USDA

United States Department of Agriculture

Agroforestry:

USDA Reports to America, Fiscal Years 2011–2012—Comprehensive Version

Message From the Secretary

In June 2011, when we released the *USDA Agroforestry Strategic Framework, Fiscal Year 2011-2016*, I committed that the U.S. Department of Agriculture (USDA) would increase its efforts to advance the science, practice, and application of agroforestry across the country because I believe it has a key role to play in enhancing America's rural economy and increasing our resilience to climate change—at the same time.

Agroforestry is the intentional mixing of trees and shrubs into crop and animal production systems to benefit our economy, our environment, and our society. At its core, it is about putting trees to work for farms, ranches, woodlands, and communities.

As part of a larger suite of multicropping practices, agroforestry systems such as silvopasture, alley cropping, and forest farming provide farmers and ranchers with strategies to manage risk, whether it stems from uncertain markets or extreme weather patterns. Wider use of agroforestry can help diversify incomes because these systems enable farmers to produce several products all on one piece of land. Agroforestry will also increase the resilience of our agricultural lands to a changing climate because trees and shrubs tend to handle droughts and floods better than annual crops, and we expect to have more extreme weather in the years to come.

Agroforestry is not a new concept and has been practiced by indigenous people here and around the world for generations. In more recent times, however, its use has been limited in the United States because modern agriculture and forestry systems developed somewhat concurrently but without much interaction. Today, USDA estimates that agroforestry is practiced on less than 1 percent of the suitable land in the United States, but we know great potential exists.

Thus, it is with great pleasure that I present to you an insider's view of the U.S. agroforestry landscape: *Agroforestry: USDA Reports to America, Comprehensive Version, Fiscal Years 2011-12*. This report was written under the guidance of the Agroforestry Executive Steering Committee, a team of senior leaders from eight USDA agencies. It synthesizes the agroforestry efforts that the USDA supported during the past 2 years and the next steps we plan to take to further implement the *Strategic Framework*. Especially noteworthy are the enterprising people engaged in agroforestry who allowed us to highlight their great work in 15 case studies contained in this report—from silvopasture pioneers in Georgia and Alabama to an Alaska Native corporation that manages its tree canopy to ensure plentiful blueberry harvests.

The report is organized around the *Strategic Framework's* three simple yet all-encompassing goals: (1) Adoption, (2) Science, and (3) Integration, and it is available in both long and short versions. The longer and more comprehensive version may be more useful to agroforestry practitioners, scientists, and other key stakeholders, while the shorter version is intended for those who may be new to agroforestry and USDA resources.

If you are like me, you too will be surprised and impressed with the scope and depth of USDA-supported agroforestry activities even though they comprise less than 1 percent of our funding. It seems that in this time of shrinking budgets, cross-disciplinary partnerships, such as those inherent in agroforestry, are the key to success.

USDA has established an e-mail address (agroforestry@USDA.gov) to which you can send us comments about the report and USDA's role in agroforestry. We look forward to hearing from you and learning about how you put agroforestry to work on your farm, on your college campus, and in your community.

Thomas J. Vilsack
Secretary of Agriculture

Executive Summary

Introduction

To advance agroforestry as a way to enhance the Nation's agricultural landscapes, watersheds, and rural communities, U.S. Department of Agriculture (USDA) Secretary Tom Vilsack and Deputy Secretary Kathleen Merrigan released the *USDA Strategic Framework for Agroforestry, Fiscal Year 2011-2016* (hereafter referred to as the *Strategic Framework*) in June 2011. It provides a roadmap for advancing the science, practice, and application of agroforestry, and it directs USDA to report annually on its accomplishments, outcomes, and financial commitments to agroforestry.

Responding to that direction, this is the **first ever technical report of USDA's role in agroforestry**, which provides a comprehensive view of the ways entrepreneurs, early adopters, scientists, natural resource and extension professionals, and Government officials advanced agroforestry in fiscal years 2011–12, how USDA supported those efforts, and USDA's 15 key next steps. This report is organized around the *Strategic Framework*'s three goals: (1) Adoption, (2) Science, and (3) Integration; and also has a section on (4) Next Steps.

Highlights of the report include the following:

- 15 case studies that highlight the enterprising ways Americans are advancing agroforestry;
- maps of agroforestry demonstration sites, research locations, and on-the-ground applications;
- a list of nearly 200 peer-reviewed agroforestry publications; and
- a guide to agroforestry-relevant USDA resources.

> Agroforestry is the intentional mixing of trees and shrubs into crop and animal production systems to create environmental, economic, and social benefits
>
> *USDA Agroforestry Strategic Framework, Fiscal Year 2011-2016*

Who prepared the report? An Agroforestry Executive Steering Committee composed of eight USDA agencies guides implementation of the *Strategic Framework* with staff support from an Interagency Agroforestry Team. These eight agencies follow:

- Agricultural Marketing Service
- Agricultural Research Service (ARS)
- Farm Service Agency (FSA)
- Forest Service
- National Agricultural Statistics Service (NASS)
- National Institute of Food and Agriculture (NIFA)
- Natural Resources Conservation Service (NRCS)
- Rural Development

Additionally, the following USDA agencies and offices also provided important information and review to support the report:

- Economic Research Service
- Foreign Agricultural Service
- Office of Budget and Program Analysis
- Office of the Chief Scientist
- Research, Education, and Economics Mission Area Office

What is agroforestry? Five widely recognized categories of agroforestry practices can be designed and applied to accomplish many of the goals in the USDA Strategic Plan, including bioenergy production,

resilience to climate change, sustainable agriculture, clean and abundant water, and economic revitalization of rural communities. These five categories follow:

- **Windbreaks** shelter crops, people, animals, buildings, and soil from wind, snow, dust, and odors. (Windbreaks are also called **shelterbelts, hedgerows**, or **living snow fences**.)
- **Riparian forest buffers** are areas along rivers and streams planted with trees, shrubs, and grasses. They serve as sponges to filter farm runoff, and the roots stabilize streambanks to prevent erosion.
- **Silvopasture** combines trees with livestock and their forages on one piece of land.
- **Alley cropping** means planting crops between rows of trees to provide income while the trees mature.
- **Forest farming** operations grow food, herbal, botanical, or decorative crops under the protection of a managed forest canopy. (Forest farming is also called **multi-story cropping**.)

USDA Financial Commitments to Agroforestry

Seven USDA agencies[1] reported a total of approximately $333 million obligated to agroforestry activities in FY 2011–12, which represents less than 1 percent of USDA total obligations during those 2 years (see appendix A).[2] FSA and NRCS financial commitments were the largest, comprising 95 percent of the total because of the technical and financial assistance they provide through conservation programs (e.g., Conservation Reserve Program and the Environmental Quality Incentives Program). Windbreaks and riparian buffers accounted for 99 percent of the financial assistance provided through these conservation programs, with silvopasture, alley cropping, multicropping, and edible forest buffers accounting for the rest.

Goal 1—ADOPTION

Desired Outcome: *Landowners, managers, tribes, and communities adopt agroforestry practices resulting in improved water, soil, and air quality; sustainable agriculture; product diversity; and rural wealth.*

Landowner adoption and application of agroforestry practices in the United States is currently very low. No national database or inventory of agroforestry practices exists largely because most of the plantings are too small to be classified as forest land and thus are not included in Forest Service and NRCS inventories. Considerable potential exists for agroforestry, however, based on 5 years of reports from agroforestry practices applied through USDA conservation program and current land use data. During FY 2008–12, USDA provided assistance to apply windbreaks, riparian forest buffers, and alley cropping on 336,000 acres, or less than 1 percent of U.S. cropland with potential for agroforestry (372 million acres).[3] The application of both silvopasture and forest farming was also less than 1 percent of U.S. pasture, grazed forest land, and ungrazed forest land.

The three objectives in Goal 1 focus on forming partnerships, educating professionals, and engaging in the global community. Accomplishments include the following:

- Established the Forest Farming eXtension Community of Practice.
- Established a council to coordinate McIntire-Stennis Cooperative Forestry Research funding and help advance agroforestry research, extension, and education at 1890 land-grant universities.
- Formed multistate interagency agroforestry working groups in the Chesapeake Bay, Midwest, and Pacific Islands.
- Played a supporting role in 40 agroforestry demonstration sites.

[1] AMS, ARS, FSA, Forest Service, NIFA, NRCS, and RD.

[2] 2014 USDA Budget Explanatory Notes for Committee on Appropriations

[3] Major Uses of Land in the United States, 2007 (Table 2).

- Assisted in the application of 175,000 acres of agroforestry practices, with most being riparian forest buffers (77 percent) and windbreaks (22 percent).
- Funded first agroforestry academy for resource professionals through USDA's Sustainable Agriculture Research and Education program. The program will be conducted in five Midwest States in 2013–14.
- Signed Memorandum of Understanding to enhance cooperation between the National Agroforestry Center and Agriculture and Agri-Food Canada's Agroforestry Development Centre.

Goal 2—SCIENCE

Desired Outcome: *Tailored science-based agroforestry tools are created and used by landowners, managers, tribes, and communities to address complex environmental, economic, and social conditions across all lands.*

The three objectives of this goal address **planning** to advance agroforestry science, conducting the research (**discovery**), and **translating** it into useful tools. Accomplishments include the following:

- Supported 69 agroforestry research projects that were focused in the following 5 areas (number of projects):
    - **Natural Resources, Ecosystem Services, and Environmental Markets** (22), with specific focus on water (6), pollinators (1), soil (3), air (1), carbon (7), and multiple environmental services (4).
    - **Agroforestry Systems** (31), with specific focus on silvopasture (8), alley cropping (3), forest farming (8), windbreaks (1), and edible tree crops (9).
    - **Climate Change Resiliency** (2).
    - **Bioenergy (7)**.
    - **Economics and Profitability** (7).
- Through USDA scientists and partners at 41 land-grant universities and 6 non-land-grant institutions, authored nearly 200 agroforestry-related peer-reviewed publications.
- Added the agroforestry module to the Forest*A*Syst, a Web-based tool that helps landowners develop a management plan and connect with resource professionals.
- Published and distributed *Profitable Farms and Woodlands: A Practical Guide in Agroforestry for Landowners, Farmers, and Ranchers*. Developed with 1890 and 1862 land-grant universities to help limited-resource producers in the Southeast consider agroforestry as an option for their land/operation.
- Won awards for USDA scientists work on citizen science and nontimber forest products, a Conservation Buffers Guide that synthesized 1,400 publications and has been translated into 6 languages by interested foreign collaborators, and the National Agroforestry Center collaboration with Forest Service and NRCS. The American Association for the Advancement of Science, the world's largest scientific society, selected this collaboration as an exemplary collaborative case study.

Goal 3—INTEGRATION

DesiredOutcome: *USDA agencies understand, use, and integrate agroforestry into their policies and programs to maximize benefits and services to citizens.*

This goal aims to institutionalize agroforestry in USDA polices, programs, and activities; assess performance; and communicate results. Accomplishments include the following:

- Chartered the USDA Agroforestry Executive Steering Committee to guide implementation of the *Strategic Framework*, including this report.
- Received approval from the Secretary for the USDA Departmental Regulation on agroforestry.
- Had the first agroforestry practice question included in USDA's 2012 Census of Agriculture.
- Completed USDA Agroforestry Communication Plan.
- Published the first ever USDA report on agroforestry, including a 3[4]-year budget and performance crosscut that serves as a model for future reports (this report).
- Included agroforestry in USDA action/strategic plans, as conservation practices, and in grant program requests for proposals.

NEXT STEPS—FY 2013–14

The USDA Agroforestry Executive Steering Committee will continue to implement the *Strategic Framework*. Below are some of their priority activities and their associated *Strategic Framework* goals:

Establish a Tribal Relations Agroforestry Working Group to expand agroforestry outreach activities with tribal organizations (Goal 1).

Expand the establishment of silvopastures in the Southeast with a focus on limited-resource and minority landowners with pine plantations and expiring Conservation Reserve Program contracts who are (1) engaged in livestock production and (2) interested in restoring the longleaf pine ecosystem (Goal 1).

Establish a USDA Agroforestry Science Working Group to coordinate agroforestry science carried out and used by ARS, NASS, NRCS, NIFA, Forest Service, and other USDA science agencies to accomplish high-priority strategies of the *Strategic Framework* (Goal 2).

Increase agroforestry literacy across USDA and with cooperators (Goals 1 and 3).

Review the results of the agroforestry question in the 2012 Census of Agriculture to understand potential barriers to adoption and how to best target program resources (Goal 3).

Enhance USDA communication about agroforestry to increase the understanding and awareness of agroforestry and its benefits to producers, communities, and the Nation (Goal 3).

Invite feedback by establishing agroforestry@USDA.gov to gather inquiries and comments about this report and about the *Strategic Framework* (Goal 3).

[4] Actual FY 2013 budget figures were not available at the time the report was compiled.

Acknowledgements

This report was a collaborative effort produced under the leadership of the Agroforestry Executive Steering Committee:

- **Frank Boteler**, Assistant Director, National Institute of Food and Agriculture (NIFA) (Chair)
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We wish to thank the following individuals for their time and effort to produce and review this comprehensive report of USDA agroforestry activities. Those who are members of the **Interagency Agroforestry Team** (working group that supports the Agroforestry Executive Steering Committee) are denoted with an asterisk (*).

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Acronyms

A&M	Agricultural and Mechanical
AAFC	Agriculture and Agri-Food Canada (Canada's Department of Agriculture)
AAMU	Alabama A&M University (Huntsville, AL)
ADC	Agroforestry Development Centre (part of AAFC)
AFRI	Agriculture and Food Research Initiative (NIFA program)
AgMRC	Iowa State Agricultural Marketing Resource Center
AMA	Agricultural Management Assistance Program (NRCS program)
AMS	Agricultural Marketing Service
ARS	Agricultural Research Service
AWEP	Agricultural Water Enhancement Program
BCAP	Biomass Crop Assistance Program
CBWI	Chesapeake Bay Watershed Initiative
CCPI	Cooperative Conservation Partnership Initiative (NRCS program)
CINRAM	Center for Integrated Natural Resources and Agricultural Management—University of Minnesota
CREP	Conservation Reserve Enhancement Program (FSA program)
CRP	Conservation Reserve Program (FSA program)
CSP	Conservation Stewardship Program (NRCS program)
EQIP	Environmental Quality Incentives Program (NRCS program)
EWP	Emergency Watershed Protection Program
FAO	United Nations' Food and Agriculture Organization
FAS	Foreign Agricultural Service
FIA	Forest Inventory and Analysis (Forest Service program)
FRRE	Forest and Rangeland Research (Forest Service Research and Development program budget code)
FSA	Farm Service Agency
FSC	Federation of Southern Cooperatives/Land Assistance FunD
FY	Fiscal Year
Forest Service R&D	Forest Service Research and Development (Deputy Area)
Forest Service S&PF	Forest Service State and Private Forestry (Deputy Area)
GRA	Global Research Alliance for Agricultural Greenhouse Gases
HFRP	Healthy Forests Reserve Program
IDEA	Integrated Data for Enterprise Analysis
INCA	Indian Nations Conservation Alliance
MAAWG	Mid-American Agroforestry Working Group
MOU	Memorandum of Understanding
NAC	National Agroforestry Center (Forest Service-NRCS partnership)
NACD	National Association of Conservation Districts
NASF	National Association of State Foresters
NASS	National Agricultural Statistics Service
NC A&T	North Carolina Agricultural and Technological State University
NIFA	National Institute of Food and Agriculture
NRCS	Natural Resources Conservation Service
NTFPs	Nontimber forest products
NRI	National Resources Inventory (NRCS program)
OWC	Oregon Woodland Cooperative
RD	Rural Development
REE	Research, Education, and Economics (Mission Area)
RREA	Renewable Resources Extension Act Program (NIFA program)

S#	Refers to one or more of the 40 strategies in the *USDA Agroforestry Strategic Framework*. The # is replaced with the corresponding strategy number from the *Strategic Framework*.
SAF	Society of American Foresters
SARE	Sustainable Agriculture Research and Education (NIFA program)
SCRI	Specialty Crop Research Initiative (NIFA program)
SPCH	Forest Health Management—Cooperative Lands (Forest Service State and Private Forestry program budget code)
SPS2	State Fire Assistance – National Fire Plan (Forest Service State and Private Forestry program budget code)
SPST	Forest Stewardship (Forest Service State and Private Forestry program budget code)
SPUF	Urban & Community Forestry (Forest Service State and Private Forestry program budget code)
STEWARD	Sustainable and Thriving Environments for West African Regional Development (Forest Service & USAID)
TSP	Technical Service Provider (USDA/NRCS program term)
TCD	Tribal Conservation District
UMCA	University of Missouri Center for Agroforestry
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
VAPG	Value Added Producer Grant (RD program)
Virginia Tech	Virginia Polytechnic Institute and State University (Blacksburg, VA)
WRP	Wetlands Reserve Program (NRCS program)
WHIP	Wildlife Habitat Incentive Program (NRCS program)

Contents

List of Figures and Tables

Introduction

What Is Agroforestry?

