postdoctoral fellow in Schmidt's lab, and Jianwei Zhang, a research assistant professor in the School of Plant Sciences.
Top 10 wineries in Arizona

Dos Cabezas Wineworks

Todd and Kelly Bostock co-own this winery that uses grapes grown in their Pronghorn Vineyard in nearby Elgin and the Cimarron Vineyard near Willcox. The 2009 El Campo was named one of the top 100 wines of 2012 by the San Francisco Chronicle. Bostock also makes and offers tastes of Cimarron wines, whose production is overseen by Oregon winemaker-turned-Arizona retiree Dick Erath.

Details: 3248 Arizona 82, Sonoita, 520-455-5141, doscabezaswineworks.com, $$

Callaghan Vineyards

While he wasn't the first vintner in the region, Kent Callaghan's winery could be considered the place where the state's industry truly took root. His wines drew rave reviews from wine critic Robert Parker, raising the bar for other winemakers. It is no accident that so many vineyards started popping up near his. Arrive near closing time and you may spot other winemakers stopping by to talk shop with Callaghan. On the way here from Sonoita, you pass Rancho Rossa, and right next to Callaghan is Flying Leap. A little further down is the Tuscan-looking wine room of Keif-Joshua.

Details: 336 Elgin Road, Elgin, 520-455-5322, callaghanvineyards.com, $

Arizona Hops and Vines

Two sisters run this winery, which, thanks to a change in the law they lobbied for, will soon house a brewery as well. The field where the hops are growing is next to the vineyard. According to the sisters' tasting notes, most of the wines pair well with Cheetos.

Details: 3450 Arizona 82, Sonoita, 888-569-1642, azhopsandvines.com, $

Keeling-Schaefer Vineyards

The vineyard started nearly a decade ago in a remote area south of Chiricahua National Monument. The tasting room is in an old bank building in downtown Willcox. Its 2009 Three Sisters Syrah was the first Arizona wine to receive a rating of 89 from Wine Spectator. Across the tracks and well worth the short walk is Carlson Creek.

Details: 154 N. Railroad Ave., Willcox, 520-766-0600, keelingschaefervineyards.com, $

Zarpara

This tasting room is listed as being just 15 minutes from downtown Willcox, but that does not include the time you may spend checking directions and second-guessing yourself. Twelve miles and a few left turns take you to this location in Willcox vineyard country.

Details: 6777 S. Zarpara Lane, Willcox, 602-885-8903, zarpara.com, $

Page Springs Cellars

The only tasting room with a hostess stand and which, when crowded, uses those buzzers seen in chain restaurants to let you know your spot at the bar is ready. And that was before a Page Springs wine earned 90 points from Wine Spectator. Eric Glomski’s flagship winery produces a wide variety of wines from its vineyards as well as some from select California properties. Cheese plates and appetizers available. Once here, you are close to both Oak Creek Vineyards and Javelina Leap. The winemaker at Javelina Leap, Cynthia Snapp, won a gold at the International Women’s Wine Competition.

Details: 1500 N. Page Springs Road, Cornville, 928-639-3004, pagespringscellars.com, $

Arizona Stronghold Vineyards

The mass-market Arizona Stronghold wines are poured here, but the primary reason to stop by is to sample the small-production Site Archive bottles. These wines, made by Michael Pierce, are meant to be a living journal of the grapes grown at the various vineyards that make up Arizona Stronghold wines. Live music on Friday evenings. Once in downtown Cottonwood, you can hit Pillsbury Wine Co. and the Fire Mountain and Cellar Dwellers tasting rooms across the street.

Details: 1023 N. Main St., Cottonwood, 928-639-2789, azstronghold.com, $

Burning Tree Cellars

Burning Tree Cellars pours the work of “co-conspirators” Mitch Levy and Corey Turnbull. They get grapes from Arizona and California vineyards and turn them into small batches of wine with artistic labels. The tasting room, in a former car dealership, features a patio and music on weekend evenings. One of their wines, made with grapes from the Colibri Vineyard & Winery in southeastern Arizona, was one of the first two Arizona offerings to earn 90 points from Wine Spectator.

Details: 1040 N. Main St., Cottonwood, 928-649-8733, burningtreecellars.com, $

Caduceus Cellars

Caduceus Cellars is the label of Maynard James Keenan, lead singer of rock bands Tool, a Perfect Circle and Puscifer. Keenan, who lives nearby, makes wine using grapes grown on his property in the Jerome and Cornville areas. There are no seats in the tasting room, a result of town ordinances on parking spaces. Small-plate snacks are available. Open at 8 a.m. for espresso and coffee.

Details: 158 Main St., Jerome, 928-639-9463, caduceus.org, $-$

Four Eight Wineworks

A co-op of Arizona winemakers, this tasting room pours a selection from labels including Iniquius, Chateau Tumbleweed, Saeculum and Merkin. This is the first tasting room in downtown Clarkdale, a couple of miles northwest of Cottonwood.

Details: 907 Main St., Clarkdale, 928-649-2007, http://www.four8wineworks.com, $$

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It is actually illegal in Colorado to collect the rain that falls on your home

By Jeff Guo March 24, 2015

Do you live in Colorado? Does it rain on your house? Do the drops patter off the roof, compose romantic puddles on your porch?

Guess what: That water isn’t yours. You can’t have it. And you most certainly cannot set out a tank to catch what falls from the sky, you thief.

Water laws are so strict in Colorado that rainwater collection is virtually prohibited. The doctrine is written into the state’s Constitution. All the rain is already spoken for. It belongs to someone, and that someone probably isn’t you. So don’t you touch it.

“The rain barrel is the bong of the Colorado garden,” local columnist Dave Philipps wrote in 2007. “It’s legal to sell one. It’s legal to own one. It’s just not legal to use it for its intended purpose.”

That might change soon, slightly.

On Monday, Colorado representatives voted to allow people to store up to 110 gallons of the rainwater that flows off their roof. One hundred gallons is on the high end of how much water a person in America uses per day. It’s about three tubs full of water, or four loads of laundry.

Rain barrel legalization will not save the world, nor even Colorado, where already the law against rainwater collection is rarely enforced. H.B. 1259 might not even pass Colorado’s Senate. But it’s a symbolic step toward a more modern way of thinking about water in America’s dry Western states.

In the West, water belongs to someone

The principle at stake is called prior appropriation, which is legalese for “first come, first served.” This doctrine forms the bedrock of water law in the Western states, where long ago settlers raced to gobble up all the water rights. Prior appropriation helps explain why water-intensive agriculture is still a major industry in a place as arid as the West: Many of the early claimants were farmers seeking to irrigate their crops.

These days, with drought parching the region, there’s hardly enough water to go around. According to the law, the people who get first dibs are the ones who called it first, which tend to be the agricultural users and not the city dwellers.

In Colorado, other people’s water rights even extend to the raindrops that fall onto your roof.

http://www.washingtonpost.com/blogs/govbeat/wp/2015/03/24/it-is-actually-illegal-in-colorado-to-collect-the-rain-that-falls-on-your-home
Why? Because those raindrops might tumble into the gutter; they might seep into the ground; might, in some other eventual, serpentine fashion, find their way to a river where somebody’s great-great-grandfather once established a claim.

Legal experts have long criticized the Wild West principle of prior appropriation. They say that the tradition of dibsies is incongruent with the way that people demand water in the 21st century.

“It’s this very rigid, very old system of water rights that hasn’t really changed that much in over a century,” said Reed Benson, a law professor at the University of New Mexico.

“Prior appropriation is so deeply embedded in Western water law,” said Robert Glennon, a law professor at the University of Arizona. “We academics criticize it but it’s not going anywhere.”

Benson has studied all the different ways that Western states have grappled with an increasingly stale idea like prior appropriation, which allocates water according to seniority instead of need. Bills legalizing rainwater collection are an example of how legislators have sought to carve exceptions into that way of thinking. (California passed a similar law in 2012.)

“There are a lot of good, practical, common-sense arguments in favor of a bill like this,” Benson said. “The fact that it’s controversial, the fact that it’s taken this long, shows you how well-entrenched that old tenacious legal system is.”

Whose idea was this, anyway?

Some laws are crafted by Congress; but the system of water rights in the West is a lesson in how customs can calcify into legal doctrine.

As the story goes, the dibsies approach to water management dates to the California Gold Rush. Flowing water has long been a gold miner’s best friend: As it cuts through the landscape, it picks up pebbles, dust, and occasionally, specks of something more precious.

These treasures end up naturally at the bottom of riverbeds, waiting to be sorted out of the sediment. During the 1849 Gold Rush, prospectors schlepped across the country to pan for those rare glints in California’s streams.

Miners of means sought to speed up the process. They set up high-pressure hoses to blast entire cliff sides. The runoff would flow through boxes that caught any gold fragments washed loose.

Hydraulic mining harmed the environment and placed exorbitant demands on a dry region’s water resources. The practice eventually fell out of favor, but not before it made a lasting impact on water law.

To feed their thirsty operations, miners dug channels that siphoned water from sources that could be miles away. They followed an apportioning rule carried over from mining principles. The first person to dig his canal was entitled to whatever water he carried away.

Eventually, Western states began to recognize and regulate this practice. They parcelled out permits to surface water in the order and quantities that people came to claim it. As settlers arrived to start irrigated farms on parched soil,

http://www.washingtonpost.com/blogs/govbeat/wp/2015/03/24/it-is-actually-illegal-in-colorado-to-collect-the-rain-that-falls-on-your-home
people continued to treat water as its own and separate property right: Just because you owned the land didn’t mean you owned the water.

The Eastern states, in contrast, were wet enough that they regarded surface water as a shared, inexhaustible resource (as in the common-law tradition, imported from soggy England). They did not keep tabs on how much water anyone took out of a river. People who owned land next to a river were free to use that river’s water in any reasonable fashion, as long as it didn’t affect their neighbors.

Though it’s maligned today, the system of prior appropriation suited the West’s arid climate. Unlike in the Eastern states, settlers could not rely on what streams, if any, ran through their property. They needed a legal system that allowed them to bring in water from far afield. Furthermore, water was scarce enough that it had to be measured out, which called for an orderly system of permits. These rights were given to those who would use the water productively — to irrigate a field, or to supply a mine.

In theory, prior appropriation made sure that water wasn’t wasted. People could not simply claim part of a river and divert it onto their property. They had to show that they had plans for the water, and that their plans did not interfere with the designs of the people who came before them.

Only then would they get rights to the water — and only enough water to serve their needs. As long as they continue putting the water to work, those rights are theirs forever.

Decades later, the unforeseen consequences

Fast forward 150 years to the present, when nearly every river basin has been burdened with claim on top of claim. Cue a record-breaking drought.

Prior appropriation has no provision for shared water conservation; the priority system is strict. During dry times, someone with a senior claim gets to suck down her full allotment. The people down the line might get nothing.

(In Colorado, she’s even entitled to the rain that falls onto her neighbor’s roofs. That rain, by law, must be allowed to flow unimpeded into the river for her to use.)

Critics say this system encourages waste. People with senior water rights don’t have any reason to cut back on their water use. (In practice the system is a bit looser, Illinois Institute of Technology law professor Dan Tarlock notes. It’s frowned upon to completely hog the water, even if someone has the legal right to do so. There’s some cooperation among growers.)

Consider the situation in California, where last week the governor imposed mandatory water conservation rules. Residents may not water their lawns more than a couple times a week. Restaurants can no longer serve water unless patrons specifically ask for it. If these measures don’t work, the state will consider punishing people with fines.

Yet, as the Economist noted last year, agriculture guzzles 80 percent of the water that California pumps, while representing only 2 percent of the state’s economic activity. Cities are responsible for most of the growth in the West, but irrigated farms still account for most of the water used.

http://www.washingtonpost.com/blogs/govbeat/wp/2015/03/24/it-is-actually-illegal-in-colorado-to-collect-the-rain-that-falls-on-your-home
California Gov. Jerry Brown (D) has set a goal for homeowners to cut back on water consumption by 20 percent; but even if every suburbanite complies, the reduction would mostly be symbolic.

“There’s a strong push to conserve municipal demand in part to send a message, because that’s where the people are,” said Benson. “But also because that’s viewed as easier to accomplish. Agricultural water conservation is hard to do: in part because it’s expensive, and in part because the law doesn’t incentivize conservation.”

How to make water markets more liquid

It’s a tired refrain, but economic theory says that water, like any scarce resource, should go to the highest bidder.

“The water used to grow California cotton, for example, has much higher value producing silicon chips in San Jose or as drinking water in Los Angeles than it does as irrigation water,” George Mason economists Tyler Cowen and Alex Tabarrok write in their economics textbook.

Already this is happening a bit. Before he became a law professor, Benson was a lawyer in Colorado who specialized in helping cities buy water rights from farmers. “Markets are almost the only thing that gives prior appropriation a chance of making any kind of sense in the 21st century,” he said.

Colorado has a fairly robust system of trading water permits, though the agricultural industry has been reluctant to give up those rights. There’s even a derogatory phrase for those transactions: “Buy and dry.”

“The agricultural industry sees that as eroding their irrigated land base, taking away from their economy and their future,” Benson said.

But farmers who have inherited senior water rights could be sitting on fortunes, especially in drought years when they are the first ones in line for available water. Los Angeles is offering to buy up to $71 million worth of senior water rights, at top dollar. Just last week, rice farmers in the Sacramento Valley announced that they had sold some of their rights for the stunning price of $700 per acre-foot. (An acre-foot is roughly how much water a household uses in a year.)

That price translates into $2,100 per acre of rice that they don’t plant, KQED calculated. The profit on an acre of harvested rice? Maybe half that.

Los Angeles’s expensive water-buying spree illustrates one reason city residents need to conserve water; not because there isn’t enough out there, but because it costs a lot to buy water rights. The farmers who hold those rights tend to sell only as a last resort.

Robert Glennon, the law professor, believes that more farmers would participate in the market if they had more sophisticated ways of trading water rights.

“It’s critical to recognize that the cities and industry don’t need a huge percentage of agricultural water,” Glennon said. “But they do need a low single digit percentage.”

In a report for the Brookings Institution last October, he and co-authors Peter Culp and Gary Libecap suggest a menu of water contracts that farmers and cities could buy and sell.

“The perfect example is a dry year option, whereby a broccoli grower agrees not to grow broccoli in a dry season to let either a thirsty orchard producer or a city...
use the water,” Glennon said. The broccoli grower gets paid every year, wet or dry, for a steady stream of income. The orchard producer gets insurance that he’ll have enough water for his almond trees, even during a drought.

“It’s a win-win,” Glennon said.

What does this all have to do with rain barrels?

In 2012, California passed a law allowing residents to capture and store the water that runs off their roofs. It used to be illegal in California to harvest the rain, but now cities like Los Angeles are handing out rain barrels for free.