Agroforestry is the intentional mixing of trees and shrubs into crop and animal production systems to create environmental, economic, and social benefits

For a land-use practice to be called agroforestry, it typically must satisfy the four "i"s: intentional, intensive, integrated, and interactive.[5] Five widely recognized categories of agroforestry practices exist in the United States:

Windbreaks shelter crops, people, animals, buildings, and soil from wind, snow, dust, and odors. (Windbreaks are also called **shelterbelts, hedgerows**, or **living snow fences**.)

Riparian forest buffers are areas along rivers and streams planted with trees, shrubs, and grasses. They serve as sponges to filter farm runoff, and the roots stabilize streambanks to prevent erosion.

Silvopasture combines trees with livestock and their forages on one piece of land.

Alley cropping means planting crops between rows of trees to provide income while the trees mature.

Forest farming operations grow food, herbal, botanical, or decorative crops under the protection of a managed forest canopy. (Forest farming is also called **multi-story cropping**.)

Agroforestry practices can be designed and applied to accomplish many of the goals in the U.S. Department of Agriculture (USDA) Strategic Plan, including the following:

bioenergy production,

resilience to **climate change,**

sustainable agriculture,

clean and abundant **water,** and

economic revitalization of **rural communities.**

[5] Chapter 3 in Garrett, H.E. 2009.

What Is the USDA Agroforestry Strategic Framework?

The Secretary published the *USDA Strategic Framework for Agroforestry, Fiscal Year 2011-2016* (hereafter referred to as the *Strategic Framework*) in June 2011 to create a roadmap for advancing the science, practice, and application of agroforestry.

Five USDA agencies and two partners—the National Association of Conservation Districts and the National Association of State Foresters—developed the *Strategic Framework.* In addition, a diverse group of more than 90 stakeholders provided input at the Agroforestry Roundtable Workshop, which was held May 26, 2010, in Washington, DC.

To assist the country in addressing today's challenges, USDA committed to three overarching goals:

Goal 1—Adoption: Increase use of agroforestry by landowners and communities.

Goal 2—Science: Advance the understanding of, and tools for, applying agroforestry.

Goal 3—Integration: Incorporate agroforestry into an all-lands approach to conservation and economic development.

Each goal has three objectives and a total of 40 strategies that describe specific supporting actions.

The *Strategic Framework's* goals and objectives are shown in figure 1 on the next page.

Figure 1.—Strategic Framework goals and objectives

Goal 1: Adoption
Increase use of agroforestry by landowners and communities

Goal 1 Objectives:

1.2 Develop Partnerships: Expand learning partnerships with stakeholders, with a priority on tribes and underserved and minority audiences.

1.2 Educate Professionals: Enable natural resource professionals to provide technical, educational, financial, and marketing assistance.

1.3 Engage Globally: Support the exchange of agroforestry technology between the United States and other countries.

Goal 2: Science
Advance the understanding of, and tools for, applying agroforestry

Goal 2 Objectives:

2.1 Plan: Identify, assess, and prioritize interagency agroforestry science and technology needs, opportunities, and investments.

2.2 Discover: Conduct interagency, multidisciplinary research to advance agroforestry science and technologies.

2.3 Translate: Move agroforestry innovations into products and services.

Goal 3: Integration
Incorporate agroforestry into an all-lands approach to conservation and economic development

Goal 3 Objectives:

3.1 Institutionalize: Incorporate agroforestry into USDA policies, programs, and activities.

3.2 Assess Performance: Account for and monitor agroforestry impacts and applications.

3.3 Communicate Results: Promote awareness and appreciation of agroforestry.

What Is This Report?

This report is a comprehensive review of the activities USDA has taken in the first 2 years (Federal fiscal years 2011–12) since the adoption of the *USDA Agroforestry Strategic Framework, Fiscal Year 2011-2016*. It also describes future actions that USDA and its partners should consider implementing to achieve the vision and desired outcomes set forth in the *Strategic Framework*.

The preparation of this report is 1 of the 40 strategies included in the *Strategic Framework* under Goal 3, Objective 3.1: "Report annually to the Secretary of Agriculture, including a review of USDA financial commitments to agroforestry, accomplishments, and outcomes."

How Is the Report Organized?

The organization of this report corresponds to the organization of the *Strategic Framework* (figure 1). The information contained herein is aligned with the three goals (adoption, science, and integration) and the nine underlying objectives.

Under each of the nine objectives, the report is further divided into two sections that describe **accomplishments** and **next steps,** which include the original 40 strategies and additional efforts. Strategies that have been completed are described in the "accomplishments" section; strategies not completed are discussed in the "next steps" section. An "(S1)" to the left of the activity descriptions denotes that the activity corresponds to strategy 1 under the same objective of the *Strategic Framework*.

In addition, the activities related to each objective are organized by **regions** because agroforestry systems are site-specific and vary geographically. This report uses the four Natural Resources Conservation Service (NRCS) regions plus an additional "Islands" region that includes islands in both the Caribbean and Pacific regions (see fig. G1 in appendix G).

At the end of each bulleted activity, a parenthetical note cites the USDA agency partners and supporting programs, if applicable.

Objectives under Goals 1 and 2 have corresponding **case studies** (appendix D) that illustrate how people are advancing the science, practice, and/or application of agroforestry with the assistance of USDA. Appendixes A through K include additional supporting information.

What Do YOU Want To Find in This Report?

Learn from others: To read specific examples of how individuals and organizations have used USDA programs to—

1. **Adopt agroforestry practices**, refer to Objectives 1.1 (Partnerships), 1.2 (Educate Professionals), and 1.3 (Engage Globally);
2. **Advance agroforestry science and extend knowledge**, refer to Objectives 1.2 (Educate Professionals), 1.3 (Engage Globally), 2.2 (Discover), and 2.3 (Translate).

Find USDA resources: To learn how USDA programs and information can strengthen your research and extension activities or help you implement agroforestry practices, refer to appendix J.

Opportunities to collaborate and partner: To learn about ways to work with USDA and its partners to advance the science and application of agroforestry, read about the efforts underway in Goals 1 and 2. To contact any of the USDA agencies, see the USDA agroforestry points of contact in appendix K.

Learn USDA's next steps for agroforestry: To learn what USDA plans next, see the "Next Steps" section under each objective and at the end of the document.

Talking points for leadership: To find agroforestry information regarding the USDA agencies that provided the assistance—

1. Search this report for the agency acronym [e.g., ARS (Agricultural Research Service), AMS (Agricultural Marketing Service, FSA (Farm Service Agency), Forest Service, NASS (National Agricultural Statistics Service), NIFA (National Institute of Food and Agriculture), NRCS (Natural Resources Conservation Service), or RD (Rural Development)]; or
2. Refer to appendix D, which lists the case studies, agroforestry practice highlighted, and supporting agencies.

Goal 1: ADOPTION

Increase use of agroforestry by landowners and communities

Desired Outcome: Landowners, managers, tribes, and communities adopt agroforestry practices resulting in improved water, soil, and air quality; sustainable agriculture; product diversity; and rural wealth.

Introduction

Ideally, to understand agroforestry adoption by landowners and communities in the United States and report on progress toward Goal 1 (Adoption), we would have demographics about the adopters and information about where, how much, and what type of agroforestry practices exist across the country. No such information currently exists, however, because no national survey focuses specifically on agroforestry.

Moreover, many agroforestry practices are relatively linear and small and therefore missed by the two national natural resource inventories: the Forest Inventory and Analysis (Forest Service) and the National Resources Inventory (Natural Resources Conservation Service).

Until 2012, the U.S. Census of Agriculture[6] made no mention of agroforestry; thus, no reliable information exists about the number of producers applying such practices on their land. In 2012, however, the first-ever agroforestry question was included in the Census of Agriculture (on alley cropping and silvopasture), and results are expected in 2014. This collection will be the first national agroforestry dataset of its kind.

Until then, the only U.S. Department of Agriculture (USDA) data available on agroforestry adoption have been the amounts of agroforestry practices that producers have applied to conserve their natural resources with assistance from USDA conservation programs administered by Natural Resources Conservation Service (NRCS) and Farm Service Agency (FSA).

In the last 5 years,[7] USDA assisted landowners—both financially and through technical support—to establish about 336,000 acres of windbreaks, riparian forest buffers, and alley cropping; 2,000 acres of silvopasture; and 500 acres of forest farming[8] through these conservation programs. Again, it is important to note that the agroforestry established through these programs represents only a portion of what is occurring in the country because they do not include landowners that applied agroforestry without USDA assistance or those who received assistance before 2008.

To put these numbers in context, the total amount of agroforestry applied through these programs in the last 5 years was 1 percent or less of the land where it may have potential, suggesting that a great amount of work remains to be done (see table 1).

Additionally, anecdotal evidence suggests that agroforestry practices are being removed from agricultural lands due to recent high crop prices, which have provided incentives for farmers to remove windbreaks and riparian buffers to expand their acreage of annual crops. While benefitting producers' bottom line in the short term, this may have detrimental effects longer term to both producers and society because of its impacts on their soil and water resources.

Another indicator of potential adoption of forest farming is the 14 percent of family forest owners that reported harvesting nontimber forest products (NTFPs) from their land.[9] Again, this dataset is incomplete because although some of these activities may qualify as agroforestry (by satisfying the four "i"s); others may be considered "wildcrafting," or the harvesting of wild-grown NTFPs.

[6] Previous Censuses of Agriculture have asked producers to report the amount of woodland grazed, but it is not clear how much of this may be a silvopasture, which involves managing the trees, livestock and forages together in a system that is integrated, intensive, intentional, and interactive.
[7] Fiscal years (FY) 2008–12.
[8] Also called multi-story cropping.
[9] Estimates of family forest owners harvesting NTFPs are from Vaughn et al. 2013.

Table 1.—Agroforestry potential in the United States, organized by land use type.

Land Use	Acres With Potential for Agroforestry*	Potentially Relevant Agroforestry Practice	Agroforestry Acres Applied With USDA Assistance, FY 2008–12**
Cropland	372 million	Windbreaks, riparian forest buffers, alley cropping	336,000 (<1%)
Pasture and grazed forest land	179 million	Silvopasture establishment	2,000 (<1%)
Ungrazed forest land	363 million	Multi-story cropping (forest farming)	500 (<1%)

*These are estimates of privately owned acreage where agroforestry could physically be applied, by land use, as of 2007. The amount of land on which landowners would actually find it profitable to adopt agroforestry may be much lower. Estimates are based on data used to develop land use estimates in Nickerson, C. et al. 2011. Major uses of land in the United States, 2007. EIB-89. U.S. Department of Agriculture, Economics Research Service. Main data sources are National Agricultural Statistics Service's Census of Agriculture, Natural Resources Conservation Service's National Resources Inventory, and Forest Service's Forest Resources of the United States.

** FY = fiscal year. Estimates of FY 2008–12 agroforestry practices applied (acres) with USDA assistance include all Farm Service Agency and Natural Resources Conservation Service program reporting in the ProTracts and Integrated Data for Enterprise Analysis databases.

In the following section, we provide detailed summaries of USDA's activities that align with the three Goal 1 objectives, including accomplishments and the next steps needed to realize a significant increase in the adoption and application of agroforestry by landowners and communities. In addition, we reference several case studies that describe how people are using USDA programs to adopt agroforestry, educate others, and engage globally. These case studies can be found in appendix D.

Please note that the numbers in table 1 are different from those reported in the following sections because those following include only fiscal years (FY) 2011–12, while those in table 1 span FY 2008–12 in an attempt to describe all agroforestry practices currently on the ground.

Objective 1.1: Develop Partnerships

Overview

To increase the adoption of agroforestry systems, USDA agencies have expanded learning partnerships with forestry and agricultural extension professionals, including State departments of agriculture and forestry, land-grant universities, tribal organizations, conservation districts, and others. A special emphasis was placed on outreach to tribal and other historically underserved and minority audiences, consistent with the Secretary's priority on civil rights.

Accomplishments

1. **(S1, S4) USDA supported numerous partnerships and working groups at the national, regional, and State levels, and helped create "communities of practice"** composed of practitioners, technical advisors, and other learning networks. These include the following.