Municipalities like rain barrels because they take pressure off city water systems. People don’t need treated, chlorinated water to quench their thirsty lawns anyway; rain works just fine.

The law used to be the only obstacle; collecting rain was technically illegal in many states because any precipitation was subject to that strict hierarchy of water rights stretching back to the mid-1800s.

But studies estimate that only a fraction of rain actually makes it to a river — less, during a drought. One influential 2007 report from Douglas County, Colo., estimates that only about 3 to 15 percent of rainwater returns to a stream system. Most of it is lost to evaporation, rising into clouds only to fall again later.

On the strength of that report, Colorado began a pilot program in 2009 that allowed people who got their water from wells to apply for rain collection permits. Yesterday, the house voted 45 to 20 to allow all homeowners to store up to 110 gallons of rainwater. HB 1259 now heads to the Senate.

Setting up a rain collection system takes at least a couple hundred dollars, and many households won’t find it cost-effective. But legalizing rain barrels in Colorado sends a twofold message to the state’s farmers.

On one hand it can be interpreted as a gesture of goodwill. Encouraging residents to collect the rain shows that municipalities care about their impact on the state’s water resources.

“One concern from the agricultural community is that farmers are getting a raw deal and that the cities are not doing their part,” Glennon said. “I often hear farmers say, ‘Well, why is a lawn in L.A. better than my alfalfa in Imperial Valley?’”

But the bill also signals that as Colorado’s cities grow, and as the political balance shifts, the legal custom of prior appropriation may be slowly renegotiated in favor of the urbanites. At the committee meeting last week, agriculture industry representatives strongly opposed HB 1259.

“It is a small step. And it’ll get bigger, and bigger, and bigger, until you dry up all of agriculture without buying it,” said Jim Yahn, a commercial water manager and farmer.

“At least the other way that we do it, farmers get compensated for the water that’s used. This is a small step in the wrong direction.”

Jeff Guo is a staff writer for Storyline. He’s from Maryland (but outside the Beltway). Follow him on Twitter: @jeffguo.
Surprise! GMOs aren’t just in the foods you eat

COMMENTARY by Robert T. Fraley

September 23, 2015

Over the past few months, developments in the ongoing debate over GMOs have led more to question if genetically modified foods really harm us. In April, Chipotle announced it would use only non-GMO ingredients. More recently last month, Germany has moved to stop the growing of genetically modified crops under new European rules.

It’s clear the use of genetic modification in agriculture continues to be vilified in some circles, despite decades of testing and endorsement by the world’s leading scientific and medical organizations. GMO crops, critics allege, are untested science experiments, foisted upon technology-addicted farmers and the general public by powerful corporate interests.

Given all the words that I and many others have already devoted to this subject, I won’t revisit that debate here. Instead, I want to bring attention to a fact that many people may not realize: GMOs in agriculture are just one small part of a much bigger story. The use of GMOs in crops is not an isolated development. To the contrary, GMO science and its applications are everywhere around us. And GMO technology is saving lives every day.

GMOS are found, for example, in life-enhancing and life-saving medicines. Take diabetes. Not long ago, the insulin product that diabetics took to regulate diabetes came entirely from the pancreas organs of slaughtered pigs, cows or sheep. Sometimes this insulin caused allergic reactions. In the late 1970s and early 1980s, scientists developed a new form of insulin made by bacteria that had been given the human insulin gene with GMO methods. The approach raised various concerns not unlike those that have been raised with respect to GMO food. But in 1982, the Food and Drug Administration (FDA) approved it, making human insulin the first GMO medical product.

“Despite early reservations about the technology,” the FDA now says, GMO proteins like insulin have turned out to “actually have an enhanced safety profile.” And with diabetes having become epidemic worldwide, it is difficult to imagine how the demand for insulin would be met without the GMO product. About five million Americans now use it.

What’s more, several forms of cancer, including brain, colorectal and cervical, are commonly treated with a marvel of GMO technology called Avastin bevacizumab. This drug is a “humanized monoclonal antibody” — an antibody made from human as well as mouse genetic material that stops blood vessel growth in patients’ tumors. Many cancer patients also suffer from chemotherapy- or radiation-induced anemia. These people, and others who suffer from anemia, are often treated with epoetin alfa, a hormone produced through genetic modification that stimulates red blood cell production.

Until recent years, the only source of human growth hormone (HGH) for treatment for Dwarfism or short stature came from the pituitary glands of human cadavers. In 1985, however, three children died from neurological diseases they contracted through such treatments. Since then, GMO-derived HGH has been made safely in laboratories from genetically modified bacteria or yeast.

Ebola is another area in which GMOs are coming into play. ZMapp, a drug showing great promise in the treatment of this frightening virus, is a blend of three GMO monoclonal antibodies that are produced in GMO tobacco plants.
Meanwhile, vaccines derived from GMO techniques are preventing many other diseases — including hepatitis A and B, diphtheria, tetanus, pertussis (whooping cough), and polio — while lowering health care costs and increasing access to treatment. And GMO vaccines to fight cholera, malaria, and many other diseases for which non-GMO methods have proved ineffective are under development.

Many food ingredients and processing aids, such as yeast and enzymes, also have links to GMO technology. If you eat cheese, for example, you’re likely eating a product made with the first approved GMO food ingredient.

The enzyme that curdles milk to make cheese is called chymosin. It’s found in coagulants called rennet, which cheese makers used to get from the stomachs of young calves slaughtered for veal. Eventually, however, cheese demand exceeded the supply of young calves. As a result, cheese makers began in about 1990 to shift to GMO-derived chymosins. Produced under sterile lab conditions through the genetic modification of bacteria, fungi or yeast, these chymosins are free of the allergens, bacteria and other pathogens often associated with animal extracts. Today, GMO chymosins are used to make some 80% to 90% of the cheese in the United States.

Likewise, many of our most common vitamins are produced with GMO methods that enable us to make them in much greater volumes and at lower cost than with our older methods, which used to include extracting them from the organs of animals. Riboflavin (B-2), Vitamin B-12, Vitamin C and Vitamin E are all made through the fermentation of GMO microbes.

Finally with respect to food, research published in May in the Proceedings of the National Academy of Sciences showed that all cultivated sweet potatoes carry genetic material transferred to them naturally from a bacterium contained in their soil millennia ago. The bacterium is the same Agrobacterium scientists commonly use today in conducting genetic modification. The fact that this process took place naturally, the researchers wrote, “may change the paradigm governing the ‘unnatural’ status of transgenic crops.”

Nature, it turns out, is a pretty good genetic engineer — and we’ve all been eating the result for a long, long time!

Since the 1960s, laundry and dishwasher detergents increasingly have featured enzymes that help digest and remove different types of stains. These innovations have brought major benefits to consumers and to the environment. By enabling the use of cold water washing, for example, they save energy.

Few people recognize, however, that many of the enzymes used in these detergents today have been genetically modified to give them these desirable characteristics, or that many of them have been harvested from GMO microbes that have been fed GMO-derived sugars. Not to mention that the blue jeans they are washing are made from GMO cotton.

Save for the jeans, all the examples I just shared come from other industries and companies – not agriculture and not Monsanto MON -0.54% . They illustrate a simple point: GMOs are important, pervasive and often unrecognized part of our daily lives.

When people take an overly narrow and reductionist view of GMO science, when they see it as dealing only with crops, this vital perspective is easily lost. And the risk grows that we won’t see genetic modification for what it is — a tool with the potential to solve many different problems and enhance our lives in many different ways.

It’s my hope that over time, the all-too-common narrow perspective will be resolved through greater transparency and dialogue. Because we do need to be able to use science — including genetic modification techniques — to help solve our problems – both those we face today and the ones our children will face tomorrow.

Robert T. Fraley is the Chief Technology Officer of Monsanto Company.
9/27/2010

**Dairying in the Desert**

*Caballero sees weather as benefit, challenge of dairying in Arizona*

by Jennifer Burggraaf

**ELOY, Ariz.** – Dairying in the desert does not sound appealing to most Midwest producers. But to Craig Caballero, the arid climate of central Arizona provides a nearly perfect dairy scenario.

“We battle the heat, but we’ve become very effective at it here in Arizona,” Caballero said. “There’s four months where it’s tough, but I don’t know a better place to dairy then Arizona because of the dry, cool weather [the rest of the year].”

Caballero is the manager and an owner/partner of Caballero Dairy Farms near Eloy, Ariz., along with his wife, Heather. They have four children: John, Anika, Joseph and Ethan.

The dairy was started by Caballero’s parents, Manuel and Dorothy Caballero, in 1958 as a 90-cow operation in Mesa, Ariz. Since then it has grown to an 8,000-head (including youngstock, dry cows and milking cows) dairy based out of Eloy, about 45 minutes southeast of Phoenix in Pinal County. Fifty people are employed between the main dairy and their heifer raising facility, which houses calves from one day to one year old.

“Pinal County is a big dairy area,” Caballero said. “There are close to 100,000 dairy cows in the county, and the infrastructure is very dairy friendly.” That’s over half the dairy population in the entire state.

“Arizona is a very small dairy state, with only 150,000 to 170,000 milk cows,” he said. “About 98 percent of the dairies are within a 100-mile radius of Phoenix.”

Today the Caballero family has a mixed milking herd of 3,600 cows, almost twice the size of the average Arizona dairy. The herd is milked three times a day in a 72-cow rotary parlor, another fact that sets them apart from other Arizona dairies.

“There are around seven rotary parlors in the state. That’s less than 10 percent,” Caballero said. Part of that stems from the fact that they are also one of the newest dairies in the state, opening at the Eloy location in June 2006.

Being in a desert climate where summer temperatures average 108 to 110°F, with lows between 80 and 85°F, the Caballeros have learned to handle the heat. The Caballeros’ herd is housed in Saudi barns – large, high-roofed, composted bedded pack loafing sheds designed from the barns used in Saudi Arabia. Fans hang every 20 feet throughout the barn.

“We have to spend millions of dollars of capital investments in cooling [our cows],” Caballero said. “We don’t deal with humidity, but we have four to five months that we have to concentrate on cooling by fans, misters and overhead soakers to keep our milk production and reproduction. Dairies here are built around cooling and cow comfort.”

But while June through September are challenging, the rest of the year provides ideal temperatures for dairying. Winter temperatures average 65°F for the high and 30°F for the low, though Caballero has seen it drop

http://www.dairystar.com
as low as 12°F in winter and get as hot as 120°F in the summer.

“Ninety degrees in Arizona is more comfortable than 90°F in Minnesota,” Caballero said. “It’s very dry here, and if there is any breeze, it’s not as uncomfortable as it sounds.”

While the fact that it’s dry helps with cow comfort and cow health, it does present a problem when it comes to growing crops. The average rainfall in Arizona is approximately 7.5 inches per year, Caballero said.

“Typically we get three-fourths of that in a three-month window. There are four to five months [out of the year] when it won’t rain at all,” he said. “We’re in the desert, so water is and always will be a huge problem and challenge.”

Because of this, all cropland in Arizona is irrigated. Producers have to purchase water rights for home and farm use. In many cases, water rights for irrigation are grandfathered in when a farm is purchased, Caballero said.

“There’s a lot of cost to water here,” he said. “… We have to do things here to make water last, to make the ground more efficient.”

One of those practices is laser leveling their land – discing fields so the water is evenly distributed throughout. Excess water is caught up in drains at the end of a field and recycled for the next field.

While part of their water supply comes from the summer rains, what they depend on for irrigation and farm use comes during the winter months, in the form of snow pack in the northern part of the state, which drains into their reservoirs.

But although it snows in the mountains surrounding the desert, Caballero has only seen it snow twice in the Phoenix area, averaging once every 15 to 20 years, he said. The last snow they got was in 2006, shortly after opening in Eloy.

The Caballeros raise around 2,000 acres of alfalfa and 1,000 acres of corn silage each year. The soil is mainly fertile clay with some sand, and because they are in a valley, the landscape is flat, surrounded by mountains. “Most dairies [in Arizona] have to purchase a majority of their feed,” Caballero said. “In our case, we are able to grow around 70 percent of our forages in house, but the other 30 percent we buy. We’re able to grow more than most.”

They also buy soybeans and corn each year, most of which comes from the Midwest. “Ultimately, we’re more dependent on purchasing than growing,” he said. In recent years, this has caused their cost of production to drastically increase.

“Since ethanol took off, our cost of production has gone up inherently,” Caballero said. “It costs us $1 to $2 more, and it’s directly feed driven.” The cost of locally grown feed has also increased with the cost of water.

“So between what we are able to grow and the cost of water, it’s been a struggle to stay efficient,” he said.

What has helped is their co-op, United Dairymen of Arizona (UDA), which represents over 90 percent of the milk in Arizona.

“We have a great co-op. They’re very agile and producer-friendly, and they are able to make good decisions quickly,” said Caballero, who serves on UDA’s executive committee. Their co-op has helped the Caballeros build their farm to what it is today: a prominent modern Arizona dairy.

“We’re currently concentrating on doing what we can to become as efficient as we can,” Caballero said about future plans. “We’ll do as well as we can, and when an opportunity comes about, we’ll take advantage of it. We’ll keep on working hard every day.”

http://www.dairystar.com
Don’t Blame Cows for Climate Change
December 7, 2009

Despite oft-repeated claims by sources ranging from the United Nations to music star Paul McCartney, it is simply not true that consuming less meat and dairy products will help stop climate change, says a University of California authority on farming and greenhouse gases.

UC Davis Associate Professor and Air Quality Specialist Frank Mitloehner says that McCartney and the chair of the U.N.'s Intergovernmental Panel on Climate Change ignored science last week when they launched a European campaign called "Less Meat = Less Heat." The launch came on the eve of a major international climate summit, which runs today through Dec. 18 in Copenhagen.

McCartney and others, such as the promoters of "meatless Mondays," seem to be well-intentioned but not well-schooled in the complex relationships among human activities, animal digestion, food production and atmospheric chemistry, says Mitloehner.

"Smarter animal farming, not less farming, will equal less heat," Mitloehner said. "Producing less meat and milk will only mean more hunger in poor countries."

Mitloehner traces much of the public confusion over meat and milk’s role in climate change to two sentences in a 2006 United Nations report, titled "Livestock’s Long Shadow." Printed only in the report’s executive summary and nowhere in the body of the report, the sentences read: “The livestock sector is a major player, responsible for 18 percent of greenhouse gas emissions measured in CO2e (carbon dioxide equivalents). This is a higher share than transport.”

These statements are not accurate, yet their wide distribution through news media have put us on the wrong path toward solutions, Mitloehner says.

"We certainly can reduce our greenhouse-gas production, but not by consuming less meat and milk.

"Rather, in developed countries, we should focus on cutting our use of oil and coal for electricity, heating and vehicle fuels."

Mitloehner said leading authorities agree that, in the U.S., raising cattle and pigs for food accounts for about 3 percent of all greenhouse gas emissions, while transportation creates an estimated 26 percent.

"In developing countries, we should adopt more efficient, Western-style farming practices, to make more food with less greenhouse gas production," Mitloehner continued. In this he agrees with the conclusion of "Livestock’s Long Shadow," which calls for “replacing current suboptimal production with advanced production methods — at every step from feed production, through livestock production and processing, to distribution and marketing."

"The developed world’s efforts should focus not on reducing meat and milk consumption," said Mitloehner, "but rather on increasing efficient meat production in developing countries, where growing populations need more nutritious food."

http://news.ucdavis.edu/search/printable_news.lasso?id=9336&table=news
Mitloehner particularly objects to the U.N.'s statement that livestock account for more greenhouse gases than transportation, when there is no generally accepted global breakdown of gas production by industrial sector.

He notes that "Livestock's Long Shadow" produced its numbers for the livestock sector by adding up emissions from farm to table, including the gases produced by growing animal feed; animals' digestive emissions; and processing meat and milk into foods. But its transportation analysis did not similarly add up emissions from well to wheel; instead, it considered only emissions from fossil fuels burned while driving.

"This lopsided 'analysis' is a classical apples-and-oranges analogy that truly confused the issue," Mitloehner said.

Most of Mitloehner's analysis is presented in a recent study titled "Clearing the Air: Livestock's Contributions to Climate Change," published in October in the peer-reviewed journal Advances in Agronomy. Co-authors of the paper are UC Davis researchers Maurice Piteskey and Kimberly Stackhouse.

"Clearing the Air" is a synthesis of research by the UC Davis authors and many other institutions, including the U.N. Food and Agriculture Organization, U.S. Environmental Protection Agency, U.S. Department of Agriculture, California Environmental Protection Agency and the California Air Resources Board. Writing the synthesis was supported by a $26,000 research grant from the Beef Checkoff Program, which funds research and other activities, including promotion and consumer education, through fees on beef producers in the U.S.

Since 2002, Mitloehner has received $5 million in research funding, with 5 percent of the total from agricultural commodities groups, such as beef producers.

About UC Davis
For 100 years, UC Davis has engaged in teaching, research and public service that matter to California and transform the world. Located close to the state capital, UC Davis has 31,000 students, an annual research budget that exceeds $500 million, a comprehensive health system and 13 specialized research centers. The university offers interdisciplinary graduate study and more than 100 undergraduate majors in four colleges -- Agricultural and Environmental Sciences, Biological Sciences, Engineering, and Letters and Science. It also houses six professional schools -- Education, Law, Management, Medicine, Veterinary Medicine and the Betty Irene Moore School of Nursing.

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http://news.ucdavis.edu/search/printable_news.lasso?id=9336&table=news
For Dairy Farm Families, Sustainability Is A Way of Life
Posted on June 13, 2012

By Paul Rovey
Arizona Dairy Farmer and Chair, Dairy Management Inc.

My father, Emil Rovey was born in 1916 on his parent’s 80-acre farm in Arizona. He milked the cows by hand, hauled their milk to the creamery in 10-gallon cans, and cultivated their crops with teams of horses and mules.

In 1943, he bought a 145-acre farm in Glendale, Arizona. He continued to acquire nearby farmland as it became available throughout the 40s, 50s and into the 60s. He was connected to the land at an early age and would continue his involvement for the rest of his life.

Because my father was a sustainable dairy farmer, Rovey Dairy is now run by the second and third generations of Roveys. Dairy farmers have a legacy of being sustainable. It’s nothing new. It’s in our blood. It springs from an industry of people accustomed to caring for assets passed down to us for generations and a strong belief in the wholesome, nutritious dairy products we produce to help Americans eat healthfully.

That’s why it was natural for dairy producers – through Dairy Management Inc. – to help lead the industry in a sustainability commitment through the Innovation Center for U.S. Dairy. We made this formal commitment in 2008, and last year more than 800 people were actively involved in our projects. They included dairy farmers and others from dairy companies, as well as experts from academic institutions, state and federal governmental agencies, and other partners, like World Wildlife Fund.

http://dairygood.org/for-dairy-farm-families-sustainability-is-a-way-of-life/
Arizona Dairy Farms, Cows and Sustainability

Cow Comfort
Dairy farmers genuinely care about their animals. Most dairy farmers grew up on a dairy, and absorb a sense of love and responsibility for their animals from a very young age. Arizona dairy farmers are also very clear that consumers want to purchase food from sources they know will take care of animals, and operate in a way that is consistent with their values and expectations.

In Arizona, where summer temperatures regularly exceed 100 degrees, cow comfort and animal well-being have always been top priorities. That’s why Arizona dairy herds are larger, average 2000 head, compared to a national average of 100-150 head, and have some of the highest production levels in the country. The summer conditions have prompted dairies to take particular pains to ensure cow comfort. They use misting systems to cool the animals, with droplets so tiny they evaporate before they reach the ground, thus avoiding the creation of muddy corrals. Fans are mounted on the sides of the cow shades (structures which are located to minimize exposure to the sun), along with canvas curtains which drop down automatically when the temperatures reach a specified level; the curtains roll back up automatically when wind velocity reaches a designated limit. The cow shades are typically installed on elevated ground to increase drainage of cow waste away from the shaded areas where cows linger. When it does rain, the slope from the elevated shades also aids in draining the water away from the animals. The corrals are scraped or "groomed" 2-3 times a day, and the manure is replaced with clean, dry bedding for the cows to lie in.

Some of Arizona’s newer dairies house their animals in a barn known as a "Saudi Barn", because the design was originally crafted for the hot weather conditions in Saudi Arabia. These structures feature very high ceilings, with a ventilation gap running the length of the barn. The sides of the structure are open, and the high peak (typically 14-18 feet) enhances air flow.

As a final measure of the attention to animal well-being, Arizona dairy-men consult with a veterinarian and a nutritionist. Together with herdsmen and/or dairy manager, these professionals form a dedicated team to ensure that sound practices for animal well-being and cow comfort are built into the daily procedures and monitored regularly.

Sustainability - "Going Green" on AZ Dairies
For 51 years, United Dairymen of Arizona (UDA) farm families have shown responsibility for the earth and a passion for dairy. In order for a dairy to thrive, the land and environment must be taken care of. Dairy families have been "Going Green" since before the term was coined, so it only makes sense that the largest Dairy Cooperative in the state would follow in its member’s footsteps.

Since 2008, UDA has been effectively making improvements on its carbon footprint. Becoming more environmentally friendly has proven to be good for the planet and the bottom line, which is always a factor in a tough economy. Using energy efficient lighting and motion controlled sensors have contributed to an over $200,000 savings on energy costs in 2008. The addition of the combustion catalyst system (CCS) in UDA’s milk tankers decreased fuel consumption, decreased exhaust gases and increased engine life. UDA has saved over $400,000 since introducing CCS in 2008.

The first phase of a solar dairy farm project was completed in the spring of 2011 on Zimmerman Dairy. After almost two years in the making, the Queen Creek dairy is the first and only in the U.S. of its kind. The Zimmerman’s have seen their electricity bill decrease by thousands of dollars a month and feel great knowing they are more environmentally friendly.

UDA also pledged to participate in responsible building practices. All building improvements must adhere to at least one of three standards: longevity, recyclables and reducing carbon footprint. Updates like acid brick to the floors and Arco-plast to the walls and ceilings in the dairy plant will meet UDA’s 15 year longevity standard and are made from natural or recycled materials.

Arizona’s dairy farm families and UDA strive to take care of the land they live and work on. Improvements that are made now will all be beneficial in securing a healthy future for the next generation.

Adapted from information found on www.uda.coop
History of the Arizona Cattle Industry

The cattle industry has been a vital part of Arizona for over 300 years. In the mid-1700s Father Kino introduced cattle into our state. For almost a century cattle flourished in the arid climate, providing early American immigrants, Indians and Spaniards with beef. The marauding Apache Indians were pacified with gifts and rations. However, after the commencement of hostilities between the U.S. and Mexico in 1846, Spanish support ceased and the ensuing Indian uprising drove miners and ranchers southward, away from Apache land.

As haciendas were abandoned, great numbers of beef animals spread throughout the hills and canyons to roam in a truly wild state. Military brigades that passed through the area commented on the huge herds of cattle and horses that grazed the Arizona ranges. They were surprised that although the gramma grass on the hills was straw colored and dead looking, the thousands of wild cattle and horses were fat.

The discovery of gold in California in 1849 created a great beef market. Still, the local industry did not revive until miners came to reopen old Spanish workings and prospect new fields. The first actual rancher is said to be William S. Oury. He began with 100 Illinois heifers and four bulls in 1858.

After the Civil War there was a tremendous stimulus to the livestock business. Unattended herds in Texas had increased while the range had declined, creating a desperate rush to relieve the overburdened grazing lands. Hundreds of discharged Texas veterans poured into Arizona. They entered Arizona four different ways: the San Pedro River, Ft. Bowie, the San Francisco River and Beale’s Road (Highway 66 and the Santa Fe Railroad route.)

As the number of cattle in Arizona grew, so did competition. The ranching industry adopted more business like methods including better blood in the herds and planned use of forage. Colonel H.C. Hooker is credited with bringing a large number of Hereford cattle to Arizona in 1884. However, Colin Cameron, established near Patagonia, ran a small group of the English breed in 1883. That winter Arizona experienced severe weather hardships, but the cattle not only survived, they were in good condition in the spring. Unrivaled rustling ability, early maturing qualities and prolific reproduction soon placed the Hereford breed in a favored position on the Arizona range.

The last years of the decade ending in 1890 were truly the heyday of Arizona's range cattle industry. Many an indolent man with money to invest must have been attracted by the imagery that claimed: “Here the climate is almost perpetual spring and even in the driest season the feed never fails and the owner can sit under the shade of his comfortable hacienda and see his herds thrive and increase in winter and summer.”

In 1890 practically every acre of range was being occupied. Unofficial estimates by experienced ranchers showed 1,500,000 cattle located on the Arizona range. However, overstocked lands and three years of drought beginning in 1891 produced catastrophic conditions for the cattle industry.

These difficulties, harsh as they were, conferred certain benefits upon Arizona ranchers. First, the realization was brought home with emphasis that stock raising had become an involved procedure an adventure had become a business. Second, planned use of range and water was necessary. Having learned these lessons, the industry turned to more scientific husbandry and subsequently recouped its losses.

Today, Arizona ranchers continue to practice sound range ecology practices. Through improvements to the land such as adding watering sites and rotating pastures, the Western rangelands are in the best condition they’ve been in for more than a century. Almost three hundred and fifty years after their introduction into our state, cattle is Arizona’s highest valued cash commodity crop.
The Beef Community: Who We Are and What We Do

Cattle Ranchers and Their Legacy

- According to the U.S. Department of Agriculture’s 2007 Census of Agriculture, which is the most up-to-date information about American agriculture, more than 97 percent of beef cattle farms and ranches in the United States were family farms and more farms were classified as beef cattle operations (31 percent) than any other type of farm.¹
- There are 687,540 farms classified as beef cattle operations.¹
- There are more than 1 million beef producers in the United States who are responsible for almost 90 million head of beef cattle.¹
- Although cattle farms and ranches are spread across the United States, nearly a third of cattle operations are located in the Plains states and 79 percent have fewer than 50 head of cattle.¹

The People Under the Cowboy Hats

- The average age of the American farmer is 57 years old and has been above 50 since the 1974 Census of Agriculture and has increased in each census since that time.¹
- The average number of years a beef producer has been on the farm or ranch is 22 years. In fact, 75 percent of beef cattle ranchers and farmers have lived and worked on the farm 10 or more years.¹
- According to USDA’s Economic Research Service (ERS), nearly one in five cattle producers is a college graduate, one in four has attended some college and 89 percent are high school graduates.²

Cattle Income

- According to USDA’s ERS, the average annual gross income from livestock on farms in this country in 2011 was $44,666.²
- Less than one-third of cattle operators claim farming as their primary occupation and 19 percent consider themselves retired. However, 61 percent say they work more than 1,000 hours a year on their farming operations.
- Eighty percent of the primary operators for beef cattle farms and ranches live on the farm or ranch.¹

Strong Demand for Beef

Consumers’ love of great steaks and burgers, their confidence in the safety of U.S. beef and their renewed interest in the nutritional benefits of protein help create strong demand for beef.

- Consumer spending on beef was $84.7 billion in 2012 and has grown $25 billion since 2002.³
- Per capita spending for beef in retail and foodservice was about $269 in 2012 – up more than $60 since 2002.³
- In 2010, per capita consumption of beef was 57.2 pounds, compared to 57.9 pounds for chicken.³

Beef in Retail

Beef dominates the retail meat department in volume (pounds) of sales and total dollar amount. Additionally, the value of beef sales continues to increase. The following statistics represent supermarkets with annual sales of $2 million or more. Data includes select supercenter and club retail stores. Data does not include butcher shops or independent grocery stores with annual sales of less than $2 million.

- Beef accounts for more than 49 percent of dollars spent on meat at retail. In comparison, chicken accounts for 23 percent of dollars spent on meat at retail.⁴
- In 2012, 5.0 billion pounds of fresh beef were sold at retail, a slight decrease of 4.0 percent in volume from the previous year.⁴
- In 2012, beef accounted for 34.4 percent of the pounds of meat purchased at retail.⁴
• For 2012, natural/organic beef sales comprised 4.9 percent of the total beef volume (pounds) and 6.1 percent of the total beef sales (dollars) in retail. This represents an 18 percent increase in total pounds and a 15 percent increase in total dollars from the previous year.

**Beef in Foodservice**

The foodservice sector includes both “restaurants” (limited and full service) and “beyond restaurants,” such as lodging, business and industry (e.g., private, corporate and employee dining facilities), colleges and schools.
- In 2012, the food supplied to the U.S. food marketing system, including food service and food retailing, was worth $1.22 trillion. Of this total, foodservice facilities supplied approximately $556 billion.6
- In 2012, beef secured 32 percent of the total protein market which totaled 25 billion pounds, thus maintaining the position of number one protein served in restaurants.
- Overall, the foodservice sector purchased 8.0 billion pounds of beef in the US in 2012. This equated to $32.9 billion in wholesale purchases.8
- Ground beef represents the largest share of volume in foodservice at 64 percent and also the largest share of dollars at 35 percent.6

The following statistics measure beef volume in commercial restaurants, which account for about 69 percent of all consumer beef spending in foodservice.
- In 2012, 5.5 billion pounds of beef were purchased by commercial restaurant operators.6
- Limited Service Restaurants, such as McDonalds and Wendy’s, accounted for more than 65 percent of all beef served in commercial restaurants in 2012.6

**Beef in the Home**

- More than eight out of 10 individuals consume fresh beef regularly (an average of 1.7 times per week) in home.7
- Ground beef is the most popular beef item for consumers preparing meals in their home. In 2010, ground beef was present at 61 percent of all in-home beef servings. Steak is the second most popular in-home beef item.7
- According to NHANES data, Americans consume 1.7 oz of beef daily, on average.8

**Impact on Society**

Beef production positively affects the U.S. economy. According to USDA, producers of meat animals in 2012 were responsible for more than $87 billion in added value to the U.S. economy, as measured by their contribution to the national output.9
- Nearly one-half of cattlemen and women volunteer with a youth organization and more than one-third donate their time to other civic organizations, compared to a national average of 7 percent of all Americans.10
- Nearly one-fourth of U.S. cattlemen and women have served in the military, more than the national average of 14 percent, and 94 percent vote in national, state and local elections; comparatively, only 64 percent of the general population votes. One-half of cattlemen and women have run for elected office and 81 percent have been elected to serve.10
- Livestock grazing is the primary use of an estimated 587 million acres of permanent grassland, pasture and rangeland. Much of the land grazed is not suitable for growing other food products.11 By raising cattle, farmers and ranchers more than double the land area that can be used to raise food for a growing population.