   Nationwide:

   - The **USDA National Agroforestry Center (NAC):** NAC is a partnership that originated in the 1990 Farm Bill. The partnership is between two branches of the Forest Service: Research and Development (R&D) and State and Private Forestry (S&PF) and the NRCS. NAC's mission is to accelerate the application of agroforestry through a national network of public and private partners. This mission is accomplished through research, development of technologies and tools, demonstrations, and training and dissemination of practical and applied information. NAC's customers are natural resource professionals who work with farmers, ranchers, woodland owners, tribes, and communities nationwide. In 2011, NAC was awarded "Special Recognition" as an exemplary collaborative case study by the American Association for the Advancement of Science based on a significant record of agroforestry research accomplishments and technology transfer and the long-standing Forest Service-NRCS partnership. (Forest Service and NRCS signed a new NAC Memorandum of Understanding (MOU) in 2011.)
   - **Forest Farming Community of Practice (CoP):** CoP is the first agroforestry community in eXtension, the Web-based Cooperative Extension System (http://www.eXtension.org). Virginia Polytechnic Institute and State University (Virginia Tech) leads a core team of 17 CoP members, which includes forest farmers, university faculty, and agency personnel. The CoP supports practitioners and scientists who are seeking information about best practices and who are willing to share information and experiences, pose questions, and find answers about forest farming. Members of the CoP produced 8 articles, 16 Frequently Asked Questions, 14 news items, and 2 Webinars in the first year, attracting 1,500 unique visitors who visited the site nearly 15,000 times in the first 6 months, accessing roughly 9 pages each time. (Funded jointly by the NAC/Forest Service and National Institute of Food and Agriculture [NIFA] through its Renewable Resources Extension Act [RREA] National Focus Funds Competitive Program 2011–13)
   - **Survey of Tribal Conservation Districts:** The Forest Service Office of Tribal Relations and NAC provided technical assistance to the Indian Nations Conservation Alliance (INCA), which conducted a survey of 23 **Tribal Conservation Districts** (TCD) to identify where agroforestry activities had occurred and to learn about opportunities to provide additional assistance. The survey showed that only about four of the TCDs had conducted

"agroforestry" activities, although the term "agroforestry" may have limited what was reported. The largest barriers to more agroforestry activity were likely insufficient funds and the belief that additional management would be expensive. Other challenges included a lack of technical assistance, demonstration sites, and knowledge about markets for products from agroforestry systems. The results were presented in December 2011 at the annual INCA-Intertribal Agricultural Council conference. NAC will use the survey results to follow up with the tribes and determine priorities for agroforestry assistance. (NAC/Forest Service-NRCS 2011)

- **Association for Temperate Agroforestry:** The Association for Temperate Agroforestry hosts the biannual North American Agroforestry Conference, which was last held in Athens, GA, in June 2011, and in Charlottetown, Canada, in June 2013. NAC helped sponsor the conferences, which in 2011, included an opening plenary session with USDA Deputy Secretary Kathleen Merrigan, Agriculture and Agri-Food Canada's (AAFC) Assistant Deputy Minister Jamshed Merchant, and the World Agroforestry Centre's Director General Dennis Garrity. At the conference, USDA Deputy Secretary Merrigan announced the release of the *Strategic Framework*. See also Objective 1.2. (NAC/Forest Service-NRCS 2011)

- **U.S.-Canada Agroforestry Partnership:** USDA Deputy Secretary Kathleen Merrigan and AAFC Deputy Minister John Knubley formally established a relationship between the USDA NAC and the AAFC Agroforestry Development Centre (ADC) by signing an MOU in April 2012. The partners are focusing their efforts on advancing agroforestry science and tools for climate change mitigation and adaption in temperate North America in support of the goals of the Global Research Alliance for Agricultural Greenhouse Gases, of which both countries are members. See also Objectives 1.2 and 1.3. (NAC/Forest Service-NRCS; 2012)

- **Joint Forestry Team MOU: Agroforestry Focus:** In September 2008, the Forest Service, NRCS, the National Association of Conservation Districts (NACD), and the National Association of State Foresters (NASF) signed the Joint Forestry Team MOU. The purpose of the MOU is to "strengthen cooperation among the four parties that results in coordinated interagency delivery of forestry-related conservation assistance to private landowners in order to sustain the health, diversity, and productivity of America's private working lands—forest land, cropland, pasture, and rangeland." The MOU has 64 actions, including 10 actions related to agroforestry. (Forest Service and NRCS 2008–13)

Northeast:

- **Northeast Silvopasture Working Group:** NAC and Cornell University Extension convened 100 landowners and government personnel to discuss hardwood silvopasture as an alternative management strategy, to develop research questions, and to form a network to develop hardwood silvopasture systems, which have rarely been used in the region. This working group organized in 2012 and continues to function. (NAC/Forest Service supported, NIFA RREA 2012) Following that initial meeting, Cornell University Extension maintains an active Web site on silvopasture, which highlights upcoming events and hosts a blog and discussion component. See also Objective 1.2 and 2.3. (NIFA RREA 2012)

- **Northeast Forest Mushroom Growers Network:** Faculty, extension specialists, and forest farmers from Cornell University, University of Vermont, and others in the Northeast formed a collaborative network to enhance the viability of forest-grown mushrooms. Together, they conduct research, extension, and education. They have produced several publications and have a growing directory of collaborators on their Web site. See also case study #7 in appendix D. (NIFA SARE [Sustainable Agriculture Research and Education] 2010-12)

- **Chesapeake Bay Agroforestry Working Group:** Researchers and extension professionals from Pennsylvania State University, Virginia Tech, Virginia State University, and North Carolina Agricultural and Technological State University (NC A&T) met with NAC, Forest Service, and NRCS personnel in May 2012 to identify ways that they could jointly expand the application of agroforestry for the benefit of the Chesapeake Bay watershed. The ideas that were considered high priority included an effort to target landowners for riparian buffer adoption based on biophysical and socioeconomic information and an effort to establish research and demonstration sites for silvopasture and other agroforestry practices to better understand the systems and increase adoption by landowners. (NIFA RREA, NRCS, and Forest Service 2011–12)
- **Chesapeake Bay Forest Restoration Strategy:** This strategy, released in December 2012 following a signing ceremony with the Forest Service Chief, U.S. Environmental Protection Agency's Chesapeake Bay Program Director, and seven State foresters (representing Delaware, District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia), is a collaborative effort that involves more than 60 representatives from more than 30 Federal, State, and nongovernmental organizations. The new strategy aims to "advance innovative and collaborative approaches to targeting restoration in areas of greatest opportunity and benefits" and includes a section specifically on agroforestry developed by the Chesapeake Bay Agroforestry Working Group. (Forest Service 2011–12)

Southeast:

- **1890 Land-Grant Universities and Agroforestry**: Two events have served to enhance the work of these institutions in agroforestry. In 2004, 1890 land-grant universities, together with Forest Service, NIFA, and NRCS, formed the 1890 Agroforestry Consortium, which enables the universities to assist each other and to collaborate on agroforestry-related teaching, outreach, and research activities. Later, the 2008 Farm Bill made the 1890 institutions eligible to receive McIntire-Stennis (M-S) Cooperative Forestry Research funding. To date, Governors of States with 1890 institutions have designated 13 of the 18 institutions as M-S institutions. In FY 2012, they received $1,657,259. To support and facilitate these institutions' contributions to the national M-S Program, NIFA worked with them to form the 1890 M-S Coordinating Council in 2011. The purpose of the council is to identify needed areas of research that are not currently or adequately being addressed by other institutions. The council identified three priority areas in which they would work together on a focused research priority. Agroforestry emerged as one of those priorities. Institutions are developing agroforestry research proposals to expand agroforestry research and practice across the South. Some of those include the following:

  Silvopasture:

  - **Alabama A&M [Agricultural and Mechanical] University (AAMU): AAMU** is developing and evaluating silvopasture systems that produce pine sawlogs, forage, and meat goats for landowners in Alabama's Black Belt. AAMU also hosted workshops for limited-resource landowners that addressed land survey, mapping, and estate planning. In this new project, Intensive Southeastern Training Expansion Program (InSTEP), AAMU plans to continue its collaboration with consortium members to provide landowners in over 20 African-American communities (6 Southeastern States) with the contacts, technical assistance, and training so they can complete conservation/forest management plans and apply for State and Federal cost-share or lending programs.
  - **Tuskegee University:** Tuskegee University is studying pine-meat goat silvopasture systems and to continue its landowner silvopasture training program.

- **Florida A&M University:** Florida A&M is continuing its study of stocking rates of hybrid Boer (S. Africa) Spanish goats in the loblolly pine forests of north Florida.

Alley Cropping:

- **North Carolina A&T University:** North Carolina A&T is introducing farmers and landowners with small landholdings to four variations of alley cropping practices, including how to incorporate vegetables, forages, biofuel crops, and pollinator cash crops between rows of hybrid eastern black walnut.

Forest Farming:

- **Alcorn State University:** Alcorn State University continues to conduct research and outreach efforts on NTFPs, and it offers an introductory course in agroforestry to students and landowners.
- **North Carolina A&T University:** North Carolina A&T worked with Forest Service R&D to establish demonstration plots (see below).
- **Virginia State University:** Virginia State University faculty and students worked with Forest Service R&D to research the soil microbial relationships with ramps and black cohosh stands and also to engage in citizen science research. (Forest Service R&D 2011)

- **Forest Farming Network in Appalachia:** This network is a central and southern Appalachia group of forest farmers and scientists who collaborate in a citizen science approach to advance forest farming of native medicinal plants. They established long-term research plots to demonstrate the viability of native plant products to provide alternative income sources and understand how to grow and market these plants. They are also examining the social factors that influence adoption of forest farming practices on private lands. (Forest Service, University of Georgia, Virginia Tech, Catawba Sustainability Center, and SARE 2011–12)

  They released several publications:
  - Growing American Ginseng (*Panax quinquefolius*) in Forestlands. Virginia Cooperative Extension (2011).
  - Opportunities for enhancing management of non-timber forest products in the United States. *Journal of Forestry* (2013).
  - Cultivating the Forest Floor in Your Tree Farm. *Tree Farmer Magazine.* July/August (2010).
  - Native Fruit and Nut Trees of Virginia's Mountains and Piedmont. Virginia Cooperative Extension Fact Sheet. ANR-23NP (2012).
  - Woody Florals for Income and Conservation. ANR-22NP (2012).

- **Silvopasture and Expiring Conservation Reserve Program (CRP) Contracts:** USDA is assisting landowners to transition CRP treed acres (estimated at 400,000 acres in 2012) into silvopasture systems between 2013 and 2015. The greatest opportunity is in Southeastern States. See also next steps in this section. (FSA, Forest Service, NRCS 2012)

Central:

- **Mid-America Agroforestry Working Group (MAAWG):** Led by the Iowa State University Leopold Center for Sustainable Agriculture, this group of university faculty members and extension educators and USDA agency personnel aims to increase awareness of agroforestry and coordinate research, training, and technology transfer activities in the mid-America region. Active members include the Iowa State Agricultural Marketing Resource

Center, University of Minnesota Center for Integrated Natural Resources and Agricultural Management, Green Lands Blue Waters, University of Missouri Center for Agroforestry, Forest Service and NRCS. A major MAAWG focus is coordinating the 2013–14 Agroforestry Academies in five Midwestern States. See also Objective 1.2. (MAAWG is partially supported by NAC/Forest Service 2011–13)

- **Hybrid Hazelnut Consortium (HRC):** Consortium members (University of Nebraska-Lincoln, Rutgers University, Oregon State University, and the Arbor Day Foundation) are testing hazelnut cultivars across a broad geographic area in the United States and conducting research to develop hazelnuts as a widely adapted, high-yielding, low-input sustainable crop suitable for marginal soils that is comparable to annual crops for its use as food, feed, or bioenergy. See also Objective 2.2.
- **Upper Midwest Hazelnut Development Initiative (UMHDI):** Similar to HRC, this initiative aims to support the growth and commercialization of hazelnut. (NIFA Specialty Crop Research Initiative [SCRI] grant to University of Minnesota 2011). See also Objective 2.2.
- **Healthy Foods, Healthy Lands, and Healthy Communities:** This initiative in northern Wisconsin aims to address conservation and economic development opportunities in the Chequamegon Bay watershed of Lake Superior. One outreach project includes an agroforestry demonstration planting with hazelnuts provided by the UMHDI (see bullet above) at Forest Service Northern Great Lakes Visitor Center. The partners in this project include Chequamegon-Nicolet National Forest, University of Wisconsin, Wisconsin Division of Forestry, NRCS, NAC, Forest Service Office of Tribal Relations, and Forest Service Northeastern S&PF. (NAC/Forest Service funds and cooperative agreement with Bay County Land Commission 2012)

West:

- **Oregon Woodland Cooperative (OWC)—Forest Farming:** The OWC is a network of woodland owners who are working to diversify the products from their land beyond timber and are working with Oregon State University Extension through a Value-Added Producer Grant (VAPG), the Institute for Culture and Ecology through an Agriculture and Food Research Initiative (AFRI) grant, and others to learn how to produce moss, floral greens, and medicinal plants. For more information see case study #13 in appendix D. (RD VAPG, 2005–09; and NIFA AFRI grant, 2011)
- **Pacific Northwest Agroforestry Working Group:** Oregon State University organized an exploratory workshop in May 2013 to consider establishing a working group of State, Federal, university, tribal, and other cooperators in Washington, Oregon, and northern California. At the meeting, "Agroforestry was recognized as a comprehensive tool to help urban and rural residents adapt to climate change, provide wildlife habitat, improve water quality in Pacific Northwest rivers and streams, help reduce fire risk, and add value for landowners." The group agreed that "Agroforestry can broaden and pull together what various agencies, researchers, and land managers do." The group will move forward with additional meetings to identify key priorities and opportunities for collaboration and explore potential funding sources.

Islands:

- **Organic Coffee Agroforestry Network in Puerto Rico:** The University of Puerto Rico assisted coffee growers in learning about the national organic standards and best management

practices and created a support network of organic coffee producers. (Agricultural Marketing Service (AMS) Specialty Crop Block Grant 2011)

- **Pacific Islanders Agroforestry Working Group:** Since 2011, the University of Hawaii-Extension, NRCS, Forest Service Pacific Southwest Region, Forest Service Pacific Southwest Research Station, Pacific Island State forestry agencies, NAC, and NIFA have been working together to increase understanding of Pacific Islands agroforestry systems and discussing how the partners can address the needs and issues faced by Pacific Island people (e.g., climate change, invasive species, loss of indigenous agroforestry knowledge, food security, and human health) and increase awareness on the mainland. Current projects include a "Working Trees for the Pacific Islands" brochure and proposals to establish two new positions: (1) regional agroforestry extension specialist in Guam and (2) regional agroforestry research-technology transfer specialist in Hawaii focused on climate change in strand forests in the western Pacific. (Supported by NRCS, Forest Service Region 5, NIFA RREA, NAC/Forest Service 2011–12)

2. (S2) **USDA has had a role in supporting at least 40 agroforestry demonstration sites. Of these sites, 18 were started or planned in FY 2011–12.** See figure 2 and table 2.

Figure 2.—Locations of 40 agroforestry demonstration sites by type of agroforestry practice.

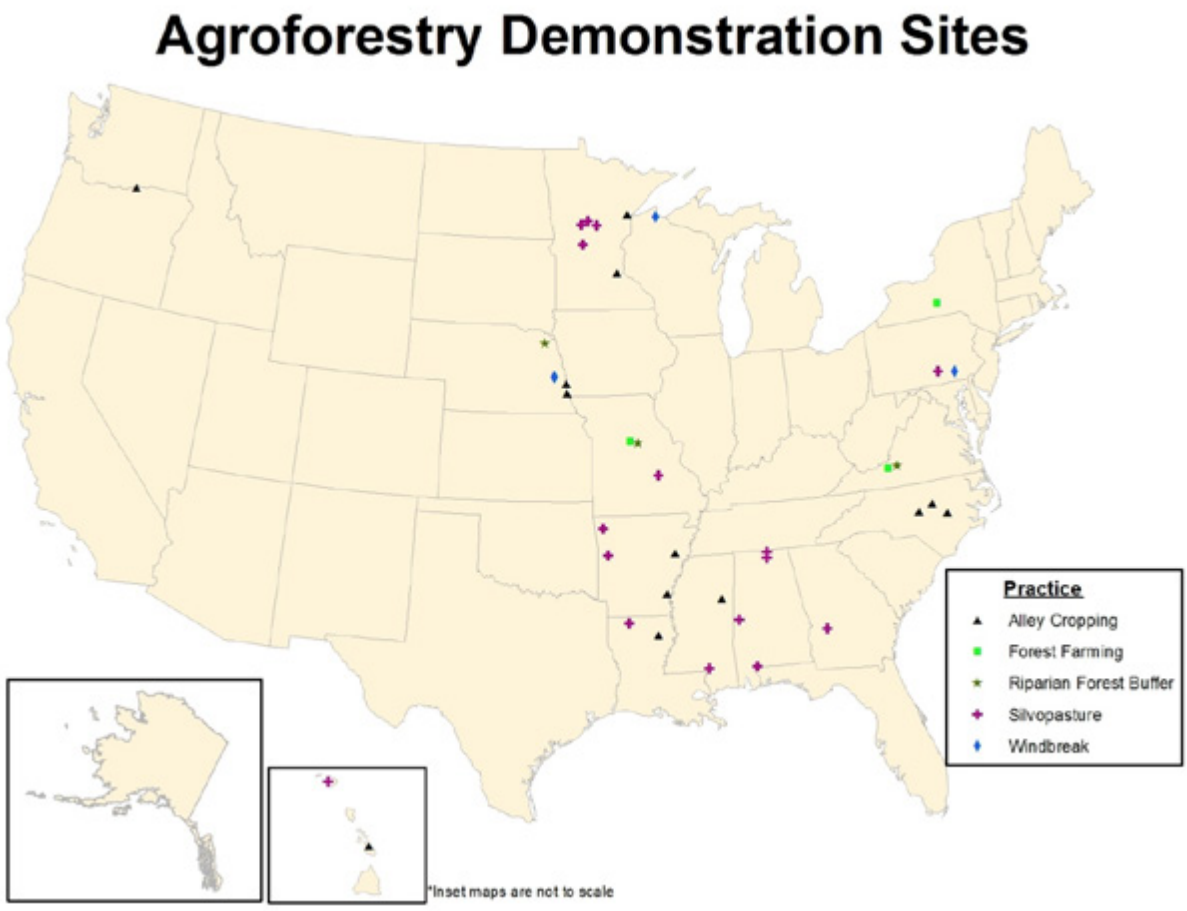


Table 2.—Descriptions of 40 agroforestry demonstration sites.
Although not a comprehensive list of all sites that exist, all have some degree of USDA support. If you know of additional sites, contact us at agroforestry@USDA.gov.

Institutions	Town	State	Focus	Established
Auburn University; Hauss Nursery; Alabama Forestry Commission, Longleaf Alliance; USDA NAC; Forest Service—State & Private Forestry	Atmore	AL	Silvopasture (replicated longleaf and loblolly silvopasture comparison, native grasses); 300 acres in total; 75 in silvopasture to start	2006
Alabama A&M University; Alabama Division of Forestry; Federation of Southern Cooperatives/Land Assistance Fund's Rural Training & Research Center	Epes	AL	Silvopasture (loblolly) site exists now, but expansion and additional sites in Georgia, South Carolina, and Mississippi planned	2006 and 2012
Alabama A&M University: Winfred Thomas Agricultural Experiment Station	Hazel Green	AL	Silvopasture (loblolly/Florida native sheep/tall fescue-clover)—8 sheep/acre; grazing: September—June	Planned (2012–14)
Alabama A&M University; Auburn University; United States Army; Redstone Arsenal	Huntsville	AL	Silvopasture (comparison of loblolly and shortleaf pine/cattle grazing Silvopasture); the Redstone Arsenal helps to monitor growth and do outreach	~2010
University of Arkansas: Center of Excellence for Poultry Science	Fayetteville	AR	Silvopasture (ruminants and poultry; beautyberry)	In progress
ARS	Boonesville			
ARS	Fayetteville			
University of Arkansas; Louisiana AgCenter; private landowners	Colt	AR	Alley cropping for bioenergy (switchgrass/cottonwood)	~ 2009
	Rohwer			
	Archibald			
NRCS: Jimmy Carter Plant Materials Center; Auburn University	Americus	GA	Silvopasture (longleaf pine at 290 trees/acre; "Pensacola: bahiagrass mixed pasture/crimson clover, ryegrass, and cereal rye; cattle)	2000
University of Hawaii	Molokai	HI	Alley cropping: overstory of high-value culturally relevant hardwoods (milo, kou, kamani, and kukui trees). Understory crops have included ginger, kava, and alfalfa	~ 2001
University of Hawaii; Kukaiau Ranch		HI	Silvopasture—Acacia koa trees and cattle	~ 2009

Institutions	Town	State	Focus	Established
Louisiana AgCenter: Hill Farm Research Station	Homer	LA	Silvopasture	
University of Minnesota Extension	Sauk Centre	MN	Silvopasture (red pine, white pine, and red oak)—see Objective 2.2	
University of Minnesota Extension; 3 landowner farms	Brainerd	MN	Silvopasture—see Objective 2.2	Starting 2013
	Verndale	MN		
	Leader	MN		
University of Minnesota Extension	Cloquet	MN	Alley cropping for bioenergy (Two systems: hybrid poplar-willow and red pine-willow)	Planned for 2013
University of Minnesota	Rosemount	MN	Alley cropping for bioenergy: perennial woody (willow) and herbaceous polyculture crops (forbs, legumes, and tall grass prairie species)	In progress
UMCA: Wurdack Farm	Cook Station	MO	Silvopasture (cattle and hardwood)	2003
UMCA: Horticulture and Agroforestry Research Center (HARC)	New Franklin	MO	Forest farming, riparian buffer, silvopasture, alley cropping, windbreak demonstrations, and forage shade trials	1993
Mississippi State University Forest and Wildlife Research Center; NIFA: McIntire-Stennis	Holly Springs	MS	Shortleaf and loblolly pine agroforestry systems for biofuel	2008
Mississippi Forestry Commission; Federation of Southern Cooperatives/Land Assistance Fund	Baxterville	MS	Silvopasture (75 acres to showcase hay, pine straw, cattle, and high-end forest products)	In progress
North Carolina State University: Center for Environmental Farming Systems	Goldsboro	NC	Alley cropping (randomized block design with five replications: loblolly, longleaf, cherrybark oak and soy/corn); silvopasture	2007
North Carolina State University; Virginia Tech; Weyerhauser	Raleigh	NC	Alley cropping for bioenergy (70 acre replicated trials of loblolly pine-switchgrass)	In progress
North Carolina A&T University	Four farms	NC	Alley cropping & forest farming (*Moringa oleifera* at North Carolina A&T University; cow peas, watermelons, corn, bok choy, collards, pecans, chestnuts, eastern black walnuts, medicinals in others)	2011

Institutions	Town	State	Focus	Established
University of Nebraska: Haskell Agricultural Laboratory	Concord	NE	Conservation buffer (23 acres: 75 feet either side of 1 mile of creek) several separate focus areas, each aimed at meeting project objectives (floral production, stormwater, biofuel)	
University of Nebraska: Agricultural Research & Development Center	Mead	NE	Windbreaks (Six 40-acre windbreak networks)	1960s
National Arbor Day Foundation; Lied Lodge and Conference Center	Nebraska City	NE	Alley cropping, windbreak, living snow fence demonstrations that incorporate nontimber-producing species and a biomass production plantation and riparian forest buffers developed with NRCS and Forest Service funds and assistance	2000
University of Nebraska: Horning State Farm Demonstration Forest; USDA NAC	Plattsmouth	NE	Alley cropping (hybrid hazelnut, black walnut cultivars, northern pecan, Chinese chestnut, woody florals, and hay); windbreaks; monitoring yield, growth, and disease	
Washington State University: Prosser Irrigated Agriculture Research & Extension Center; GreenWood Resources Tree Farm	Boardman	OR	Alley cropping (hybrid poplar and switchgrass)	~2011
Pennsylvania State University: Chesapeake Bay Watershed Demonstration		PA	Riparian buffer (urban)	In progress
Dickinson College Farm: Cheapeake Bay Watershed Agroforestry Program; Forest Service	Boiling Springs	PA	Silvopasture (swine); riparian forest buffer (pawpaw trees and highbush blueberries on Yellow Breeches Creek); forest farming	In progress
Pennsylvania State University; Rodale Farm	Kutztown	PA	Crop trees in under-utilized areas of the farm (oaks, chestnuts, black gum, sycamore, tulip poplar)	2009
Pennsylvania Department of Conservation and Natural Resources, Pennsylvania State University (Poultry Science), Lancaster County Conservancy, Forest Service	Lancaster County	PA	Windbreaks (upland buffers) around concentrated animal operations	Planned (2013)
Pennsylvania State University Farm	Rock Springs	PA	Forest farming in demonstration woodlot	

Institutions	Town	State	Focus	Established
Virginia Tech; Cornell University	Blacksburg Ithaca	VA NY	Forest farming (ramps and shiitake); responsible management	Planned (2012–14)
Virginia Tech: Catawba Sustainability Center	Roanoke	VA	Riparian forest and upland buffers (native woody edibles and florals); forest farming	2010
Chequamegon-Nicolet National Forest: Northern Great Lakes Visitor Center	Ashland	WI	Windbreak and riparian forest buffers that incorporate native nontimber species harvestable for income, including species that have cultural significance to Native American Tribes. See figure 11	2012

A&M = Agricultural and Mechanical. A&T = Agricultural and Technological. ARS = Agricultural Research Service. NAC = National Agroforestry Center. NRCS = Natural Resources Conservation Service. NIFA = National Institute of Food and Agriculture. USDA = U.S. Department of Agriculture. UMCA = University of Missouri, Center for Agroforestry.

3. (S3, S5) USDA agencies partnered with State and local agencies to implement agroforestry practices on the ground, including demonstration sites. Technical and financial assistance was provided through NRCS and FSA conservation programs, NRCS Conservation Innovation Grants, NAC, Forest Service S&PF and R&D programs, Forest Service S&PF redesign grants, Chesapeake Bay program grants, and other initiatives. Below, we describe the overall application of agroforestry practices on the ground through these various programs, beginning with USDA conservation and forestry programs.

Nationwide:

USDA Conservation Programs: NRCS and FSA both administer conservation programs that help landowners develop conservation plans and install conservation practices, some of which are agroforestry practices.

NRCS administers and provides technical and financial assistance through several conservation programs, which are listed on their Web site. These programs included Agricultural Management Assistance (AMA), Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentive Program (WHIP), and the Conservation Stewardship Program (CSP) among others (see notes below).

- Most NRCS programs support **both linear agroforestry practices** such as field windbreaks, livestock windbreaks, farmstead windbreaks, living snow fences, contour buffer strips, and riparian forest buffers and **block agroforestry practices** such as alley cropping, multi-story cropping (also known as forest farming), and silvopasture.
- **A unique program:** through the CSP, NRCS helps landowners enhance their lands with several additional practices such as edible woody buffers (see appendix F for descriptions). CSP also reports its information differently, so please see the notes below.

FSA administers the financial assistance for the CRP, and NRCS provides technical assistance for that program. Through an agreement between FSA and Forest Service, State forestry agencies provide technical assistance for tree-based CRP practices, and State forestry agencies often have State-level agreements with NRCS to provide similar technical assistance for NRCS conservation programs. The CRP provides assistance for **five agroforestry practices:** windbreaks, shelterbelts, living snow fences, riparian forest buffers, and bottomland hardwoods.

FSA estimates that 877,000 acres of riparian buffers were enrolled in the CRP as of September 2012. Of these acres, 53,000 were enrolled in FY 2011–12, and the others were enrolled previously. These 877,000 acres have improved water quality by preventing an estimated 60 million tons of sediment, 139 million pounds of nitrogen, and 28 million pounds of phosphorus from entering waterways. Of these buffers, 55 percent are located in either the Corn Belt or Mississippi Delta States. For more information, see figure G2 in appendix G.

Maps (figures 3 through 9): The agroforestry practices put on the ground (reported in acres or miles) and financial commitments (reported in dollars obligated) during FY 2011–12 are displayed graphically for *all agroforestry practices combined* in figure 3 and *each separate agroforestry practice* in figures 4 through 9.

More Information: See tables 3 and 4 and appendix B for the breakdown by official conservation practice standard. For descriptions of the conservation practice standards, see appendix F. To see which NRCS State offices have adopted which practice standards, see appendix H.

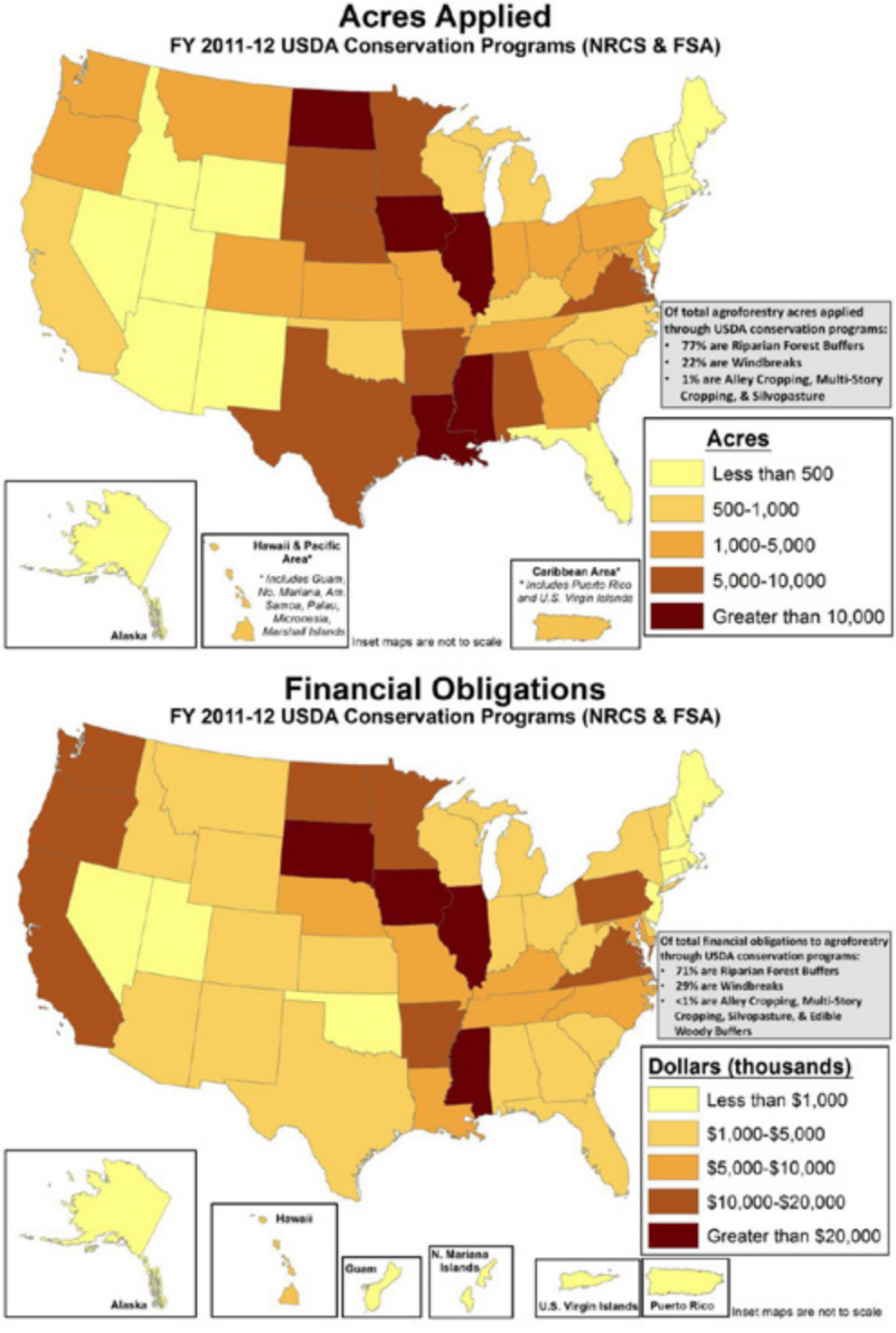
Notes for figures 3 through 9:

- **All numbers were rounded.**
- **Applications and obligations** do not correspond for each practice because (1) acres/miles reported in FY 2011–12 in most cases are the result of obligations to contracts prior to FY 2011 and (2) FY 2011–12 obligations represent contracts that in most cases will be implemented and reported applied after FY 2012.
- **CSP**: The CSP is treated differently. Information on acres and miles *applied* was not available, so a separate map exists for each agroforestry practice that includes information on the acres or miles *planned* through CSP in FY 2011–12 included in figure B1, appendix B. CSP information on financial obligations for FY 2012 **is** included in the figures below, but practice-specific financial obligations were not available for CSP in FY 2011.
- **Financial Obligations** include the following agency programs for FY 2011–12:
  - FSA—CRP.
  - NRCS—AMA program; Agricultural Water Enhancement Program (AWEP); Chesapeake Bay Watershed Initiative (CBWI); EQIP; WHIP; and CSP.
  - CSP only includes FY 2012 financial data (new contracts for sign-up #4).
  - NRCS financial data does NOT include data for these programs: Conservation Technical Assistance-General, Conservation Technical Assistance-Great Lakes Restoration Initiative, Healthy Forests Reserve Program (HFRP), Wetlands Reserve Program (WRP).
- **Acres Applied** include the following agency programs with data for FY 2011–12:
  - FSA—CRP data represents acres under contract in FY 2011–12.
  - NRCS—Biomass Crop Assistance Program (BCAP), Conservation Technical Assistance-General; Conservation Technical Assistance-Great Lakes Restoration Initiative; HFRP—2012 only; Emergency Watershed Protection Program (EWP)—2011 only; WRP; AMA, AWEP, CBWI, and WHIP.
  - Does NOT include CSP because the only data available are for planned (not applied).