3. Cattle Fax: www.cattlefax.com
4. FreshLook Data (IRI Scanner) Research
8. National Health and Nutrition Examination Survey
10. Profile of U.S. Cattlemen, Aspen Media & Market research, July 2010
More than one million beef farmers and ranchers raise cattle in every state in the country. They use the diverse resources available in their local areas to produce nutritious, safe and delicious beef. For consumers, that means there are a variety of beef choices such as grain-finished, grass-finished, natural and certified organic beef. From the pasture to the plate, the entire food chain works together to ensure high-quality and healthy beef for Americans. So, no matter what you desire, there is a great beef choice for you.

## All beef is:

<table>
<thead>
<tr>
<th>Grass-Fed</th>
<th>Natural</th>
<th>Nutritious</th>
<th>Safe</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cattle spend a majority of their lives eating grass on pastures</td>
<td>Most beef does not contain any additives and is not more than minimally processed&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>Beef is a powerful protein and an excellent or good source of 10 essential nutrients</td>
<td>Vigilance on farms, rigorous safety inspections and strict government guidelines ensure the highest level of safety</td>
</tr>
</tbody>
</table>

### Beef can be:

<table>
<thead>
<tr>
<th>Grain-finished</th>
<th>Grass-finished</th>
<th>Naturally raised</th>
<th>Certified organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle spend most of their lives grazing on pasture, then spend 4 – 6 months in a feedlot</td>
<td>Cattle spend their entire lives grazing on pasture</td>
<td>Cattle can be grain-finished or grass-finished—look at the label for details</td>
<td>Cattle can be grain-finished or grass-finished, as long as the feed is 100% organic</td>
</tr>
<tr>
<td>Fed scientifically and healthy balanced diet of grains, such as corn, wheat or soybeans</td>
<td>May judiciously be given FDA-approved antibiotics or growth promoting hormones</td>
<td>Have never received antibiotics or growth promoting hormones</td>
<td>Have never received antibiotics or growth promoting hormones</td>
</tr>
<tr>
<td>May be given vitamin and mineral supplements</td>
<td>May be given vitamin and mineral supplements</td>
<td>May be given vitamin and mineral supplements</td>
<td>May be given vitamin and mineral supplements</td>
</tr>
<tr>
<td>Can be difficult to produce year-round in North America due to changing seasons and weather conditions</td>
<td>Must be certified by USDA’s Agricultural Marketing Service&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Must be certified by USDA’s Agricultural Marketing Service&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Must be certified by USDA’s Agricultural Marketing Service&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
<tr>
<td>Have continuous access to clean water and room to grow and roam</td>
<td></td>
<td></td>
<td>Look for the official label</td>
</tr>
</tbody>
</table>

<sup>1</sup> All beef is naturally raised and is not more than minimally processed.

<sup>2</sup> All beef is naturally raised and is not more than minimally processed.

<sup>3</sup> All beef is naturally raised and is not more than minimally processed.

<sup>4</sup> All beef is naturally raised and is not more than minimally processed.
Nutrient-rich beef
All choices of beef are excellent or good sources of 10 essential nutrients and there are 29 cuts of beef that meet government guidelines for lean. Several of the key nutrients in beef, specifically iron and choline, are known to be lacking in the diets of many Americans, especially women and children. Research shows beef offers several health benefits including heart health, muscle development and weight management.

Beef’s beneficial fatty acid profile
While an animal’s diet can impact beef’s fatty acid profile, it remains primarily monounsaturated and saturated fatty acids regardless of the feeding practice. For example, extended grain feeding can actually increase the amount of monounsaturated fat, which has cholesterol-lowering effects. And, feeding grass longer can influence the amount of omega-3 fatty acid in beef. Either beef choice offers the same health benefits in a healthy, balanced diet.

Half the fatty acids in beef are monounsaturated, the same heart-healthy kind found in olive oil. One-third of the saturated fat in beef is stearic acid, which has a neutral effect on blood cholesterol levels and is the same fat recognized in chocolate for its benefits. Polyunsaturated fatty acids represent the smallest class of lipids found in beef which include omega-3, omega-6 and conjugated linoleic acid (CLA).

Grass-finished beef fatty acid profile

Grain-finished beef fatty acid profile

While all beef offers small amounts of omega-3 fatty acids and can contribute to omega-3 intake, the American Heart Association recommends fatty fish such as salmon as the primary source for omega-3 fatty acids.

1 USDA FSIS Labeling Terms http://www.fsis.usda.gov/FactSheets/Meat_Poultry_Labeling_Terms/index.asp
2 This definition only applies to how the meat was processed after the cattle were harvested and does not apply to how the animals were raised. Efforts are underway to coordinate FSIS’ regulation of natural claims with the AMS voluntary “naturally raised” marketing claim standard. http://www.fsis.usda.gov/OPPDE/rdad/FRPubs/2006-0040A.htm
3 January 2009, Federal Register: Vol. 74, Num. 12
Commitment to Safety

The top priority for cattle farmers and ranchers is to raise the safest and highest quality beef in the world. Since 1993, cattle farmers and ranchers, through the beef checkoff, have invested over $30 million in safety research programs. The industry as a whole invests over $550 million annually in beef safety research and technology implementation.

Escherichia coli

- *Escherichia coli*, or *E. coli* for short, are a large and diverse group of bacteria that live in the intestines of healthy people and animals.¹
- *E. coli* O157:H7 is a specific strain of *E. coli* that produces toxins damaging to the lining of the human intestine. It was first recognized as a disease-causing organism in 1982.
- Other forms (called serogroups) of *E. coli* may cause illness. These other kinds are sometimes called non-O157 STEC.
  - The beef community began testing beef trimmings for six additional strains of *E. coli* on June 4, 2012, including: *E. coli* O26, O111, O103, O121, O45, and O145.
- The incidence of *E. coli* O157 infection has been reduced to less than one case per 100,000 people, meeting the Centers for Disease Control (CDC) Healthy People 2010 goal.² The new CDC goals call for continuous reduction and the beef community is committed to meeting this goal.

Salmonella

- *Salmonella* are a large and diverse group of bacteria that live in the intestinal tract of various animal species, including cattle, swine and poultry.
- Salmonellosis is an infection with bacteria called *Salmonella*. These bacteria have been known to cause illness for over 100 years. They were discovered by an American scientist named Salmon, for whom they are named.
- *Salmonella* Typhimurium, S. Enteritidis, and S. Newport are the most common forms of *Salmonella* implicated in human infections.³
- *Salmonella* infections can be life threatening for people with compromised immune systems or can be mild enough that a person can recover without treatment or ever visiting a doctor.

Preventing Foodborne Illness

- The goal of the beef community is to eliminate foodborne pathogens from the beef supply chain by:
  - Placing multiple safeguards along the way and;
  - Minimizing the possibility that these pathogens survive the journey.

¹ Centers for Disease Control and Prevention, *E. coli*: http://www.cdc.gov/ecoli/general/index.html


³ Centers for Disease Control and Prevention, *Salmonella*: http://www.cdc.gov/salmonella/general/
• There are many procedures in place to help protect people from foodborne pathogens. Many of these safeguards are focused on setting standards at meat processing plants.

• Every federally-inspected meat processing facility undergoes a thorough USDA inspection, which includes review of their Hazard Analysis and Critical Control Point (HACCP) system, which is the foundation for safety intervention methods and process controls.

• In addition to the sampling and testing protocols that individual companies have in place, the U.S. Department of Agriculture (USDA) Food Safety Inspection Service (FSIS) also collects random samples of product and submits them to a laboratory for analysis.

• If a product tests positive for a regulated foodborne pathogen, it is important to notify the public and recall those products in order to prevent future illness.

Consumer Safe Cooking

• Consumers play an important role in food safety by following proper handling, cooking and storage steps.

• Always wash hands, cutting boards, utensils and countertops with hot, soapy water before and after handling meat.

• Don’t cross-contaminate – separate raw meat and poultry from other foods and don’t place cooked food on a plate that previously contained raw meat or poultry.

• Refrigerate leftovers in shallow containers promptly after eating.

• Use an instant-read thermometer to ensure the proper internal temperature of meat and eliminate any harmful bacteria. Color and juices are not an accurate way to determine doneness.

• All ground meat products should be cooked to an internal temperature of 160 F – as measured with an instant-read meat thermometer – to ensure safety.

• Whole beef cuts (steaks and roasts) that haven’t been injected with marinades or mechanically tenderized should be cooked to a minimum internal temperature of 145 F (medium rare) and allow to rest for at least 3 min, for safety and quality.

Recommended Cooking Temperatures\(^4\)

• Poultry: 165 F

• Ground Beef: 160 F

• Beef Roasts and Steaks: 145 F and allow to rest for at least 3 minutes

• Seafood: 145 F

• Pork: 145 F and allow to rest for at least 3 minutes

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Agriculture growth spurs calls for groundwater regulation in rural Arizona

Caitlin McGlade, The Republic | azcentral.com 4:40 p.m. MST December 10, 2015

Some leaders, farmers and residents in several counties want to crack down on unchecked groundwater pumping.

Political leaders, farmers and residents in several Arizona counties want to crack down on unchecked groundwater pumping as fears rise in rural areas that the lawless access to water they enjoyed for decades may leave future generations scrambling.

The call comes from places that weren't included in reform that swept Arizona's most populated areas in the 1980s to regulate groundwater withdrawal.

Places such as the Kingman area, in Mohave County, where farmers last year sank a record number of new wells into an aquifer with diminishing water. Places that aren't supplied by the Colorado River and depend on groundwater to survive.

"I think the future of Kingman and the surrounding area are in jeopardy," County Supervisor Buster Johnson said.

Aquifers nationwide can be a volatile source for water as groundwater levels even in wetter climates have dropped over the last two decades, according to U.S. Geological Survey data obtained by USA TODAY.

The Phoenix and Tucson areas bucked that trend, as water levels in more than half of the wells in their basins documented by the USGS actually rose. These areas are under tight groundwater-pumping restrictions and depend heavily on the Colorado River for supply.

Wells showing some of the sharpest declines in water level are mostly in unregulated lands. The data include wells where researchers observed change over a 10-year period or more.

Kathy Ferris, who helped drive groundwater-management rules 35 years ago, said Arizona needs its next wave of groundwater protections for rural areas to keep their economies from tanking.

The Arizona Town Hall, a non-profit organization that delivers annual policy recommendations, concluded this year that the state should allow new groundwater frameworks to be established.
"There are no limits in most of these areas about who can drill a well where and how big and how much they can pump," said Ferris, who is the director of the Arizona Municipal Water Users Association. "It's a recipe for disaster."

Dropping water levels, rising concerns

In Mohave County, agriculture has expanded so rapidly that 101 new irrigation wells were planned in 2014 for one of the area aquifers. Previous years in the Hualapai Valley basin yielded no more than seven new irrigation wells if any at all, according to Arizona Department of Water Resources data.

Domestic wells made up the majority of new wells for that basin up until 2014, according to the data.

Fearful residents flocked to their county supervisors last year only to learn that they don’t have the power to do anything because only the state can regulate groundwater.

"The people that live out here, they're not going to be able to afford to drill deeper and get water," County Supervisor Johnson said.

Travel south from Kingman and the same fears persist. Retired couples on fixed incomes, watching more crops spring up in their desert, question their financial future as water levels in their wells plummet, said La Paz County Supervisor Holly Irwin. Residents send her letters, call her, stop her on the street and bring up water concerns even in school-board meetings, she said.

The town of Wenden recently had to drill its well deeper to be able to supply its residents, she said.

The Arizona Department of Water Resources recorded groundwater-level declines in the area before the recent farming activity that Irwin said the locals fear.

North Carolina-based International Farming Corporation, for example, bought almost 13,000 acres about 100 miles west of Phoenix in 2012 that had not been farmed previously, according to the county.

Fears swirling around a pre-existing farm stoked the most discussion this fall when news outlets reported that a Saudi Arabian dairy company was growing alfalfa in La Paz County and shipping it home to its cows.

The operation is just one of many Arizona farms that export a total of $1 billion in crops and animal products each year. The land had been farmed before the dairy company’s purchase, but the news nevertheless spawned outrage. For Irwin, it was one example of how vulnerable her county’s water supply is when left ungoverned.

Irwin heard from five residents in one day this week whose wells have recently gone dry and now have to haul water until they can afford to drill deeper.

The water level in one well surrounded by the farm property documented by USGS data had dropped more than 50 feet from 1995 through 2012, prior to the new company's purchase.

"How do we go about protecting what is ours for the people here in the future?" Irwin said.

Hoping for the best, preparing for the worst

The Mohave and La Paz County supervisors want action. Irwin called for Gov. Doug Ducey this November to help her county preserve its groundwater supplies. Johnson and fellow Supervisor Steve Moss said they will appeal to the Legislature to allow for local controls.

"I think we should be hoping for the best and preparing for the worst, and I don't think we've been preparing for the worst all that well," Moss said.

To the southeast, some farmers are trying to limit their own industry’s water use.

Richard Walden, president of Farmers Investment Co., tried to persuade the state to ban irrigation expansion in the San Simon area.

Backlash from locals was immense, and many took his bid as a move to protect his pecan business from additional competition. The state determined that his groundwater basin had enough water to supply the current demands, but could not factor in whether the supply was enough to handle growth.

"Given that we live in a desert state, we need to recognize that water is our most important, threatened resource," Walden said.

About an hour’s drive to the west of Walden’s farm is ground zero: Willcox. A group of farmers and residents there penned a proposal that experts in water policy say could be the first step toward a new era of groundwater-protection policies.

On average, water levels observed in wells there have plummeted deeper than almost anywhere else in the state, leaving some homeowners with dry wells and farmers with rising electricity bills to pump the water from deeper depths.