- **Acres/Feet Conversions:** Some practices are reported in acres and others in linear feet. To convert between the two so that all windbreaks, shelterbelts, and hedgerows (all included in windbreaks below) are reported in linear miles but all other practices are reported in acres, conversion factors recommended by the agencies were used. For figure 3, windbreaks were converted from linear miles to acres.
- **FY 2012 data is preliminary** and subject to change due to final budget reconciliation.
- **Data Sources:** NRCS data came from two databases: ProTracts for AMA, AWEP, CBWI, WHIP, and EQIP; and Integrated Data for Enterprise Analysis (IDEA) for CTA, HFRP, WRP, EWP, and BCAP. IDEA provides dynamic data, with information being constantly uploaded by agency personnel on a weekly basis; meaning the data constantly change. FSA data came from FSA's Economic Policy Analysis Staff.

Figure 3.—All agroforestry practices.

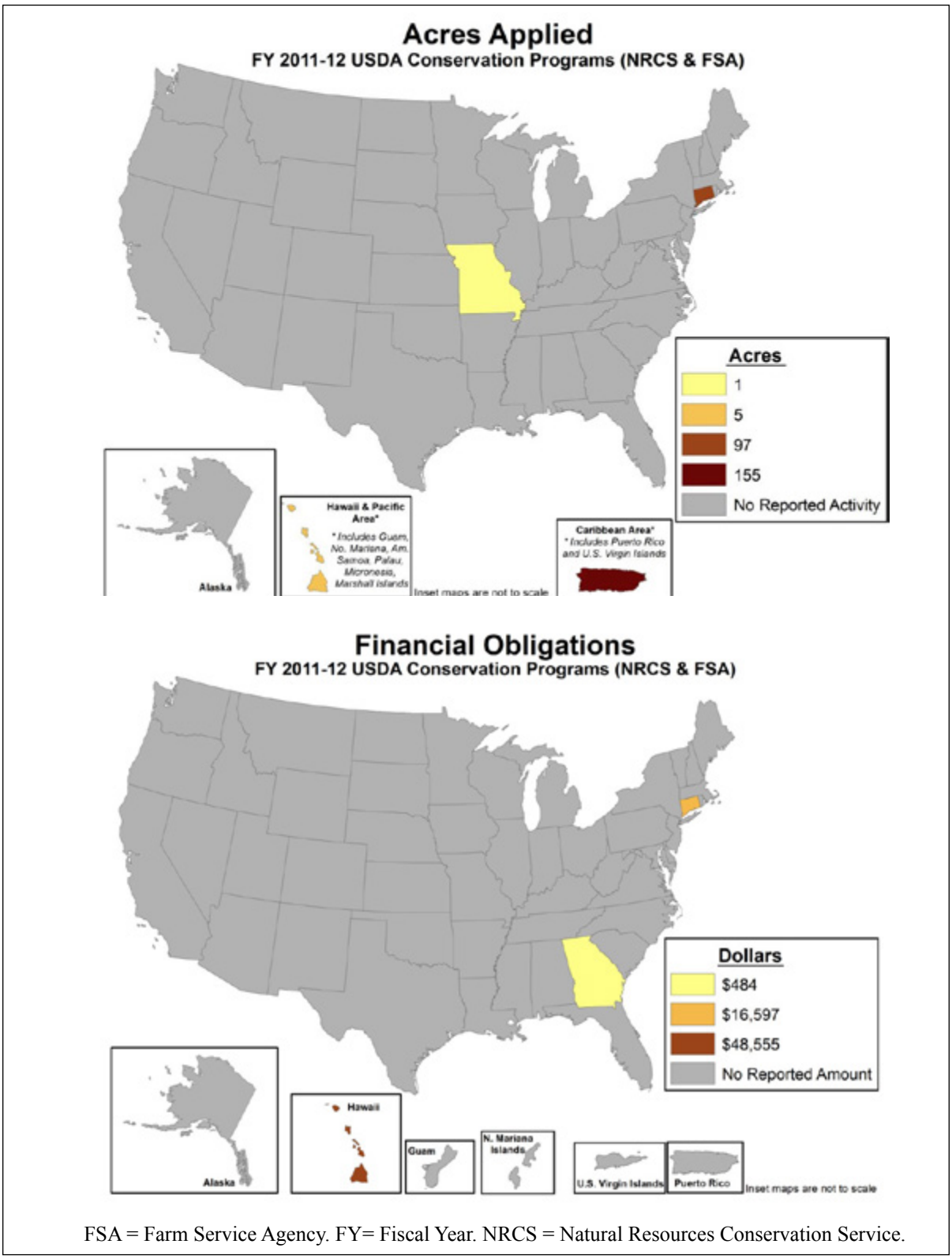
Total number of acres applied (top) and dollars obligated (bottom) per State through USDA conservation programs for all agroforestry practices in FY 2011–12. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it. CSP is included in map of dollars but not acres.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Figure 4.—Alley cropping.

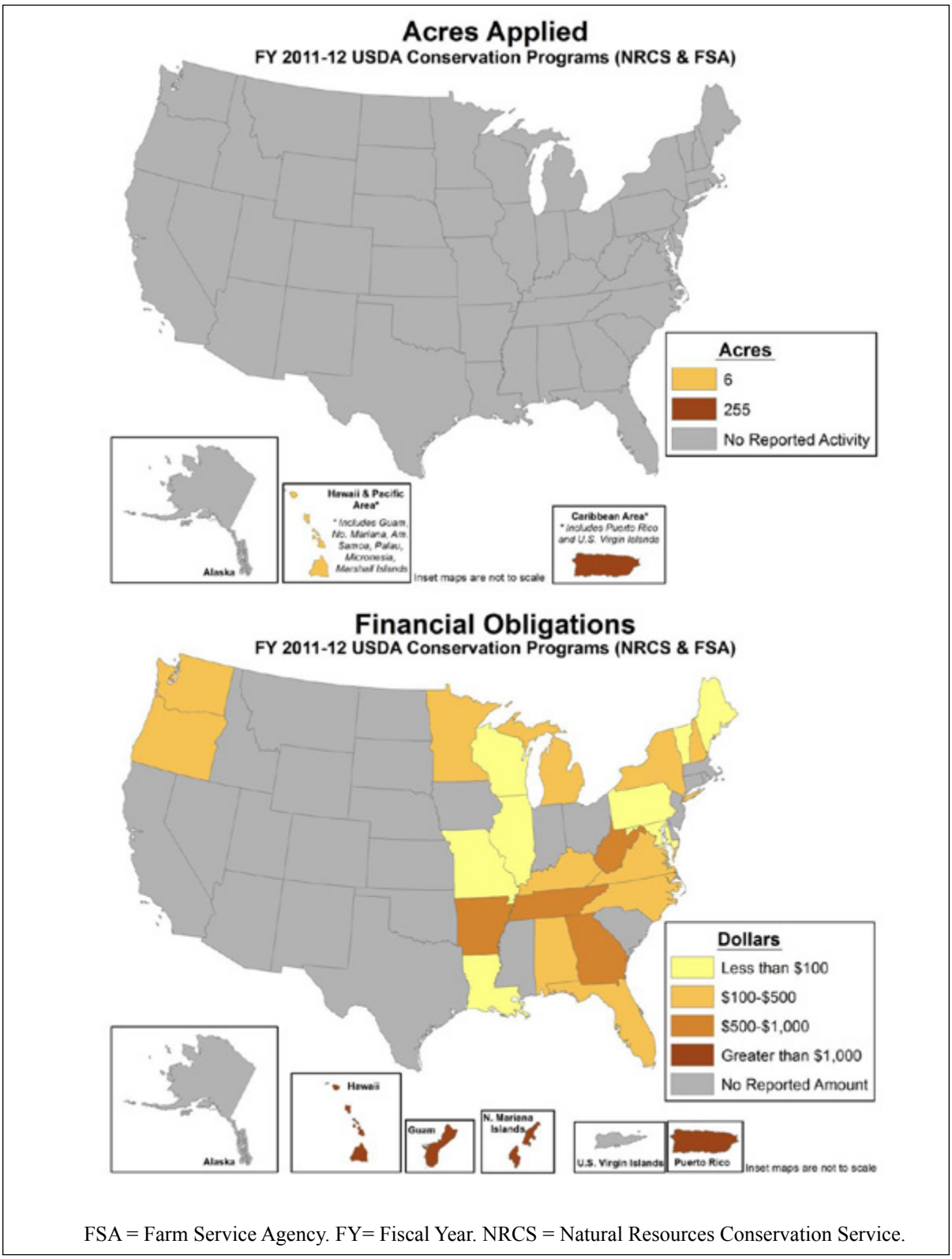
Total number of acres applied (top) and dollars obligated (bottom) per State through USDA conservation programs for alley cropping in FY 2011–12. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it. Also, the CSP is included in map of dollars but not acres.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Figure 5.—Multi-story cropping (also known as forest farming).

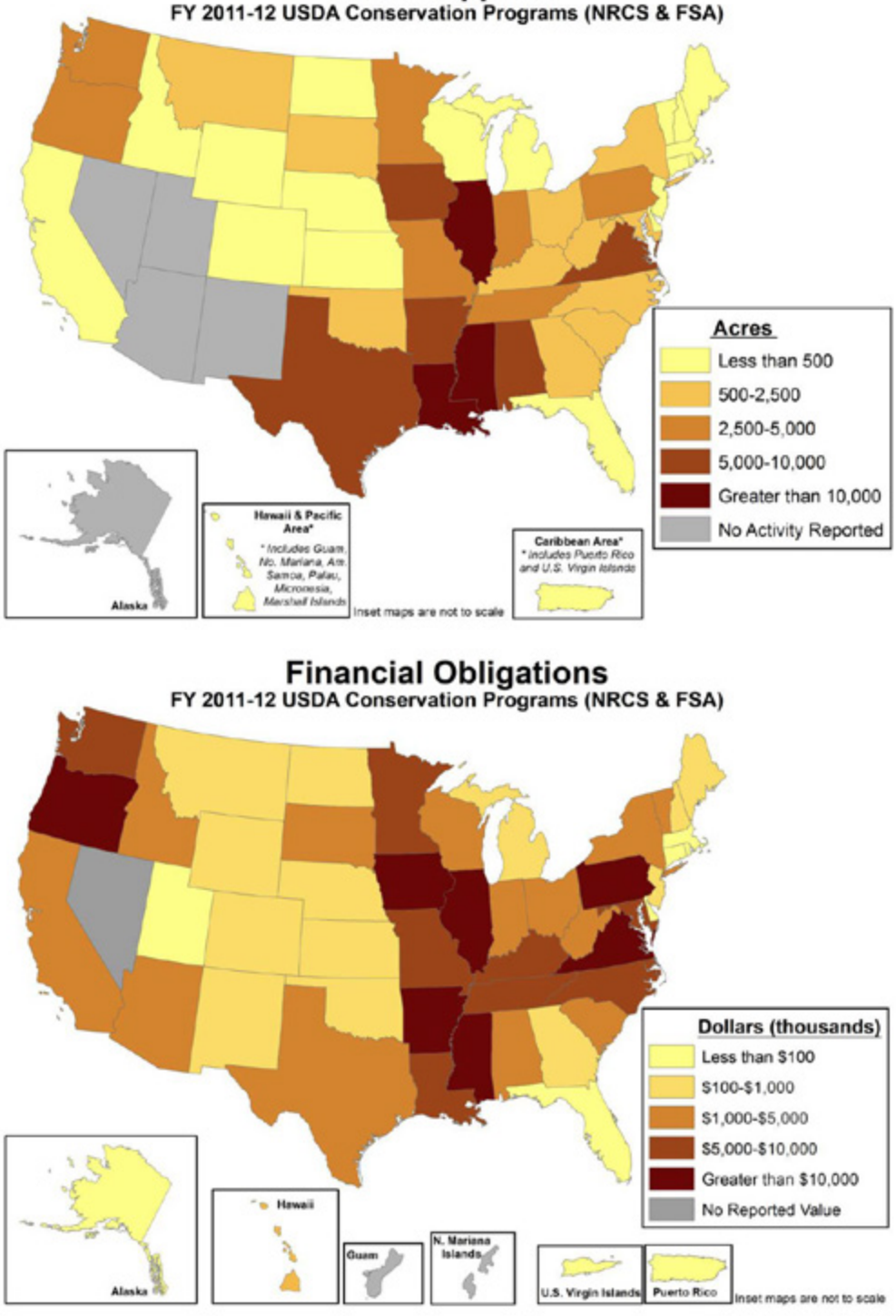
Total number of acres applied (top) and dollars obligated (bottom) per State through USDA conservation programs for multi-story cropping in FY 2011–12. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it. Also, the CSP is included in map of dollars but not acres.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Figure 6.—Riparian forest buffers.