The group’s plan would ban irrigation expansion in the area for high-water-use crops, require farmers to meter and report their water use and impose fees on groundwater withdrawal.

Cochise County Supervisor Richard Searles, who is a cattle rancher, said he doesn’t agree with the whole plan but that he could live with it.

"Even the ones that are opposing it will agree we have a problem and something should be done," he said.

What's next?

The Willcox team had hoped to take the language to the Legislature this session but has a long way to go.

Rep. David Stevens, R-Sierra Vista, represents Willcox and said he wouldn’t sponsor the plan because the group had not had enough public meetings, nor enough support from stakeholders such as the cattle-ranching lobby. Even if the language made it into proposed legislation, it wouldn't get a hearing in Senate and House committees, he said.

House Speaker David Gowan would take "a serious look" at proposed groundwater-management policies if or when a plan had statewide consensus from all stakeholders, said Stephanie Grisham, press secretary for the House of Representatives Republicans.

Bas Aja, executive vice president of the Arizona Cattle Feeders' Association, said the best place to start would be to bring back a proposed fund designed to help rural communities pay for water infrastructure. That plan was part of draft legislation that never made it through the Legislature years ago.

Gov. Ducey said he and the director of the Arizona Department of Water Resources are working on "new ideas, plans and policies" to serve water needs across the state. Ducey did not get into specifics, but said he's focusing on technologies that increase water supply.

"There is still a lot more work that needs to be done, not only for our urban areas and our agricultural industry but for our outlying rural areas," he told The Arizona Republic. "Doing the right things to take care of those rural needs is something we're going to focus on this session."

Aja said he will participate in the public vetting process for the Willcox plan but that he disagrees with the group’s premise that a crisis is eminent. He questioned the rumblings seeking groundwater controls across rural Arizona.

"I think some is driven by fear, some by emotion," he said. "The fear of the future cost of water."
Water director: Important facts have been left out of the debate on a Saudi Arabian farm using Arizona water.

Recently much hay has been made concerning certain farming operations in La Paz County.

Bad puns aside, the basic fact is that the production of any product requires water. Whether it is microchips, electric car batteries, doorknobs or alfalfa, the production of goods and services demands water.

Water is a basic necessity of life and economic activity. Another basic reality is that part of having a vibrant economy means that Arizona must export goods and services.

Some of the facts surrounding the farming operations in La Paz County have been overlooked.

What you need to know

Farming in that location dates back to at least the late 1970s. Dairies in that location, growing alfalfa for feed, have been there since 2006. The number of acres farmed has not increased; in fact, recent investments have actually increased irrigation efficiencies decreasing the on-farm water use.

While the ownership of some farms in the area have changed recently, just like their predecessors, the new owners invest in the local economy. They provide jobs, purchase irrigation equipment, tractors, fuel and fertilizer, and pay taxes.

Arizona is part of the global economy; our agricultural industry generates billions of dollars annually to our state’s economy. Our high-quality agricultural products are exported across the country and around the world.

Farms in the Yuma area produce 80 percent to 85 percent of the nation’s green, leafy vegetables in the winter months. We have some of the highest-quality alfalfa in the country. And we are more efficient with some of the largest yields per acre.

We have some of the highest-quality cotton in the world, and it is highly sought after in the Far East. Our larger pecans are prized in China; our plumper pistachios are sought after in Europe, our durum wheat grown in Pinal County is in high demand in Italy for pasta production, and our specialty beef is shipped to Japan.

Planning for our water future

Our state’s arid environment requires that we be forward thinking and ensure we have reliable water supplies to meet our future water needs. In 2014, the Arizona Department of Water Resources (ADWR) released a statewide assessment on water supply sustainability and found there is a sufficient water supply available in this area of La Paz County for at least the next 100 years.

This assessment included the water used from the farms in question.

In October, Gov. Doug Ducey announced his water initiative and tasked ADWR to work closely with local leaders to find solutions that optimize future water management in the state, with emphasis on rural Arizona.

Part of the discussions we need to have is how to balance this key part of our economy while protecting our long-term water supplies, particularly for rural Arizona, regardless of where the crop is going or who owns the farm.

*Thomas Buschatzke is director of the Arizona Department of Water Resources, which manages the state’s water supply, ensuring long-term water supplies within federal and state laws.*
Shrinking Colorado River is a growing concern for Yuma farmers — and millions of water users

By WILLIAM YARDLEY contact the reporter

The Colorado River begins as snowmelt in the Rocky Mountains and ends 1,450 miles south in Mexico after making a final sacrifice to the United States: water for the farm fields in this powerhouse of American produce.

Throughout the winter, perfect heads of romaine, red-and-green lettuce, spinach and broccoli are whisked from the warm desert soil here onto refrigerated trucks that deliver them to grocery stores across the continent. If you eat a green salad between Thanksgiving and April, whether in Minnesota, Montreal or Modesto, odds are good that some of it was grown in or around Yuma.

The summer freshness on all of those winter plates reflects the marvel of engineering the Colorado has become — and why managing the river in the Southwest's changing landscape seems so daunting.
Shrinking Colorado River is a growing concern for Yuma farmers — and millions of water users - LA Times

The Colorado is suffering from a historic drought that has exposed the region’s dependence on a single, vulnerable resource. Nearly 40 million people in seven states depend on the river, a population some forecasts say could nearly double in the next 50 years.

The drought, now in its 16th year, has made one fact brutally clear: The Colorado cannot continue to meet the current urban, agricultural, hydroelectric and recreational demands on it — and the point at which the river will fall short could come sooner than anyone thought.

That is true even after an unusually wet spring in the Rocky Mountains, where runoff feeds the Colorado and its tributaries.

In the decades to come, federal officials say, significant shortages are likely to force water-supply cutbacks in parts of the basin, the first in the more than 90 years that the river has been managed under the 1922 Colorado River Compact.

They would not apply evenly. In Arizona, which would take the steepest cuts, officials are warning that the elaborate conservation measures and infrastructure put in place in the 1980s to guard against shortages will probably not be sufficient. As the drought continues, serious shortages and more severe cutbacks have become more likely.

Farmers who grow cattle feed and cotton in central Arizona could be forced to let fields lie fallow, maybe for good, and cities like Phoenix might have to begin reusing wastewater and even capping urban growth, the region’s economic engine.

Here in Yuma, though, there may be no cuts at all. Thanks to the seemingly endless idiosyncrasies of the rules governing the Colorado, much of metropolitan Phoenix could theoretically become a ghost town while Yuma keeps planting lettuce in the desert.

The looming shortages have opened a contentious new conversation here in Arizona, with increasing calls for rethinking the way the state divides the water it also shares with six other states, including California. Some experts say that a recalibration is in order — that while it may not make sense for millions of people to live in the arid West, people should take precedence over growing leafy greens on an industrial scale.

In a 2013 study, the Bureau of Reclamation suggested transferring about a million acre-feet of water from farms. Academics say it is only a matter of time before agriculture is forced to yield some of its supply — and that farmers could benefit financially from such transfers.

That kind of talk is rattling farmers in Yuma. They know they have water priority but not necessarily political priority.

"They believe there's a target on their backs," said Tom Buschatzke, who leads the Arizona Department of Water Resources. "I believe they're right."

Farmers here do not intend to go quietly. Some come from families that were here when the big cities of the modern Southwest were little more than crossroads.

"We have a legal right to this," said Mark Smith, who farms about 500 acres in Yuma and leads one of six irrigation districts in the area. "The guys who say this is an easy fix — it’s not an easy fix. We're growing vital crops."

"This is a national debate," Smith added, "because we're supplying the entire nation."

Few rivers are asked to work as hard at the Colorado. Ranchers in western Colorado use the river to water pastures for beef cattle, while Denver and its suburbs channel it east across the mountains to enable city living. Las Vegas and other southern Nevada communities draw up to 90% of their water from the Colorado. Hoover Dam and others convert its flow into power. After Arizona and California take their share, the river exits — evaporates, really — through the dry remnants of a delta leading to the Gulf of California.

If a shortage is declared, California is one state that would not face any immediate cutbacks, thanks to an agreement reached with Arizona in 1968. That pact allowed Arizona to build one of the nation's most ambitious water-supply systems, the Central Arizona Project, but it also ensured that much of Arizona would take steep cuts if a shortage is declared.

Yuma is an exception.

Wedged into a wrinkle of borderland between California and Mexico, farms here have been drawing water from the Colorado since the late 19th century. Their early presence here earned the area the most-senior water rights in Arizona and some of the most-senior in the basin. Of the approximately 15 million acre-feet of water allocated for use each year across the entire basin, about 1 million acre-feet — nearly 7% of all of the water — goes to just 150,000 acres of farmland here.

By comparison, the 5 million water users in Phoenix and Tucson share about 1.5 million acre-feet. California has rights to the largest share, 4.4 million acre-feet, and even under the most dire scenarios it is virtually certain to always receive it. The law of the river says so.
Yet even as parties in the basin are often wary of one another — and not equal partners — most emphasize the need to work together under the current rules. The alternative, some fear, is that the federal government will intervene.

"There are many who have advocated for years that you have to change it significantly," said Wade Noble, a lawyer for the Yuma County Agricultural Water Coalition. "We, of course, resist that because with our priority we benefit from the [current] law the most."

In February, Noble helped draft a report by the coalition intended as a preemptive strike against anyone eyeing Yuma water. In it, Yuma leaders argue that the region has become more productive and profitable while also reducing its water use as it has shifted its focus to winter vegetables over the last four decades.

Yet the region still uses an extraordinary amount of water. High soil salinity has led farmers to flood fields in an attempt to wash salt away from fragile roots, then provide more water for irrigation. And in an era seeing the rise of seasonal, locally grown foods, Yuma strikes some as emblematic of old ways of thinking about what people should eat and when.

Then again, farmers in Yuma say cities have been allowed to grow with little concern for the water required to sustain them. They note, too, that most of their crops align with a growing emphasis on healthful eating.

"They are doing a lot of things right," said Robert Glennon, a law professor at the University of Arizona who specializes in water issues.

But Glennon has also warned that Yuma farmers and others in the arid West may have only so much control over their fate — a lesson farmers in parts of California, dependent on other rivers, are learning during the historic drought there. He has encouraged farmers to reduce production so they can sell or lease a portion of their water rights to cities. Research shows that a cut of just 4% in certain agricultural areas could increase the water supply by 50% for some cities, he said.

Farmers here say the entire region was settled on an ethic of national service. The Bureau of Reclamation began building canals feeding off the Colorado in the first years of the 20th century.

Edward C. Cuming arrived in the summer of 1902, an Irishman who had first migrated to Alberta, Canada, before moving south. Cuming homesteaded 160 acres just south of Yuma, irrigating them with the new canals. The Depression forced him to sell 40 acres but also led to a new era of government support for the area.
Shrinking Colorado River is a growing concern for Yuma farmers — and millions of water users - LA Times

The Civilian Conservation Corps, established by President Franklin D. Roosevelt, expanded and improved irrigation canals across the Yuma area. One of those channels, stamped "CCC 1940," is known as the Cuming Canal. It runs directly in front of fields now owned by Edward Cuming's grandson, Jim Cuming.

"When we had an abundant supply of water, the farmer was doing a great job," said Cuming, 77, sitting on a concrete culvert above the Cuming Canal while cloudy Colorado River water surged beneath him.

"Now all of a sudden he's a villain because he uses too much to produce your fruit and fiber."

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Exporting the Colorado River to Asia, Through Hay

As the West suffers long-term drought, experts look for ways to save water while still supporting local farmers.

In July in Yuma County, Arizona, Dave Sharp’s alfalfa crops, like every other living thing in the 105°F (40°C), dry desert heat, get thirsty.

All that keeps them alive, and indeed keeps these fields and the hundreds of thousands of acres surrounding them in Yuma County from going fallow, is the Colorado River, diverted one last time through the Yuma Project before flowing across the border into Mexico.

The same can be said of California’s Imperial Valley, across the river and about 60 miles (97 kilometers) to the west, which was essentially uninhabitable before the Imperial Canal first drew Colorado River water there in 1901, and then the All-American Canal brought more in 1940.

These complex irrigation systems, through an even more complex system of laws, treaties, compacts, court orders, and agreements drawn up over the past century, deliver a very specific volume of water to the hundreds of farms throughout Yuma County and the Imperial Valley.

Sharp and his brother, third-generation Arizona farmers, count themselves among the lucky rights holders of some Colorado River water, which they use to irrigate their Lyreedale Farm. Every few weeks, they release a carefully calculated bit of their allotment of the Colorado over their 2,400 acres.

Half of Lyreedale’s fields are planted with alfalfa, a legume that most people recognize as a type of hay. There are actually dozens of varieties of hay, including grasses, but alfalfa is one of the most popular. Alfalfa is a livestock forage crop that is most often fed to dairy cows. It has deep taproots that suck up water, although scorching summer heat kicks transpiration into overdrive.

Alfalfa grows fast, so every month or so, a harvester will cut the crop, which will then be packed into tight bales; trucked to Long Beach, California; and loaded on a tanker bound for China or Japan or the United Arab Emirates.

All across the lower Colorado River Basin—and especially in Yuma County, the Imperial Valley, and the Green River area in Utah—scenes like this are playing out with increasing regularity. What was once a reliable and local, if relatively low-value, crop has become a global commodity. But the fact that the Colorado River is fueling the export boom has some western water advocates worried.

Virtual Water Exports

When Robert Glennon, a water policy expert at the University of Arizona and author of the book Unquenchable: America’s Water Crisis and What to Do About It, first learned that the U.S. was exporting alfalfa crops that had been grown with the very limited western irrigation water, his reaction was "utter disbelief."

Glennon crunched some numbers and figured that in 2012, roughly 50 billion gallons of western water—enough to supply the annual household needs of half a million families—were exported to China. Not literally bottled up and shipped, but embedded in alfalfa crops grown with irrigation water. And that’s just to China, which still trails Japan and the United Arab Emirates as a top destination for American alfalfa.


The concept of exporting "virtual water" is not new. And for decades the United States has exported trillions of gallons of it.

According to a UNESCO-IHE Institute for Water Education report published in 2011, the United States exports more than twice as much virtual water, about 82 trillion gallons, as any other country. That's largely because American farms feed the whole world.

Of course, given all the foreign products that Americans buy, the United States is also the largest importer of virtual water, with roughly 62 trillion gallons coming into the country in the form of T-shirts and iPods and other products.

"We get a lot of criticism for how much water is going overseas in the form of alfalfa," said Sharp, the Arizona farmer, "but alfalfa is exported far less than wheat or rice."

Glennon agrees. "We do it in the form of wheat, soybeans, and corn," he said. "The midsection of the country has traditionally used millions of tons of water to grow crops that are shipped by rail to ports and shipped all over the world."