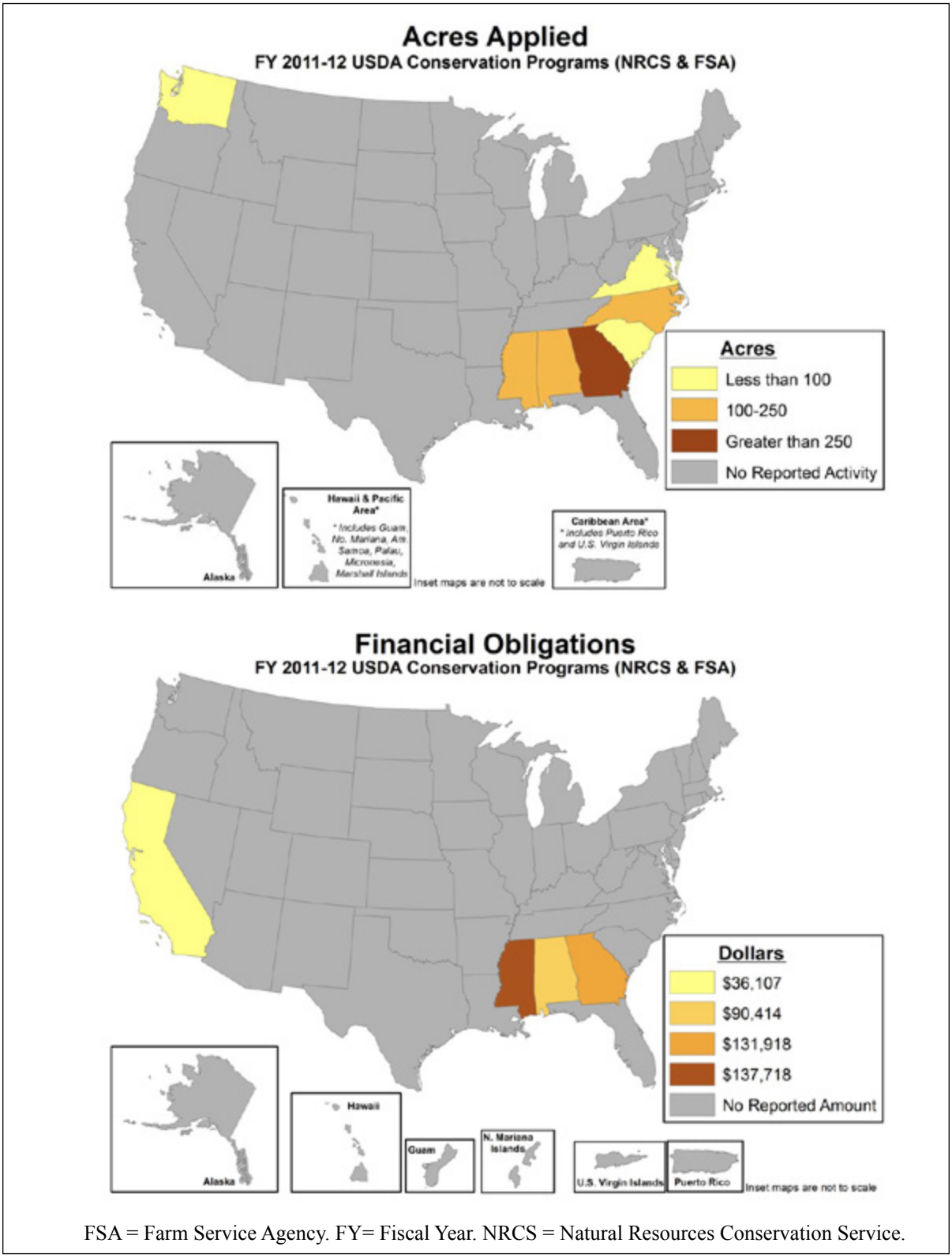
Total number of acres applied (top) and dollars obligated (bottom) per State through USDA conservation programs for riparian forest buffers in FY 2011–12. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it. The CSP is included in map of dollars but not acres.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Figure 7.—Silvopasture

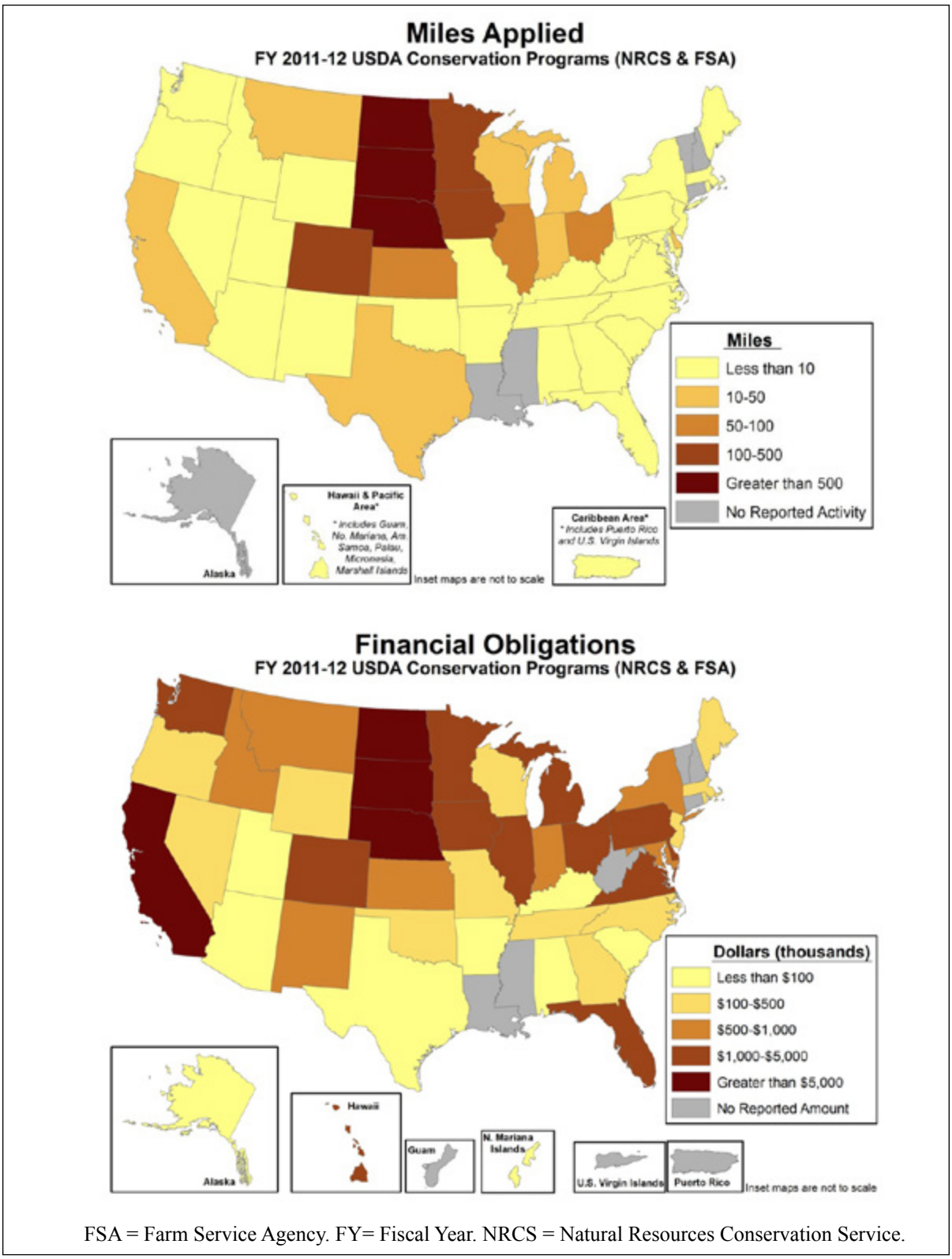
Total number of acres applied (top) and dollars obligated (bottom) per State through USDA conservation programs for silvopasture in FY 2011–12. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it. The CSP is included in map of dollars but not acres.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Figure 8.—Windbreaks (includes shelterbelts, hedgerows, and living snow fences).

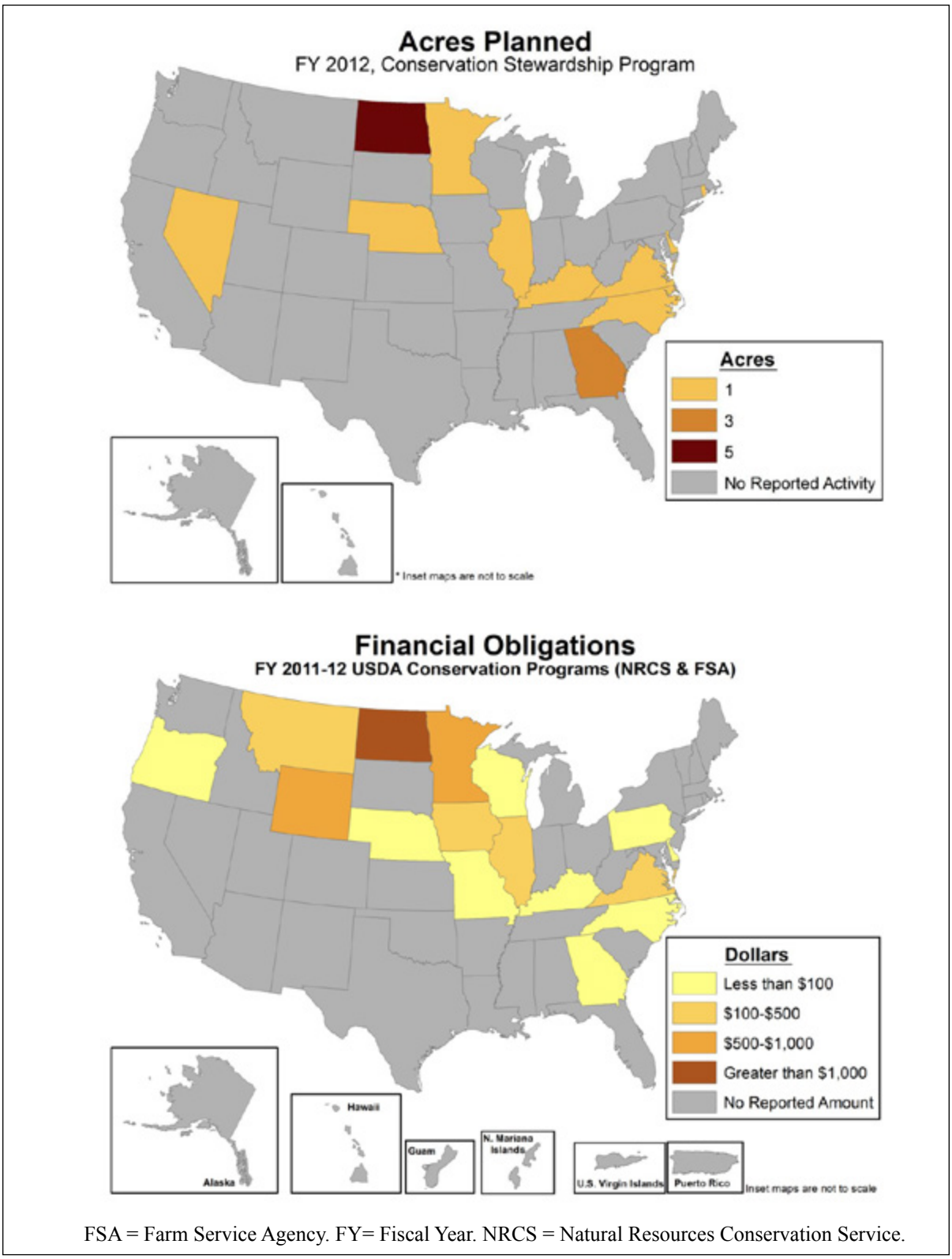
Total number of miles applied (top) and dollars obligated (bottom) per State through USDA conservation programs for windbreaks in FY 2011–12. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it. Also, CSP is included in map of dollars but not acres.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Figure 9.—Edible woody buffers.

Total number of acres planned (top) and dollars obligated (bottom) per State through the CSP in FY 2012. Note: Applications and obligations do not correspond because of the timelag between obligating dollars to a contract and executing it.



FSA = Farm Service Agency. FY= Fiscal Year. NRCS = Natural Resources Conservation Service.

Table 3.—Overview: agroforestry acres/miles applied for all FSA and NRCS conservation programs except CSP in FY 2011–12.

Note: This information is displayed geographically in figures 3 through 9.

Agroforestry Practice Applied	Unit	FY 2011	FY 2012
Windbreaks*	Miles	2,169	1,789
Riparian forest buffers**	Acres	58,684	76,751
Alley cropping	Acres	203	55
Forest farming	Acres	212	49
Silvopasture	Acres	583	332

CP = Conservation practice. CSP = Conservation Stewardship Program. FSA = Farm Service Agency. FY = Fiscal Year. NRCS = Natural Resources Conservation Service.
* Includes windbreaks, shelterbelts, hedgerows, and living snow fences (practices CP 5, CP 16, CP 17, 380, 650, and 422).
** Includes riparian forest buffers and bottomland hardwoods (practices CP 22, CP 31, and 391).

Table 4.—Specific: agroforestry acres/miles applied* FSA and NRCS conservation programs except CSP in FY 2011–12 aligned with their official practice names, codes, programs, and USDA agency.

Agroforestry Practice	Unit*	FY 2011	FY 2012	Program	Practice	Agency
Field windbreaks	Miles	324	338	CRP	CP 5	FSA
Shelterbelts	Miles	222	230		CP 16	
Living snow fences	Miles	28	29		CP 17	
Forested riparian buffers	Acres	20,366	32,664		CP 22	
Bottomland hardwoods	Acres	9,101	17,774		CP 31	

Agroforestry Practice	Unit*	FY 2011	FY 2012	Program	Practice	Agency
Alley cropping	Acres	203	55	NRCS programs except CSP*	311	NRCS
Multi-story cropping	Acres	212	49		379	
Riparian forest buffer	Acres	29,214	26,312		391	
Silvopasture establishment	Acres	583	333		381	
Windbreak/shelterbelt establishment	Miles	1,365	1,097		380	
Windbreak/shelterbelt renovation	Miles	174	68		650	
Hedgerow planting	Miles	56	27		422	
Extending riparian forest buffers for water quality protection and wildlife habitat	Acres	698	495	CSP	ANM05	
Multi-story cropping, sustainable management of nontimber forest plants	Acres	15,497	19,648		PLT05	
Renovation of a windbreak or shelterbelt, or hedgerow for wildlife habitat	Miles	119	178		PLT06	
Riparian forest buffer, terrestrial and aquatic wildlife habitat	Miles	775	1,064		ANM14	
Riparian forest buffer, terrestrial and aquatic wildlife habitat	Acres	**	9,807		ANM33	
Silvopasture for wildlife habitat	Acres	32,568	33,606		ANM20	
Alley cropping establishment for wildlife	Acres	383	716		PLT14	
Increasing on-farm food production with edible woody buffer landscapes	Acres	**	12		PLT18	
Windbreak/shelterbelt establishment	Miles	9	17		380	
Riparian forest buffer	Acres	72	200		391	
Windbreak/shelterbelt renovation	Miles	2	3		650	

* Acres and miles of CSP agroforestry practices refer to the amount of miles and acres planned while all other FSA and NRCS data refers to the amount of miles and acres applied.

** ANM33 and PLT18 were established in FY 2012, so no data available in FY 2011.

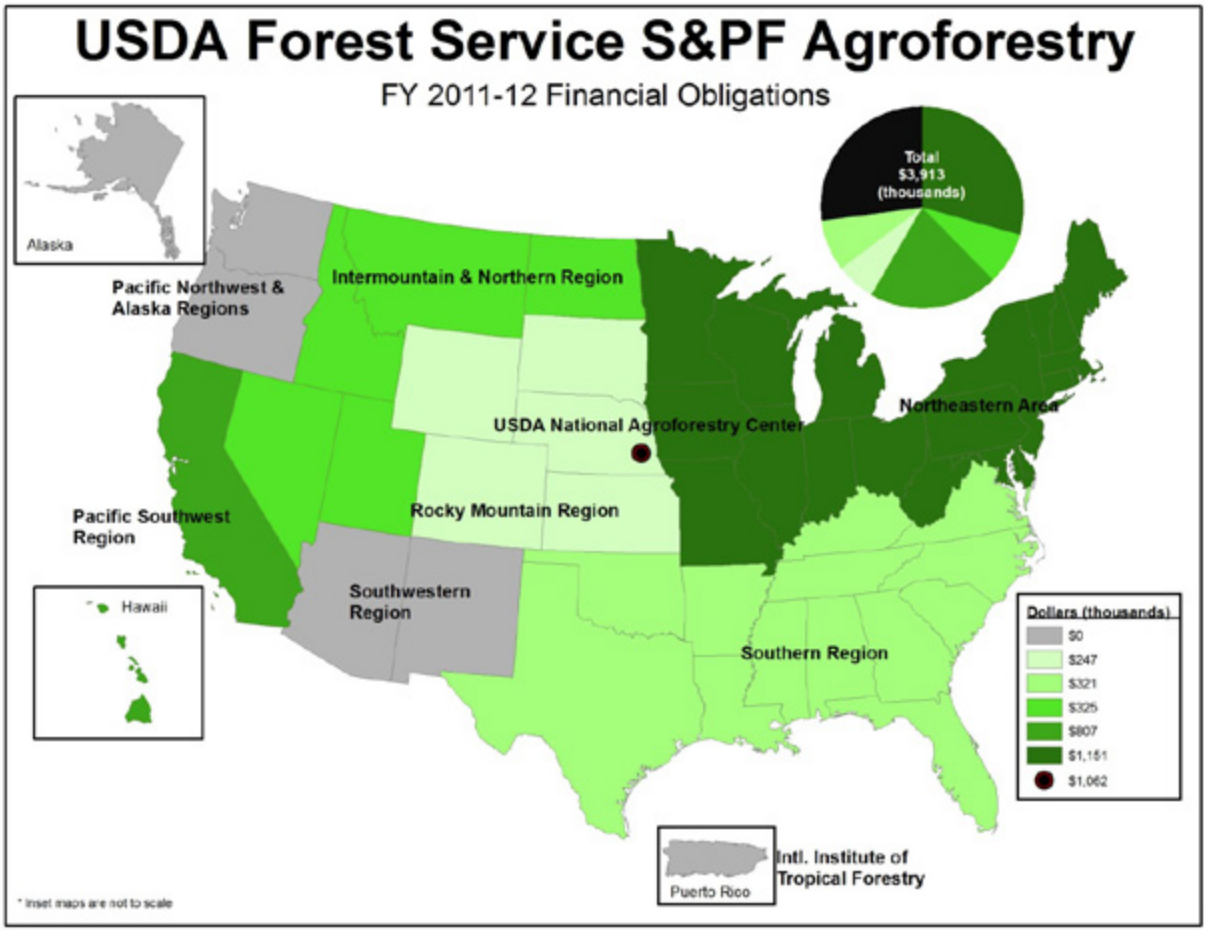
ANM = Animal enhancement practice under CSP. CP = Conservation practice. CRP = Conservation Reserve Program. CSP = Conservation Stewardship Program. FSA = Farm Service Agency. FY= Fiscal Year. PLT = Plant enhancement practice under CSP. NRCS = Natural Resources Conservation Service.

Forestry Programs: Through Forest Service S&PF grants and cooperative agreements, State forestry agencies and other cooperators deliver forestry and agroforestry educational, technical, and financial assistance to landowners and communities; this assistance may include helping with agroforestry

practices or systems. Figure 10 shows the regional distribution of financial commitments to agroforestry-related assistance made by Forest Service through S&PF programs (reported by regions, Northeastern Area, and International Institute of Tropical Forestry), including Forest Stewardship (SPST), Forest Health Management—Cooperative Lands (SPCH), State Fire Assistance—National Fire Plan (SPS2), and Urban & Community Forestry (SPUF). Figure 10 includes the financial obligations to the USDA NAC that support the center's technology development, training, and outreach activities. For more information, see appendix A.

Forest Stewardship Program is a key Forest Service program that enables State forestry agencies to help landowners develop a long-term, multiresource Forest Stewardship management plan that may include agroforestry practices or systems. After completing a Forest Stewardship management plan (or similar forest management plan), landowners are potentially eligible to apply for technical and financial assistance to plan and install agroforestry practices through NRCS conservation programs (e.g., EQIP). State forestry agencies often cooperate with NRCS and FSA to provide technical forestry-related assistance to landowners that supports the application of agroforestry practices.

Figure 10.—FY 2011–12 dollars obligated by Forest Service programs for agroforestry assistance *delivered by State forestry agencies; National Agroforestry Center; Forest Service regions, Northeastern Area, and International Institute of Tropical Forestry; and other cooperators.*



Below are specific USDA-supported partnership activities, aimed broadly at increasing the adoption and application of agroforestry practices/systems.

Northeast:

- **Silvopasture, Forest Farming, and Riparian Forest Buffers in Pennsylvania:** Dickinson College students and faculty surveyed the plants and evaluated invasive plant removal strategies on the school's organic farm. Once the invasive species are removed, they will establish agroforestry practices, including silvopasture and forest farming. They will also convert a riparian pasture on Yellow Breeches Creek to a forested buffer with edible pawpaw and highbush blueberries. Lastly, they will plant trees in an existing pasture to create a silvopasture. To share information about these activities, they plan to host educational workshops and publish case studies. (Forest Service Chesapeake Bay Program 2011–12)

Southeast:

- **Mississippi Outreach to Underserved Private Landowners in Historic Range of Longleaf:** The Mississippi Forestry Commission and the Federation of Southern Cooperatives (FSC)/Land Assistance Fund are educating landowners about community-based forestry programs to conserve the longleaf pine. These programs showcase longleaf pine silvopastures and products, such as pine straw, hay, cattle, higher value wood products, and ecosystem services (carbon sequestration and recreation). They plan to establish a 75-acre demonstration site (see table 2). (Forest Service S&PF Redesign grant 2011–13)
- **Agroforestry Outreach to Minority Landowners in Southeast:** The FSC will develop agroforestry demonstration sites and provide landowner training and youth education to expand the application of agroforestry in Mississippi, Alabama, Georgia, and South Carolina. All materials, training, and demonstrations will be oriented toward addressing land management needs and issues relevant to minority landowners and those on small pieces of land. To accomplish this goal, FSC is working with NAC, Cooperative Extension, NRCS, and others in the four States. (NAC/Forest Service 2010–13)
- **Longleaf Silvopasture Demonstration in Alabama:** A 75-acre silvopasture site was established by the Alabama Forestry Commission on the site of the former Hauss State Forest Nursery for demonstration and potential research activities regarding comparison of longleaf pine and loblolly silvopastures with native grasses and improved pasture grasses. The project is a partnership with the Longleaf Alliance, Forest Service Southern Research Station, Auburn University Extension, and NAC. (NAC/Forest Service 2011–13)

Central:

- **Kansas Windbreak Renovation:** Kansas Department of Agriculture received a 5-year grant to renovate windbreaks through the EQIP. (NRCS Cooperative Conservation Partnership Initiative (CCPI) 2010–15)
- **South Dakota Shelterbelts:** As part of the CCPI, South Dakota Department of Agriculture received funds to renovate shelterbelts to reduce soil erosion, protect livestock and property from wind, improve energy conservation, manage snow deposition, improve air quality, increase carbon storage, and provide wildlife habitat through two EQIP practices: Windbreak/Shelterbelt Renovation (practice 650) and Windbreak/Shelterbelt Establishment (practice 380). (NRCS CCPI 2010–15)

- **South Dakota Maple Syrup Windbreaks:** South Dakota State University was awarded a grant from the South Dakota Department of Agriculture to demonstrate the feasibility of maple syrup production in existing windbreaks and native woodlands. The grant also supported agroforestry education for approximately 30 rural landowners, inspiring at least 5 to begin commercial production in the next 3 years. (AMS Specialty Crop Block Grant 2011)

- **Tennessee Urban Riparian Buffers:** A large group of partner organizations worked with 180 high school students to plant 600 trees in a 100-foot riparian buffer along Seven Mile Creek in an effort to improve the water quality in Nashville, TN. (Forest Service S&PF Redesign grant 2011)

- **Forest Service Redesign Program:** At least three large-scale efforts used Forest Service S&PF Redesign program funds to increase agroforestry practices on State and private land in the Central United States. (Forest Service S&PF Redesign grant 2011).

  These efforts included extension and demonstration sites on the following:

  - Riparian forest buffers in Ohio and Michigan.
  - Protecting black walnut (a key species used in agroforestry) from Thousand Cankers disease in Missouri.

- **Tribal Plantings of Riparian Trees & Shrubs:** Kansas State Research & Extension partnered with the Haskell Indian Nations University, Prairie Band Potawatomi Nation, and the Kickapoo Tribe to propagate and plant rare, culturally important tree and shrub species. Red elm was particularly successful. Plantings occurred in riparian buffers and other places of significance to the tribes. One workshop was held on the Potawatomi Reservation. (NIFA RREA & Tribal College Research Grant Program 2011)

- **Agroforestry Visual Simulations:** The Chequemegon-Nicolet National Forest, NAC, University of Wisconsin Cooperative Extension, NRCS, and Bayfield County plan to expand the 2012 agroforestry demonstration plantings at the Forest Service's Northern Great Lakes Visitor Center in northern Wisconsin to include other native plants of tribal significance. This center receives 100,000 visitors per year and will host agroforestry and rural development workshops in the Bayfield County area. In 2012, Cody Westlund, a student intern from the Red Cliff Tribe, used NAC's CanVis software to create visual simulations of agroforestry plantings as part of a larger effort to develop a conservation catalog (see figure 11). (NAC/Forest Service grant to Bayfield County Extension and Tribal student intern jointly funded by NAC/Forest Service-Forest Service Tribal Relations 2012)

Figure 11.—Simulation of an installed windbreak at the Chequamegon-Nicolet National Forest's Northern Great Lakes Visitor Center.

- **Longleaf Pines for Traditional Basketry**: The Alabama-Coushatta Tribe in Texas worked with NRCS to plant longleaf pine on 400 acres of its reservation land to enable basketmakers to use local longleaf needles rather than having to purchase them out of State. Longleaf pine had been much more prevalent in the parts of east Texas where the Alabama-Coushatta Tribe was settled in the 1700s, but it had been replaced by faster growing pines such as loblolly and slash. This effort is part of the Longleaf Pine Initiative to restore longleaf to its native range. See case study #1 in appendix D (NRCS WHIP 2011–12).

West:

- **Kootenai Riparian Restoration:** The Kootenai Tribe is working with NRCS to restore ecosystem functions along 55 miles of the Kootenai River. Approximately 50,000 acres of floodplain have been lost to agricultural fields, and the Kootenai Tribe has invested $13 million to restore the ecosystem for fish and wildlife. An additional $1.6 million from NRCS, through the CCPI, enabled producers to get 75 percent cost-share to install conservation practices within the riparian area. The producer demand for these practices exceeded expectations, fostering the Kootenai Tribe's vision of a healthy ecosystem with clean, connected terrestrial and aquatic habits, which fully support traditional tribal uses and other important societal uses. (NRCS CCPI 2011)

Islands:

- **Forest Service Redesign Program:** Forest Service S&PF Redesign grants and SPST funds were leveraged to increase agroforestry practices in the Pacific Islands and Puerto Rico:
    - **Hawaii: Waianae Kai Forest Reserve**: The Hawaiian government used indigenous native Hawaiian and Pacific Island agroforestry systems and practices to establish shaded fuel breaks on the 2,328-acre reserve. They also restored areas damaged by grazing and fire by reforesting 20 damaged acres with appropriate native agroforestry trees and shrubs to improve water quality and produce food, wood products, and wildlife habitat. (Forest Service Redesign grant 2011)
    - **Federated States of Micronesia (FSM):**
        - **Kosrae Watershed Areas:** The FSM established Kosrae Watershed Areas and developed Forest Stewardship management plans that focus on managing land within these areas for a number of benefits, including NTFPs and community forestry. (Forest Service S&PF Redesign grant 2011)
        - **Strategic plans:** FSM Department of Resources and Development worked with State forestry offices, the College of Micronesia, and others to determine where to focus agroforestry extension efforts across all States. In addition, Yap State Forestry and Forest Service Pacific Southwest Research Station partnered with Queens University (Australia) and others to evaluate and prioritize research needs using a watershed approach to address food security and biodiversity issues by enhancing agroforestry productivity and watershed protection in the face of climate change. (Forest Service SPST 2012)
        - **American Samoa and the States of Yap and Chuuk extension:** American Samoa Community College is working with landowners and villages to address watershed concerns, agroforestry productivity, and forest health through extension programs that work to maintain greater tree coverage on steep slopes. The FSM Department of Resources and Development is working with the Chuuk and Yap Departments of Agriculture on similar extension programs, drawing on

their indigenous agroforestry knowledge to produce healthy products for food-insecure populations. (Forest Service SPST 2011–12)

- **Puerto Rico:** Coffee is an important crop in Puerto Rico. To help landowners grow coffee, staff from the Forest Service, NRCS, National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, Forest Service, Soil Conservation Districts, and Puerto Rico Department of Natural and Environmental Resources assist landowners in writing Forest Stewardship management plans. Coffee growers in priority areas have identified shade-grown coffee agroforestry practices as a priority for these plans, which address the natural resource challenges laid out in the Puerto Rico State Action Plan. These landowners can then apply to NRCS's EQIP for funding to apply agroforestry practices on the ground. (Forest Service SPST & NRCS EQIP funding 2011–12)

Case Studies

Read the following case studies in appendix D.

Title	Practice	Objective	Agencies	State
#1—Longleaf Pine Needle Baskets for Generations To Come	FF	1.1	NRCS, Forest Service	TX
#2—Managing Forests for Timber, Wildlife—and Organic Blueberries	FF	1.1	NRCS	AK
#3—Pioneering Producer and Supportive Agency Personnel: A Match Made in Agroforestry Paradise	S	1.1	NRCS, FSA	MS
#4—Shelterbelts and Adverse Weather in the Nebraska Panhandle	W	1.1	FSA, NRCS	NE
#5—Silvopasture: More Dollars Per Acre	S	1.1	NRCS, FSA	GA
#6—Hedgerows and Riparian Zones: Tasty Enough To Eat?	R	1.1 and 1.2	NIFA, NRCS, FSA	WA
#9—Bringing Chestnuts Back to American Landscapes and Diets, One Graft at a Time	A	1.1 and 2.2	NIFA, NRCS, AMS	MO
#15—Island of Pohnpei Discovers Its Agroforestry Roots	T	1.1	Forest Service	FSM
A = Alley cropping. AMS = Agricultural Marketing Service. FF = Forest farming or multi-cropping. FSA = Farm Service Agency. NIFA = National Institute of Food and Agriculture. NRCS = Natural Resources Conservation Service. R = Riparian forest buffer. S = Silvopasture. T = Tropical agroforestry. W = Windbreak or hedgerow or living snow fence.				