But what troubles Glennon, and others who obsess over the West's water woes, is the growing trend of shipping hay overseas.

"What's new here is that hay is a forage crop, and the exports are coming from the West, where water is scarce."

Daniel Putnam is quick to defend alfalfa and other forage crops, which he studies carefully as an agronomist at the University of California, Davis’s College of Agricultural and Environmental Sciences. "Alfalfa has become a whipping boy because people don't understand it, and undervalue it," said Putnam. Alfalfa may sell for cheap, he said, but people don't consider the value it provides by supporting the local dairy industry; by supplying a regular, year-round income as a "cash crop" for farmers; and by contributing to wildlife, since alfalfa fields are favored by migratory birds.

"People like to pick on alfalfa," said Putnam, "yet it receives no subsidies at all, has low sales value, but is still the largest acreage crop in California and Arizona. So how does it survive? It supports the biggest industry in California, which is dairy."

Critics argue that the water itself, available to farmers at a fraction of true market value, is a form of indirect subsidy.

Alfalfa Exports

Alfalfa's image problem also stems from the fact that exports of the highly irrigated crop are growing fast at a time when persistent drought has put the West's water struggles front and center in the public consciousness.

These exports are a relatively new phenomenon. For centuries, according to Putnam, hay was typically fed to cows close to where it was cut. What changed?

First, explains Putnam, is that demand for dairy is growing in the Middle East and much of Asia, particularly China, and these countries either can't or choose not to irrigate water to grow hay. Putnam points to a 2008 decision in the United Arab Emirates that the nation would not use its very limited water supply to grow forage crops like alfalfa.

Japan, with established dairy demand and little land to produce hay, has been the largest importer of alfalfa from the U.S. for decades, but China and the United Arab Emirates are fast gaining ground.

On top of the demand spike, a staggering trade imbalance between China and the U.S. creates an incredible advantage for any American producer to ship anything at all to China, even bulky, heavy bales of hay. For every two container ships that bring those iPods and T-shirts to California ports from China, one goes back empty.

As a result, "it costs less today to ship a ton of alfalfa from Long Beach to Beijing than it does to ship it from the Imperial Valley in California to the Central Valley," explains Glennon.

All of this leads to alfalfa and hay exports that have more than doubled since 1999 and increased by 60 percent since 2007, with the biggest increases by far being in shipments to China and the United Arab Emirates. For instance, in 2007, China imported just 2,400 metric tons of hay. By 2012, that had increased over 200 times to more than 485,000 metric tons. And in a paper Putnam presented earlier this month, he predicts another 50 percent growth over the previous year's volume in 2013.

Putnam also anticipates that Saudi Arabia will soon, like the U.A.E., restrict alfalfa growth, which would cause another big spike in overseas demand.

Today, at least 12.5 percent of alfalfa grown in western states is exported, and in some areas like California’s Imperial Valley—just across the Colorado River from Yuma County—that figure grows to a full 50 percent.

**Alfalfa and Water on the Farm**

Nowhere is the complicated—and increasingly controversial—relationship between a limited water supply and rising hay exports more relevant than in the Lower Colorado River Basin, particularly the fertile fields of the Imperial Valley and Yuma County.

Every day, the Sharp brothers make careful, cautious decisions about how to best use their limited supply of the Colorado River.

"We have a very vital resource that has been entrusted to us, and we are stewards of it," says Sharp. "We know what can happen, that things are cyclical, that it can come and go."

Alfalfa, he explains, is part of a regular rotation on his fields that responds to the seasons and helps sustain the soils.

"Over 90 percent of produce consumed in winter months in the U.S. comes from Yuma," said Sharp, a staggering figure that was confirmed by Putnam. And though Sharp could make a lot more profit selling high-value produce, "we can’t grow lettuce [all the time]. Diseases would wipe us out. We have to do rotation, and alfalfa is a key rotation crop."

Sharp added that he typically rotates in alfalfa on a field every three years. And when it comes time to move the finished crop, Sharp emphasizes that exports are just a small part of the picture. "There’s lots of demand for alfalfa in Arizona and California from dairies and feedlots," he said.

"We’re businessmen first, so we look for the best market and what will generate the most revenue," Sharp added. "There are times of year when it’s most advantageous for us to sell to local dairies. And there are times of year when it’s most advantageous to us to go to export."

However, elsewhere in Yuma, and particularly in the Imperial Valley, the export of alfalfa is becoming a business unto itself. Some large-scale industrialized hay operations have sprung up in recent years, with foreign markets at the core of the business model.

**Solutions?**

For his part, Glennon has no problem at all with an alfalfa crop that feeds into a higher-value domestic industry like dairy. And he is quick to point out that farmers, whom he calls "savvy business people who take advantage of commodity price spikes and shipping prices," shouldn’t bear the brunt of any criticism for what is essentially a policy problem.

"I’m not villainizing farmers or alfalfa," says Glennon. "But I want to expand the market for people who have the rights to this water to sell it."

He has some ideas for how to create a better alternative for farmers than exporting hay and all the water used to produce it.

One fix, though not at all an easy one to implement, would be to rework the laws and restrictions that discourage or even prohibit farmers from selling or leasing their rights to irrigation water.

"The Imperial Valley uses Colorado River water," explains Glennon. "Las Vegas and the Southern Nevada Water Authority would pay dearly for a small percentage of the water used to grow that alfalfa, and that deal is all but impossible to pull off."

When growers hear talk of expanding water markets, they immediately fear the outright loss of their rights. According to Sharp, the Yuma Irrigation District holds the primary rights, and his family’s contract is with the district. If the district were allowed to negotiate

sales with municipalities, it could in theory sell the Sharps’ allotment—along with all his neighbors’ in Yuma—to, say, the city of Phoenix, which could pay more than the farmers ever could.

"San Diego, Phoenix, and Las Vegas can all pay more for water than any agricultural operation could ever compete with," warns Putnam. "When you start to talk about markets allocating water, you have to ask some hard questions. Do you really want to dry up the Imperial Valley?"

Glennon insists that the right policies could protect farmers and keep places like Yuma and the Imperial Valley wet and productive, without sending Colorado River water overseas.

He points to research done by Mike Ottman of the University of Arizona, which shows that alfalfa farmers are actually getting less product in the summer months for the same amount of water spent.

Ottman explains that the typical alfalfa farms in the Southwest have eight cuttings, or harvests, a year, and that the last four of these, during the scorching summer months, yield about half as much product. But alfalfa is incredibly resilient, and the perennial crop survives just fine if it isn’t watered for a few months. Putnam has researched this practice, as well as so-called "deficit irrigation"—where the crops get less water than they’d need for maximum growth—and the crops fare just fine in the long term after a dry spell.

This has Glennon thinking of some creative conservation and efficiency solutions. "There’s a lot of water being wasted growing alfalfa in the summer," he said. "The farmers do it because they don’t have anything else to do with the water, and because they fear they’ll lose their rights to it if they don’t keep using it. That’s a rule that could be changed."

Glennon proposes a "temporary suspension of summertime irrigation of alfalfa," combined with changes in policy that would encourage farmers to sell limited volumes of their righted water to the highest bidder, probably cities or industries.

The legal trick is ensuring that farmers don’t lose their rights if they don’t use their water and lease it out instead. In theory, the Sharp brothers could let their alfalfa fields go dormant for the summer months, after harvesting the first four cuttings during the wetter part of the year. They would miss out on the four summer cuttings, but they could make more than enough money to compensate for that by selling their water to Phoenix or Las Vegas or a company like Intel. If they ever decided they wanted to use all their allotted water on the farm again, they’d be welcome to do it.

Glennon is confident that opening up the water market would effectively curtail exports; no ban or change in trade policy would be necessary.

"It’s really a win-win," says Glennon. Farmers stay in business and make their own decisions about which fields to leave fallow and which to harvest. Growers could even use the new water revenue to pay for more efficient irrigation systems, thereby saving even more water, the rights for which could be leased. "They grow as much product as they already do, with less water, and infrastructure improvements on the farm are paid for by the municipal and industrial sector," he said.

Glennon adds that this is just one idea, and that there are many smart policy shifts that would allow farmers to keep their water rights, make more money, and keep the Colorado River doing more productive work within the United States. "The only thing that limits us is our imagination," he says.

To get involved in helping restore the Colorado River Basin, join Change the Course, a campaign from National Geographic, Participant Media, and the Bonneville Environmental Foundation. (You can also text "River" to 77177. Don’t worry, it won’t cost you anything.)

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Building a better pepper

By Ainslee S. Wittig/Arizona range news  ----  January 27, 2010

Ed Curry found his passion in the chile fields of Southeast Arizona

Edward Curry's parents planted their first chile crop in 1957, and he grew up in those chile fields in Southeastern Arizona. "My Mom and Dad worked hard at it, and chilies kept them profitable. My Dad started us farming young," he said. "When I was just eight, my Dad was looking for a better chile and I flew with him to New Mexico to a seed farm. That made a big impression on me and I became interested in genetics at a young age."

He went to Elfrida High School and then on to one semester of college, but he really didn't enjoy learning at a desk. So, he turned to his passion for chilies, and started to build his own education. "I wanted to do more than just grow chilies; I wanted to breed chilies. It was a challenge," he said, and his desire grew into a lifelong interest in chile genetics.

Now, Curry, at 53, is internationally known for his work in chile genetics. He has just filed a utility patent on a chile that he and his partner, Phil Villa, bred. The 'Phil Villa' chile pepper, as he calls it, "has very unique properties and flavor. To file for a utility patent on a plant, you have to show extreme differences and specific value. It's a very difficult thing to do," Curry said. "I am also currently working with a group doing the Genome mapping for peppers - making descriptions of every gene in peppers. There are five scientists tied to it and the project costs about $30 billion," he said.

But let's back up a bit.

In 1986, Curry started the Curry Seed and Chile Co., now a 1,200-acre farm in the Sulphur Springs Valley near Pearce. Curry said most of his knowledge of genetics came from working with his former teacher and current partner, Phil Villa, a well-known chile breeder. Others who helped him learn were Jeff Silvertooth of the University of Arizona; Ben Villalone of Texas A&M - known as 'Dr. Pepper' for "taming" the jalapeno, and Stephanie Walker of New Mexico State University, among others. "I have spent the last 30 years trying to understand gene traits - and I still don't have near the knowledge I need," Curry said.

For many years, he has worked on developing new and improved hybrids that are now produced with uniform quality, flavor and heat. "In 1993, we were the first to stabilize heat in the commercial chile industry. Once you learn how, it's not hard to do," he said.

Then about eight years ago, Curry was asked by Mexico's Department of Agriculture to improve the yield of the Guaillo pepper. "I doubled the yield and kept the unique flavor of the Guaillo," which is a popular Mexican pepper with high oil content used for drying, he said.

In another pepper, Curry has developed a thin-skinned cross. "By making the epidermis of the chile thinner (for roasting purposes), this has made a 10-percent difference in sales in the industry and several millions of dollars per season," Curry said. "This allows people to start eating the skin, which has more nutrients."

"We have a patent pending for this new thin-skin variety," he added. Curry summed up his work: "We're playing with gene packages."

In 1995, Curry was asked to attend the Asian Vegetable Research & Development Center in Taiwan, where he was invited to swap genetic material, which PhDs use for breeding work. "I came back with the specific gene I was looking for," he said. "I was very honored to be there. This center is supported by the United Nations and there are 7,000 cultivars of pep-

http://www.willcoxrangenews.com
per in the seed bank there."

Curry said, "In third world countries, most of the farms are very small - often one acre - and they're trying to keep up with growing populations. The numbers of acres of farmland are shrinking and the population is growing. It is the job of the agriculturists to feed the world. Nutrition and high yield are important. That is why genetic breeding is important."

Locally, the Currys hosted their fourth Field Day in September 2009, where about 70 researchers from the Southwest (and elsewhere in the U.S.) come to his farm to study the genetics of the chili industry. The genetic origins for 80 to 90 percent of the New Mexico variety green chilies grown commercially in the U.S. can be traced back to Curry's farm in Arizona, he said, as the Curry Seed & Chile Company supplies chile seed to growers in the Southwestern U.S. and in several states in Mexico. "We're at the heart of chili research," he said.

"There's great joy in that, however I always worry about making a mistake. I could screw up and that could affect 90 percent of the industry," he said. In 1996, he partnered with Jeannie England at the Santa Cruz Chili & Spice Co., a manufacturer and retailer of chili products. He said his father and Jeannie's father (Gene England) had worked together since Gene started the company in 1943.

His chile paste is canned at Curry's Farm in Pearce and he sends it to Santa Cruz. It ends up at several big-name companies. And, Curry's hot pepper mash ends up at Tyson Foods for hot wings. "Our farm is one of the few seed-to-shelf farms. We do the genetics, grow the crops in the fields, and then all the processing and canning right here," he said. Chile research is not only for the food industry, however.

Capsaicin is the ingredient found in different types of hot peppers that makes the peppers spicy hot. When a capsaicin cream or ointment is used on the skin, the capsaicin helps relieve pain by first stimulating and then decreasing the intensity of pain signals in the body. "The capsaicin is formed at the top of the placenta where the seed is formed and it can be used for anesthesia - it deadens the nerves. The chile industry is on the cutting edge in bio-pharmaceuticals. In the work that I am doing (generally, making genetic selections based on Scoville heat unit measurements for peppers and the five genes that make up capsaicin), I had to sign a silence agreement," Curry said.

Created in 1912, the Scoville heat unit is the closest thing to a standard for measuring the heat in a pepper. It is a measurement that involves adding sugar to a solution until one can no longer taste the pepper. The more sugar, the higher the spice, the greater measurement in Scoville units. "I'm 53 and my kids think I can eat fire! I've spent 30 years tasting chilies - it deadens the nerves over the years, so I really can't taste the heat as much. That's what we've found out for local anesthetics, as well," Curry said, adding if you walk into the area where the chile is crushed, the atomized capsaicin "is great for a sinus headache." "Over the next 30 years, there will be a lot more usage of capsaicin medicinally," he added.

Curry is a bit surprised by his status at this point. In September 2008, he was the guest speaker at the International Pepper Conference held at Rutgers University in New Jersey. "I was this farm boy talking to a bunch of doctors!" he said, obviously amazed at his own predicament.

Curry and his wife Jeanette have four children currently at home, Keiffer, Mikey, Jordan and Tyler, who is running part of the farm: "We may be Curry & Sons Farm one day," he said.

While speaking to members of several FFA chapters who visited Curry's farm in October, he said, "If I can inspire one of you to study genetics, it's worth doing this. Gene manipulation is what will hold our world together and keep us from being hungry. And I'd like to keep America in the forefront of this industry. "But, I enjoy speaking and encouraging young folks. And I tell them, whatever you do, you've got to have passion for it. Education never stops. We are searching every day for something to uncover. So, if there's one thing I can pass on, it is, love what you do.

"For me, my heart is here on my farm. I put what profit we make back into my research — it is my hobby, my passion. People go on vacation, or love fishing. For me, I don't have to go to the mountains to have fun. It's here. The farm and my research ... it's my life."
Temple Grandin’s innovative work has revolutionized animal husbandry practices around the world.

Temple Grandin takes new angles to solve modern problems

By Richard Deitsch
When discussing her age recently—she turned 65 last August—Temple Grandin compared herself to a creaky automobile that needs constant tinkering. “I used to be able to stand in a forklift truck loading dock at a feed yard and I could jump up on the ramp,” she says. “Gosh, there is no way I could do that now. But one of the things that getting older does give you is wisdom and a perspective that you didn’t have before because you’ve been to a lot of places and you’ve seen a lot of things. That’s why, in a lot of societies, they look up to their elders. In elephant society, younger elephants look up to the matriarchs. Why? Because they know where to find the water from 50 years ago.”

Plenty of people seek Grandin for her wisdom these days. She is a doctor of animal science and professor at Colorado State University, a best-selling author, the subject of an Emmy Award-winning HBO biopic, a much-in-demand public speaker and a consultant to the livestock industry on farm animal behavior (see “Shaping Costco’s policy,” page 23). As the most well-known adult with autism in the United States and perhaps the world—she regularly makes presentations at autism and Asperger’s syndrome conferences—she is an inspiration and a role model for that community and beyond.

“It’s hard to overstate Temple’s impact as a role model for young adults on the autism spectrum,” says Amy Harmon, the best-selling author of Asperger Love and a Pulitzer Prize-winning reporter for The New York Times who has written extensively on autism. “Probably the biggest impact she has had for the population I’ve reported on, young adults on the autism spectrum, is in how she turned her fascination with animals into a rewarding career. The employment statistics for people with autism are really dismal. Fewer than one in 10 hold jobs, even among the group considered ‘high-functioning.’ Yet many of them have skills and talents and interests that could be quite valuable to employers. Temple is a testament to that and an inspiration to many.”

From isolated to expert
Little was known about autism when Grandin was a child in the 1950s—she did not speak until the age of 4—but she benefited from the structure provided by her mother and school administrators. (Her father recommended she be institutionalized, but her mother refused.) Children with autism, a developmental disorder, have varying degrees of difficulty communicating and socializing, and often lock onto repetitive behaviors. It was at an aunt’s cattle ranch in Arizona...

Grandin’s lifelong bond with animals began as a teenager at an aunt’s cattle ranch in Arizona.
TEMPELE GRANDIN
CONTINUED FROM PAGE 21

Arizona one summer, during her teens, that Grandin first became connected to horses and cattle and discovered a shared characteristic between animals and those with autism: Both think by making visual associations. She eventually received degrees from Franklin Pierce College and Arizona State University, and a Ph.D. from the University of Illinois at Urbana in 1989. The public became aware of her in 1995 when famed neurologist Oliver Sacks wrote about her in his book *An Anthropologist on Mars.*

"Autism is an important part of who I am," says Grandin, who has had a poster of Albert Einstein on her wall since graduate school, "I get asked all the time: If I could snap my fingers, would I want to not be autistic? Well, I like the logical way I think. I don’t want to lose the logical way I think. But on the other hand, doing my animal work and being a college professor and a scientist, that comes first. Autism comes second."

At least half of all cattle in the U.S. and Canada, as well as many in other countries, are handled in humane slaughter systems with equipment designed by Grandin. Those designs have revolutionized animal agriculture around the globe, and Grandin has been a key figure in formulating the beef industry’s guidelines for animal handling and welfare as well as in training a new generation of agricultural professionals in animal behavior theory, humane design and auditing techniques. She consults for many companies, including McDonald’s, which first hired her in 1999 to audit the meatpacking plants that supplied the fast-food chain.

"Dr. Grandin’s work has anticipated and dovetailed with societal concerns related to welfare in animal agriculture, and as a result there is hardly a high-profile conference or symposium around the world focusing on this issue that does not include Temple Grandin," says Craig Beyrouthy, the dean of the College of Agricultural Science at Colorado State University (CSU). "We hear stories of students who are almost dumbstruck that they can enroll in Dr. Grandin’s classes, that she might be an adviser for them as they pursue graduate studies. We have a student who came to CSU in fall 2012 from an agricultural community in southeastern Colorado, a student with Asperger’s syndrome who was not expected to graduate from high school. On the first day of the semester, his mother shared that the student was ‘living his dream.’ He had his first day of class with his mentor and hero, Temple Grandin."

"Temple Grandin has helped all of us understand the power of different ways of thinking and being," adds CSU president Tony Frank. "Her unique perspective, raw intellect and ability to see challenges and solutions from new angles, to connect dots that most of us don’t even see.”

**Thinking in pictures in a verbal world**

Grandin, who once believed that everybody thought in pictures, is now a sensory-detailed oriented. Then, how does she interact with the verbal world? “You can get verbal thinkers to be aware of visual thinking,” she responds, "The thing is, there are degrees. Most people, if I was to say to them right now, ‘Visualize you are [at your] office at work.’ Well, you could do that. Or visualize your car. Most people can do that, too. But if I asked you to visualize something like a church steeple, something you see all the time, most people just see a vague, generalized one. That’s not something they pay much attention to. So it was a shock to me to learn that most people just get this vague, generalized church steeple image rather than a specific one. I’ve had to learn how to communicate more with the verbal people.”

Author Richard Panek met Grandin three years ago after he was invited to collaborate with Grandin on *The Autistic Brain: Thinking Across the Spectrum,* which was published in April. Asked what he admires most about his co-author, Panek says, "The obvious answer is the work she does on behalf of people with autism, as well as their families, but what comes to mind first is what makes that work possible—that she’s learned how the world works. She’s had to figure out how people

**The Costco Connection**

The Autistic Brain and Animals Make Us Human, by Temple Grandin, along with the HBO film Temple Grandin, will be available in most Costco warehouses.
behave in order to modulate her own behavior accordingly, and that’s the behavior that makes her work on behalf of people with autism possible.”

Grandin says that watching the 2010 HBO film on her life was like traveling back in a time machine. She gave actress Claire Danes old family tapes and spent half a day with Danes, who taped her every move and ended up winning an Emmy for her performance. “Claire Danes became me,” Grandin says. “But the thing I loved is the movie showed cattle accurately, and I had a lot of input into that. It showed real cattle handling and something that was good for the public to see.”

The film significantly added to Grandin’s fame—she cut an equally distinctive figure in real life, with her signature cowgirl shirts, blue jeans and black boots—and she now speaks at large venues around the country.

“I’ve gotten moved to basketball stadiums, and that’s all happened since the movie,” she says. “A lot of people who come to events—1 estimate 75 or 80 percent of them—are probably interested in autism. But then there is another group interested in animals. One thing I am getting concerned about is I’m seeing too many kids who are considered mildly autistic come up to me and all they want to talk about is their autism. I’d rather have them tell me about their science project.”

Grandin lectures frequently about autism and animal husbandry around the country. Above, she appears with actress Claire Danes who portrayed Grandin in the 2010 HBO film on Grandin’s life.

or how they are training dogs or that they are in 4-H or they like to write science fiction. Tell me about what you like to do? Autism would totally take over if I let it, but I am not going to let it.”

For years, Grandin says, she was hypersensitive to sound and touch, but both have gotten manageable. “I am hugging people now,” she says. “Little kids who don’t want to be hugged, you need to work on desensitizing them. I’m a little better with sound, but I still have to have a quiet place to study when I do serious writing. But I do get distracted by motion. One thing that drives me crazy is photographers walking in front of me. I tell them to stop. If there is a video camera in the back of a room that just sits there, it’s no problem.”

“What are the worlds left for her to conquer? “There are things that would be really fun to do, like go to the Space Station, but I don’t think I will be doing that,” Grandin says. “But if I had a chance to go for a week, I would go. Definitely.”

Richard Deitsch is a freelance writer based in New York City.

Shaping Cosco’s policy

WHEN COSTCO SET out a decade ago to adopt a policy for the treatment of cattle being raised for beef, the first person company officials contacted for guidance was Temple Grandin.

Grandin helped Costco formulate animal welfare rules that apply to the operations of all of the companies that supply Costco with beef, veal, pork and poultry—a critical task, given that Costco is one of the world’s largest sellers of meat products.

Those policies were extended to companies that raise poultry for eggs and dairy cattle, explains Craig Wilson, Costco vice president of food safety and quality assurance.

“She is a tremendous sounding board and resource for us,” he says.

Costco’s policy addresses animal welfare and husbandry practices, including specific steps to ensure those practices are followed. When it was adopted, it was one of the first such programs among retailers, Craig says. Grandin helped train Costco’s meat-buying staff on animal welfare practices.

One key step was formulating an animal welfare scoring system. “Temple helped us develop it so that all of our suppliers are treated the same to ensure all animals are being treated properly,” Craig says. “That included helping our employees and our audit companies fully understand animal welfare from a very practical perspective.”

Costco still consults with Grandin on animal welfare issues whenever they arise.

—Tim Tulevich
Arizona teachers become the students at Summer Agricultural Institute

BY JOYCE LOBECK, SUN STAFF WRITER
July 8, 2007 - 12:02AM

Twenty teachers from around the state recently got a crash course in agriculture in Yuma County. They were participants in this year's Summer Agricultural Institute, held annually to educate the state's educators about the scope and value of agriculture in hopes they will take that awareness back to the classroom, said Monica Pastor, a University of Arizona Cooperative Extension agent in Maricopa County and coordinator for the program.

The goal is expose K-12 teachers to the diversity of agriculture in the state, provide motivation and resources for them to incorporate it into their lesson plans and demonstrate the career possibilities for their students, Pastor said.

"Many start with no background in agriculture," she said. "But we all eat, wear clothes, have a roof over our heads. We need to keep agriculture in this country."

Hundreds of teachers have participated since the program began 17 years ago. In past years, the five-day institute has visited various areas of the state. This year was Yuma County's turn.

"We've been avoiding Yuma because of the heat," Pastor said, "but there is so much agriculture here. It is the top agriculture area for the state."

The trip proved to be eye-opening. "We had never done seed distribution," she said. "We had never seen black-eyed peas, never seen dates processed." Pastor said the group also heard about the need for more students to go into science, whether in farming or agriculture-related careers such as research and technology development.

Among the participants were two teachers from eastern Yuma County. Even they were amazed at the scope of agriculture here, and the experience has them considering the many ways they can use what they learned and the resources they were given in their classrooms.

"Even with my background, I found out new things," said Judy Newman, a longtime Roll-area resident since the eighth grade whose family has been involved in agriculture. She was particularly impressed by "all the new high tech stuff. I'm very aware of laser leveling ... and knew about GPS (Global Positioning System), but I didn't realize how much it is used in farming."

Newman also said she was familiar with produce being grown in the fields, but a tour of the Dole salad processing plant gave her a new awareness and appreciation for Yuma County's fresh vegetable.

Newman, Joyce

She was an experienced teacher and had taught agriculture in her classroom. She wanted her students to gain more awareness of agriculture beyond the fields. She brought in people to talk about high tech in agriculture. She planned field trips to help her students become more aware of agriculture and bring them to the classroom. She had previously known one presenter, Marcos Moore, who works for the University of Arizona, and he talked about his work. He gave Newman the opportunity to go on a trip and meet people she had never met before. It was a nice trip for her students, and she said, "It's just not the guy in overalls." She shared her experience with her students, and they gained an awareness of what agriculture is about. She also appreciated gaining a network with other teachers to share ideas.

A highlight of the trip for Newman was listening to her fellow participants talk about how much the experience had changed their perception of agriculture and the people who labor to provide this nation's food. One said she had never met so many intelligent people, and Newman said, "They gained an awareness of what agriculture is about. It's not just the guy in overalls."

Sarah Rodriguez, who teaches seventh- and eighth-grade science at Wellton Elementary School, said the trip "re-energized me" and will be a big help in teaching science. "It was an eye-opening experience in how we can use our surrounding area in our teaching," she said. "Everything we observed was tied in with our curriculum and (teaching) standards. There are a lot of good ideas out there, but it's not always clear how we can tie it in. They gave us a lot of resources and even lesson plans." She also appreciates gaining a network with other teachers to share ideas.

Even though she was born and raised in Wellton, Rodriguez said she "learned so much about agriculture" and the importance of farming there to the region and nation. As a result, she not only will be able to share with her students the many opportunities in the industry, but also to help them gain "new pride in what their fathers do. Without them, we wouldn't have what we have today."

Both teachers would recommend the trip to others. "It was an inspiring week and educational," Newman said. Rodriguez expressed appreciation to her administrator for recommending her for the trip and to Wellton-Mohawk Irrigation and Drainage District for sponsoring her.

For more information, contact Monica Pastor, coordinator, at 1-602-470-8086 or mpastor@ag.arizona.edu.

Joyce Lobeck can be reached at jlobeck@yumasun.com or 539-6853.

More than 20 schoolteachers and administrators from throughout Arizona recently visited Maricopa to expand their knowledge of agriculture. All were participants in the annual Summer Ag Institute, a program presented by the University of Arizona Cooperative Extension.

Monica Pastor, associate agent for the extension in Maricopa County, said the program arose 17 years ago from a desire to bring the subject of agriculture into the classroom and to be able to do so without time restrictions and staff limitations.

"I may have gotten into a classroom one time in a school year for maybe half an hour," Pastor said. "We decided if we could train the teachers that we could have them in the classroom 180 days a year, all day long, if they wanted to incorporate agriculture into their lessons."

This year's five-day institute was held June 18-22, and encompassed hands-on activities and classes not only in Maricopa, but also in Phoenix, Yuma, Wellton and Stanfield.

On Thursday, June 21, the group visited the Maricopa Agricultural Center (MAC), a 2,100-acre educational research facility on Smith-Enke Road.

Outdoor activities included using a net to "sweep" an alfalfa field for insects, placing the insects in bags and then freezing them. Later, the group identified what kind of insects they had gathered and cataloged them as either "good" or "bad" bugs.

"(Sweeping) gives them an appreciation for how many insects they found because they go out in the field and ... they don't really see much. For every insect they see, there are probably 500 to 1,000 more they don't see," said Ed Minch, task leader and an Arizona Department of Agriculture retiree.
Participants also learned how to operate irrigation siphoning tubes and listened to presentations about cotton, plant science, the Gila River Community Project and Project WET (Water Education for Teachers).

The week's curriculum had a positive impact on the teachers. "The broad spectrum of farming and agriculture has really opened my eyes to a lot of things," said Lee Scott, a seventh- and eighth-grade teacher at Gilbert Junior High School. "We stayed with a farm family a couple of nights ago, and that was really neat because I would never have the time to just chat and get to know them. I was surprised at how much they are like me. It's been a really fun experience."

Anne Howe teaches fourth grade at Sacaton Elementary School in the Gila River Indian Community, which is home to the 16,000-acre Gila River Farms. It produces cotton, alfalfa and various food crops. "We've been asked by the tribe to work with the elementary school to get the students more interested in agriculture," she said. "I'm hoping to plant gardens and to do some kind of in-classroom agricultural activities, so that when the students get to middle school, where they have more agricultural options, they will participate in it."

Pam Petterborg, a seventh- and eighth-grade teacher at Gilbert Junior High School, said, "I'm all about food in the classroom, so I like to enhance the perspective of how food goes from the seed to the plate and all that's involved in the agricultural industry to produce it.

Mike Cox, principal of Alpine Elementary School, said he looks forward to sharing what he's learned with his staff. "It's going to help, especially with the AIMS science test coming up," he said.

Darryn Elliott, a second-grade teacher at Buckeye Elementary School, said the institute was "very beneficial."

Admission to the program is by application. The process requires a detailed account of the reasons for applying and an explanation as to what the applicant plans to do with what is learned. "We want to make sure we get good-quality teachers," Pastor said. "We accepted 22 teachers this year, and we have funding for up to 30. They pay an $85 registration fee, but it actually costs us $450 per person to present this program."

Funding is provided by the Arizona Foundation for Agricultural Literacy. Victor Jimenez, project leader for the Ag-Literacy program at MAC, said the Summer Ag Institute is one of several programs available.

"We reach all ages," he said, "from elementary school to high school through to the winter visitors and senior citizens who come from around the country."

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Animal Agriculture and Responsible Antibiotic Use

By Alun M. McClure, DVM with Hard Health Management, LP

Last month, CBS News producers created a special report on the use of antibiotics in livestock production. The piece, reported by Evening News anchor Katie Couric, is not a factual representation of the scientific, safe and careful use of antibiotics in animal agriculture. My lifetime of experience in animal agriculture makes their report seem to me biased and misleading. My parents who migrated from family farms in Oregon raised us in a small Southern California community with chickens and rabbits for meat and eggs. I worked my way through high school and college on farms and fruit orchards, a 12,000 head beef feedlot, and a university-owned dairy and milk processing plant. Professionally I have worked for 36 years with dairies, feedlots, cattle and sheep ranchers in 12 states in the U.S. and in Mexico.

Without exception I have found these owners and managers to be very concerned about the ethical treatment and welfare of their animals, including the responsible use of antibiotics. They have been interested in scientific and applied research, and have worked diligently to improve every aspect of herd health and implement management programs to prevent disease and minimize the need for the use of antibiotics.

Last week I was leaning against a fence post on a third generation family dairy farm in Arizona pondering how I might respond to the CBS report since I’d gotten word they’d be airing a story on the subject. While I was reflecting, I was watching cows returning from the milking parlor playfully loping back to their pen and rapidly placing their heads side by side through the self-locking stanchions to eat. They were voraciously consuming a well-balanced total mixed ration of locally grown forages, processed grains and agricultural by-products. They had just been calmly milked by caring professional milkers using state-of-the art milking equipment. These cows walk to and from their pen twice a day on dry, padded concrete walkways to be milked. They are bedded on clean, dry and comfortable bedding in open dry lots and under shades that protect them from the elements in the winter and cool them with water spray and fans in the summer. This family has implemented many technologies to now efficiently and humanely manage thousands of milk cows better than when they started with 40 cows years ago. These cows have never been fed antibiotics, and are only treated with antibiotics when needed to cure or prevent a bacterial infection to prevent pain, suffering and death, to enable these cows to achieve their potential to feed us and a starving world with safe, wholesome, and affordable food. That is how less than 1% of the U.S. population is involved in agriculture and can provide for the other 99% and have surplus to export to developing nations.
How are antibiotics used in animal agriculture? Besides treatment of an individual sick animal, after every possible effort has been made to successfully manage genetics, housing, environment, nutrition, feeding, vaccination and other herd or flock health practices, antibiotics may be used in feed or water to treat, control or prevent disease and to promote growth and feed efficiency. This use has been proven to improve animal health and welfare (less disease and mortality), improve growth and feed conversion (reduces bad bacteria; promotes good bacteria), and improve food safety.

I welcome open dialogue and evaluation of our agricultural production practices. It can only make us better. I do ask the evaluation to be scientific and objective, and the reporting to avoid sensationalism, hyperbole, and misleading statements aimed at inflaming opinion. The CBS News report is extremely critical of the use of antibiotics in agriculture, repeating the oft-stated but unsupported assertion that there is an alarming rise in the incidence of antibiotic resistant bacteria among farm animals. I have not recognized this as a problem in 36 years of dairy practice. Surveillance data regarding bacterial isolates from cattle by the National Antimicrobial Resistance Monitoring System does not support their claim either.

Opponents of antibiotic use in food animals claim that we don’t need antibacterials to produce meat and eggs, that their use has lead to a significant increase in antibiotic resistant bacterial infections in humans, and that their use reduces the effectiveness of human medicines. In 1999, the Heidelberg Appeal Nederland Foundation, renowned for its unbiased scientific research, conducted a study on the effect of antibiotics used for growth promotion in food animals, and concluded that there was no conclusive evidence that their use contributed to human disease or compromised the efficacy of related antibiotics in human medicine.

After growth-promoting antibiotics were legislatively banned in food animals in Denmark in 1999 in an attempt to protect public health from antibiotic resistance, there has been no reduction in the incidence of antibiotic-resistant hospital isolates in humans. In some cases resistance has increased and the incidence of some types of infections in humans has also increased. Unfortunately, disease and mortality have increased among animals, producing adverse animal welfare conditions. As a result, to treat the higher incidence of disease in animals in Denmark, it has been necessary to increase the use of antibiotics for therapeutic treatment in animals. The use of antibiotics in humans has also increased. The increased health costs and labor and the reduction in growth and feed conversion in pigs have resulted in increased production costs of $5.29 per pig.

Some purport that antibacterial-free farming makes food safer. The truth is that antibiotic use in food animals makes them healthier which makes our food safer. Chickens raised without antibiotics are three times more likely to carry bacteria that can make people sick. When the EU phased out certain antibiotic uses there was no discernable improvement in food safety. Food handling and preparation has a much greater impact on food safety. In the U.S., food-borne pathogens decreased by 15 to 49% from 1996 to 2001 following the implementation of the new FSIS/HACCP (Food Safety Inspection Service/Hazard Analysis Critical Control Points) regulations. Proper food handling and cooking prevents human infection by food-borne pathogens.

Some bacteria are naturally resistant to certain antibiotics; others acquire resistance by genetic mutation over time; and some acquire resistance after exposure to an antibiotic used in human medicine or animal production. For a person to have an antibiotic treatment failure due to acquiring a foodborne bacterial disease from eating, for example, pork, the following things would have to happen:

- The antibiotic would be used in the animal;
- The animal would have to develop a resistant bacterial strain;
- The resistant strain would have to survive through food processing/handling;
- The resistant strain would have to survive through food preparation;
- The resistant strain would have to transfer to the human;
- The resistant strain would have to colonize;
- The resistant strain would have to cause a disease; and
- The antibiotic treatment would have to fail.

What is the probability of a person experiencing a treatment failure due to antibiotic use in swine? Here are some risk comparisons:

<table>
<thead>
<tr>
<th>Risk Comparison</th>
<th>Annual Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being struck by lightning</td>
<td>1 in 550,000</td>
</tr>
<tr>
<td>Dying from a bee sting</td>
<td>1 in 6 Million</td>
</tr>
<tr>
<td>Dying from a dog bite</td>
<td>1 in 18 million</td>
</tr>
<tr>
<td>Acquiring resistant campylobacter from macrolide-treated swine resulting in treatment failure</td>
<td>&lt; 1 in 53 million</td>
</tr>
<tr>
<td>Acquiring resistant <em>E. faecium</em> from macrolide-treated swine resulting in treatment failure</td>
<td>&lt; 1 in 21 million</td>
</tr>
</tbody>
</table>

It’s easy for me to say that antibiotic resistant bacteria are not a problem when I haven’t personally experienced such an infection, but that’s meaningless to a person who has. It’s like trying to console a person who has been unable to find work for six months by informing them that the national unemployment rate is only 10%. In fact, while competing in high school athletics my daughter got a nasty skin infection on her leg caused by antibiotic resistant staphylococcal bacteria (MRSA). A few months later my wife got a lip infection caused by the same type of bacteria. These infections did not come from animal agriculture nor did the antibiotic resistance. The resistance is real but many scientists believe the primary cause is misuse (over prescribing) of antibiotics in human medicine and/or failure of patients to complete the prescribed regimen.

Antibiotic use in animal agriculture is by or on the order of a licensed veterinarian using antibiotics approved by the FDA, having passed its stringent testing requirements for efficacy and safety (for animals, our food and the environment). All major industry associations have established prudent drug usage guidelines: the American Veterinary Medical Association, American Association of Bovine Practitioners, American Association of Swine Veterinarians, American Association of Avian Pathologists, National Chicken Council, National Pork Board, National Cattlemen’s Beef Association, and others. These guidelines and FDA oversight insure that antibiotic use in food animals will protect animal health and welfare leading to production of safe, affordable and abundant food, critical to our U.S. food security.

Maintaining the health of U.S. herds and flocks requires agriculture producers and their veterinarians to have all approved safe and effective technologies, including animal health products, available to us. It would be a tragedy for misconceptions, misrepresentations or non-science based political agendas to deprive us of any valuable tools for preventing animal disease without substantial evidence of a benefit to human health.

*Editor’s Note: Many of Dr. McClure’s clients are members of the United Dairymen of Arizona and the Arizona Farm Bureau.*
Corporate Environmentalism is Generating Big Green

Want to Know How Charitable Donations Really Work?

By Stefanie Smallhouse
Arizona Farm Bureau Second Vice President

Having recently concluded that time of year when the dining room table was buried in paper, we pored over receipts, notes scribbled on the checkbook, cancelled checks, deposit records, and of course our charitable donations. According to Giving USA, Americans contributed a total of $307.7 billion to charity in 2008. For those donations going to environmental organizations to save anything and everything, have you ever wondered what you get for your donated dollar?

I suggest the last time you hung up your shower towel at the Holiday Inn instead of dropping it on the floor (this is code for don’t waste precious water on providing me with another fresh towel since theoretically I was clean when I dried off anyway) resulted in a more genuine investment for the environment than the check you wrote to Big Green.

Your donation to one of the big corporate environmental groups – Sierra Club, The Nature Conservancy, or Natural Resource Defense Council to name a few – most likely went to pay for litigation or buying land, but what was the on-the-ground result for conserving anything? How did the cactus ferruginous pygmy owl benefit from your generous donation? How was your dollar used to stop erosion along Arizona’s river ways, or improve water quality along the Colorado River?

In 2008, $758 million was donated to The Nature Conservancy, $43 million to the Sierra Club, and $108 million to the Natural Resources Defense Council (NRDC). The NRDC prides itself on “defeating, blocking, and freezing” through litigation any action that it deems harmful to the earth. But I was unable to find any on-the-ground work that they are doing to actively conserve natural resources. Apparently this organization is the self-appointed legal representation for Mother Nature and that’s it.

The self-appointed realtor happens to be The Nature Conservancy (TNC). Unfortunately, Mother Nature is hard to pin down, so not only does the sales commission go to TNC, but so does all the profit. For example TNC currently has land for sale along the San Pedro River in southeast Arizona acquired as 2,156 acres of contiguous farm land and now subdivided by TNC into 5 parcels with the option of splitting further into 10. This land could have remained unfragmented and seeded with native grasses, but instead has been left to a hostile takeover by invasive woody plants that use significantly more water than farm land.

Other large expanses of land have either been donated to the organization to take advantage of tax
credits or sold to TNC for less than appraised value and then in turn flipped to the federal government for more than appraised value. This organization is in the business of nationalizing private land for a profit, while shrinking the tax base for our schools and community infrastructures.

Purchasing agricultural land, beautiful landscapes, and waterways facing no eminent threat of destruction should not exactly qualify for saving anything. To other environmental groups this is considered to be focusing on “sub-national targets.” These targets generate revenue directly for the non-profit and would be very valuable on a carbon offset market. This is the same carbon market that would be created following passage of a cap and trade taxation system fiercely lobbied for by these same groups.

This type of focus results in what is called “leakage” in environmental language. A specific action stopped in one area only shifts or leaks the same action into other areas, but is in no way diminished. It does not result in any on the ground conservation work. I know of a few old mine reclamation sites that could sure use some of Nature Conservancy’s $758 million annual revenue for re-seeding and erosion control. Of course those pieces of land are neither profitable for flipping nor for carbon credits.

It’s no wonder that the spectrum of environmental groups ranging from land baron organizations like TNC to small potato radical organizations like the Center for Biological Diversity (CBD) are eating their own. CBD is trying to change policy on a national level to send us back to the 17th century, while TNC is subdividing farm land, and the Sierra Club in return for corporate cash is providing its stamp of approval on cleaning products sold as “green” chemicals to flush down your toilet. Where are your conservation dollars in all of this? Despite their differences, all of them are successfully using your donations for systematically dismantling roads, dams, logging, mining, ranching, farming, fishing, and manufacturing throughout the United States — forcing industry to move across international boundaries and oceans unregulated; All the while increasing the costs of agriculture production by those few left in this country.

Remember that shrinking tax base I mentioned before? Maybe your donation would be better spent going toward your local education tax credit to make up for the loss in property tax base to the school.

*Editor’s Note: Stefanie Smallhouse is married to a fifth-generation farmer and rancher in Southern Arizona. She previously worked for a federal land management agency as a wildlife biologist, and is currently working to further conservation of Arizona’s natural resources through the locally led efforts of Arizona landowners.*
*** Journaling ***
It takes a group of dedicated individuals to pull together all the pieces and put on a program such as this. The Summer Agricultural Institute would like to thank the SAI Planning Committee for all their efforts to organize and coordinate the entire week of activities.

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University of Arizona Cooperative Extension, Maricopa County

Committee Members

Ashley Estes  Arizona Department of Agriculture
Ashley Schimke  Arizona Department of Education
Bruce Watkins  Arizona Department of Education
Colleen Bergum  Dairy Council of Arizona
Farm Family Hosts  Local Farmers and Ranchers
Jeannette Fish  Maricopa County Farm Bureau
Jennifer Weber  Arizona Department of Agriculture
Jimmy Wojcik  Arizona Agribusiness & Equine Centers
Katie Aikins  Arizona Farm Bureau
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Tiffany Selchow  Arizona Beef Council
Tyler Grandil  Arizona Department of Education
Victor Jimenez  U of A Maricopa Agricultural Center

HAVE A GREAT SUMMER!