Next Steps**

- (S1) **Establish a Tribal Relations Agroforestry Working Group.** The Agroforestry Executive Steering Committee plans to establish a working group to use results from the survey of Tribal Conservation Districts and expand outreach with tribal organizations.
- (S1, S2, S3, S4, S5) **Increase Silvopasture Application in Southeast United States.** The Agroforestry Executive Steering Committee is exploring funding opportunities for this initiative,

which will focus on limited-resource and minority landowners in the Southeast United States with pine plantations and expiring CRP contracts who are (1) engaged in livestock production and (2) interested in restoring the longleaf pine ecosystem. The initiative will emphasize cooperation with 1890 land-grant universities including those in the Agroforestry Consortium.

- (S1, S2) **Increase Pacific Islands Agroforestry Extension and Research Capacity.** USDA, State agencies, and university cooperators will continue to pursue funding and other support needed to establish two positions: (1) a regional agroforestry extension agent in Guam to help producers deal with new pests, diseases, and invasive plants affecting agroforests throughout the Pacific Islands; and (2) an agroforestry research scientist to synthesize and deliver agroforestry-related science to help Pacific Island people mitigate and adapt to climate change in the western Pacific, where strand forests and atoll islands are already experiencing the effects of sea-level rise.
- (S1, S2, S3, S4) **Expand Agroforestry Learning Partnerships.** USDA agencies and cooperators will continue to pursue opportunities to initiate and establish other regional agroforestry working groups, peer-to-peer learning networks, demonstration sites, communities of practice, and on-farm/action research.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Objective 1.2: Educate Professionals

Overview

Through workshops and formal education programs, USDA and its partners educate natural resource professionals and provide technical and financial assistance to increase the adoption of agroforestry systems and practices. Although these educational opportunities exist in parts of the country, they are happening on an ad-hoc basis and often depend on the creativity of leaders at land-grant universities and State departments of agriculture and forestry. Silvopasture and shiitake mushroom production seem to be topics of interest on the East Coast; windbreaks in the central region of the country; and forest farming in Puerto Rico and the Pacific Islands, where agroforestry has a long history. Many gaps exist, however, throughout the country where agroforestry has potential but where not many hands-on educational opportunities are available. USDA's Interagency Agroforestry Team will continue to encourage and support opportunities for agroforestry education across the country by sharing resources that have worked well in the past, creating communities of practice and increasing awareness of the various funding opportunities for such education.

Note—Many of these educational activities result in tools and publications that translate the science into practice. Those tools and publications are described in Objective 2.3 (Translate).

Accomplishments

1. (S1) **Colleges and universities have developed agroforestry courses, majors, certificates, and areas of expertise with USDA support**. A Classification of Instructional Programs (CIP) code is not yet available to track agroforestry as a discipline in USDA's Food and Agricultural Education Information System (FAEIS); however, several universities have started to offer agroforestry courses and degrees that enable students and natural resource professionals to become more knowledgeable. Although this list is not comprehensive, these courses and degrees include the following. (Please contact agroforestry@usda.gov to let us know if you are teaching an agroforestry course or if you offer an agroforestry degree.)

    - **Master's:** The University of Missouri Center for Agroforestry offers an online Master's Degree in forestry with focus on agroforestry.
    - **Graduate Area of Focus:**
        - **University of Florida,** School of Forest Resources and Conservation offers a Tropical Forestry & Agroforestry area of focus for its graduate degrees.
        - **Oregon State University**, College of Forestry, Department of Forest Ecosystems and Society offers a Sustainable Forestry and Agroforestry Option.
    - **Community College Programs:**
        - Joliet Junior College, in Illinois, is developing a "Sustainable Plant and Food Production" certificate, which will include agroforestry in the introductory course and as a new stand-alone course (transferable to Roosevelt University). (NIFA 2011–13)
        - Hawaii Community College offers a Tropical Forest Ecosystem and Agroforestry Management Associate's Degree.

- The Forest Service has supported the Micronesian Conservation Trust, colleges, and State foresters in the Micronesia region to provide continuing education for agroforestry practitioners at community colleges that can lead to associate's degrees. This support is important because island agroforestry extension agents have not had education opportunities, and this program provides basic education as a foundation and enables professionals to describe indigenous agroforestry practices in terms that U.S. scientists can understand. (Forest Service SPST 2012)

- **Classes:** Many other universities offer courses in agroforestry.
  - Alcorn State University
  - Iowa State University
  - North Carolina A&T University
  - North Carolina State University
  - Oregon State University
  - Pennsylvania State University
  - University of California–Berkeley
  - University of Florida
  - University of Georgia
  - University of Hawaii
  - University of Missouri
  - University of Nebraska-Lincoln (Note: USDA NAC is on the University of Nebraska-Lincoln campus)
  - Virginia Tech

- **Study Abroad:** USDA NIFA supported several international science exchange programs in agroforestry. These exchange programs are listed under Objective 1.3.

2. (S3) USDA agencies partnered to provide **learning opportunities** for landowners, managers, and natural resource professionals, including the following.

   Nationwide:

   - **Silvopasture Online Course:** Developed a silvopasture online course with seven modules that teach about site preparation; tree species; and canopy, cattle, and forage management. After completion of all modules and quizzes, the user receives 3.0 continuing forestry education credit hours from the Society of American Foresters (SAF). (NAC and University of Georgia-Athens 2011)

   - **Silvopasture Webinar:** Held the first nationwide agroforestry Webinar on silvopasture with 347 attendees. (NAC, NRCS-Louisiana, and North Carolina State Extension 2011)

   - **12th Annual North American Agroforestry Conference:** University of Georgia held this conference from June 4–9, 2011. There were 164 attendees, including extension and natural resource professionals, consultants, landowners and managers, policy makers, scientists, and students from 20 States and 7 foreign countries. (NIFA RREA funds 2011)

     Key aspects of the conference are included in the following:

     - USDA Deputy Secretary Kathleen Merrigan spoke at the opening plenary session and released the Strategic Framework.
     - Tours highlighted research and real-world farms: goat silvopasture (Fort Valley Small Ruminant Research and Extension Center), longleaf pine/cattle silvopasture (NRCS Plant Materials Center in Americus), riparian buffers (Georgia Coastal Plain Experiment

Station in Tifton), alley cropping, silvopasture (sheep used to manage invasive species in riparian areas), bioenergy, small-scale forest production of medicinals and mushrooms, and a vineyard where sheep graze orchards (off-season).
    - The conference produced a proceedings, a temperate agroforestry network between North America and Europe, and support for a Global Agroforestry Coalition to share science and technologies that support agroforestry adoption worldwide.

- **(S2) Certification of Agroforesters:** Agroforestry professionals from USDA, land-grant universities, the States of Indiana and Nebraska, and private industry coauthored a commentary in the *Journal of Forestry* that asks the SAF to consider establishing a "Certified Agroforester" program in partnership with the Tri-Societies (American Society of Agronomy, Crop Science of America, and Soil Science Society of America). This new credential could incorporate elements of existing certification programs, such as SAF's Certified Forester® and the American Society of Agronomy's Certified Crop Advisor. The commentary is titled "Advancing Agroforestry through Certification of Agroforesters: Should the Society of American Foresters Have a Role?" and was published in the December 2012 issue of the *Journal of Forestry*.

- **Agroforestry Cooperative Development:** USDA Rural Development (RD) funds cooperative development centers that provide technical assistance to those who want to form sustainable agroforestry, forestry, and agriculture cooperatives. RD provides support through Rural Cooperative Development Grants and other grants. Below are two examples:

    - **Cooperative Development Services (CDS).** These organizations have helped "many sustainable forest owner cooperatives and associations develop since 1998. They strive to provide their members with a return equal to or greater than what they would get from a traditional timber buyer, while at the same time maintaining or improving the ecological and aesthetic condition of their woods." (RD Rural Cooperative Development Grant 2011–12)

    - **WoodWorks:** This national network of cooperative development organizations helps farmers and rural landowners transform private forest land and marginal farmland into productive resources. They fulfill this mission by providing educational workshops on sustainable land management and technical assistance to help landowners form forestry and agroforestry cooperatives and associations. They have been awarded funds from both USDA's RD and Forest Service.

Northeast:

- **Agroforestry in Pennsylvania:**

    - **Forest Farming:** Pennsylvania State University held three forest farming workshops for farmers, woodland owners, and consulting foresters, with an emphasis on mushrooms and maple syrup. (Forest Service 2011)
    - **Agroforestry at the annual Pennsylvania Agricultural Sustainability Association (PASA) Conference:** For 3 years in a row, Pennsylvania State University Forestry Extension partnered with PASA, Shaver's Creek Environmental Center, and the Pennsylvania Department of Conservation & Natural Resources' Bureau of Forestry to provide a 2-day preconference workshop at the annual PASA conference. (NIFA 2009–11)
    - **On-Farm Workshops:** Pennsylvania State Forestry Extension and Cornell University Extension partnered with Shaver's Creek Environmental Center, and the Pennsylvania Department of Conservation & Natural Resources, Bureau of Forestry to hold four workshops for natural resource professionals (including technical service

providers). The workshops focused on silvopasture, forest farming, and riparian forest buffers. All workshops had on-farm components to show agroforestry in action. Afterward, the workshop leaders guided agroforestry demonstration site development at several sites including Dickinson University. Attendees came from Pennsylvania State University, Pennsylvania Bureau of Forestry, NRCS, ARS, Fulton County Conservation District, Pennsylvania State University-Extension, Chesapeake Bay Foundation, Franklin County Conservation district, Alliance for the Chesapeake Bay, Dickinson College, Cornell University Extension, and Maryland Forestry. (Forest Service Chesapeake Bay program, NIFA capacity funds 2011–12)

- **Silvopasture in New York and New Hampshire:** Cornell University Extension held two 1-day silvopasture courses at farms in New York and New Hampshire for 85 graziers, foresters, and government employees. Course topics included site evaluation, economics, planning, and best practices. See also Objective 2.3. (NIFA RREA funds 2012)
- **Windbreaks and Living Snow Fences in New York:** Cornell University Extension and NRCS held the first agroforestry field day in New York with field tours to show windbreaks, biofuel crops, living snow fences and to teach people how to establish these practices. (NRCS and NIFA capacity funds 2012)
- **Forest Farming in Maine:** University of Maine Cooperative Extension led three workshops on NTFP production, and now at least four participants have begun selling NTFPs to pay property taxes. (NIFA RREA funds 2011)
- **Polyculture Design: Intensive Planting of Mixed Annuals and Perennials in Appalachia:** Seeing the effect of the economic recessions on nearby farmers, an entrepreneur worked with an Ohio State University entomologist and students from Hocking College to demonstrate the potential for producing high yields on small acreage through the intensive and intentional mixing of annuals and perennials. The demonstration plot aims to produce high-yielding crops of high-nutritional quality that also provide habitat for pollinators and wildlife and build topsoil. (NIFA-SARE grant 2009–11)
- **Delaware Agroforestry:** Between 2007 and 2011, 35 educational events were held to promote agroforestry and bioenergy economic opportunities. (NIFA RREA funds 2011)
- **Forest Farming of Shiitake Mushrooms in New England:** Cornell University led a series of workshops on shiitake mushroom cultivation for approximately 400 farmers. See also case study #7 and Objectives 2.2 and 2.3. (NIFA-Northeast SARE grant 2010)

Southeast:

- **Beginning Farmer Training in Agroforestry in Arkansas:** The University of Arkansas created a comprehensive online modular training program for new and beginning farmers (28 modules). It focuses on integrated poultry, livestock, and agroforestry systems, with an emphasis on Spanish-speaking populations and returning veterans. In its first year, they developed farmer networks and 32 mentoring opportunities, and they reached 800 people through workshops, seminars, and conferences. Of these people, 65 were veterans or military personnel, and 55 were African-American farmers. (NIFA Beginning Farming and Ranching Development Program 2010–13)
- **The 1890 Agroforestry Consortium** (see Objective 1.1)**:** The consortium hosted 37 participants from nine 1890 land-grant universities to build skills related to agroforestry,

which ranged from establishing agroforestry demonstration sites to grant writing. (NAC, 1890 Agroforestry Consortium, and Forest Service 2011)

- **Edible Riparian Buffers and Forest Farming in Virginia:** To enhance the Chesapeake Bay Watershed, Virginia Tech trained more than 50 landowners to grow floral and edible plants in riparian and other marginal lands by establishing native fruit and nut tree riparian buffers at the Catawba Sustainability Center demonstration site (see table 2). They hosted 15 public presentations that reached 200 stakeholders. They developed materials, such as fact sheets, newsletter articles, and how-to publications, which can be found on the Virginia Cooperative Extension Web site (listed below). (NAC and Forest Service funded 2011–12).

  See also Objective 2.2:

  - Native Fruit and Nut Trees of Virginia's Mountains and Piedmont.
  - Woody Florals for Income and Conservation. Virginia Cooperative Extension Fact Sheet.
  - How to Plan for and Plant Streamside Conservation Buffers Using Native Fruit and Nut Trees and Woody Floral Shrubs.

- Silvopasture Workshops:
  - **Georgia:** A forestry workshop included sessions for silvopasture and alley cropping operations as well as information about USDA programs that can assist such operations. (NRCS, University of Georgia, Georgia Forestry Commission, Fort Valley State University and Abraham Baldwin Agricultural College, and Georgia Department of Natural Resources 2012)
  - **North Carolina:** NC A&T University led workshops on incentive programs and the economic and conservation benefits of silvopasture in the Southeastern United States for small farmers and woodland owners. (NIFA RREA funds 2012)
  - **Alabama:** Tuskegee Cooperative Extension staff led workshops to teach landowners alternative ways to manage small woodlots and how to apply silvopasture techniques. (NIFA RREA funds 2011)

- **Rainwater Catchment Training and Shiitake Mushroom Production in Alabama:** Responding to the severe drought, Alabama A&M University trained 78 extension agents and specialists how to catch rainwater for use in shiitake mushroom production. These agents then trained nearly 3,000 producers, which resulted in more than 8 on-farm demonstrations and many inoculated logs. They also conducted several demonstrations for the general public, which reached an additional 1,600 people. Fifty-seven producers adopted shiitake mushrooms as a new crop. (NIFA RREA funds, 2009–11)

- **Forest Farming in Kentucky:** University of Kentucky held 154 programs with 7,827 attendees to provide economic opportunities for forest owners and rural communities, some of which included the production of NTFPs such as shiitake mushrooms and maple syrup. (NIFA RREA funds 2006–11)

- **Alley Cropping for Bioenergy Along the Mississippi River:** University of Arkansas and the Louisiana State University AgCenter produced three field tours, nine landowner and natural resource professional workshops, and one Webinar to share information about their cottonwood and switchgrass alley cropping system to produce feedstock for cellulosic biofuel (see also Objective 2.2).

Central:

- **Perennial Agriculture to Combat Hypoxia in the Gulf of Mexico:** The Leopold Center for Sustainable Agriculture engaged with several partners of the Mississippi basinwide Green Lands Blue Waters Initiative to hold 4 agroforestry workshops for producers and 93 Walk and Talk events to introduce farmers and ranchers to continuous living cover practices that included agroforestry. The group also collaborated to secure funding for the recently established MAAWG that will soon launch Agroforestry Academies for professionals in the Midwest (see Objective 1.1). Key partners of this effort include Iowa State University; University of Minnesota; Minnesota Institute for Sustainable Agriculture; University of Michigan; Midwest Cover Crops Council; ARS National Laboratory for Agriculture and the Environment; Iowa State University: Leopold Center for Sustainable Agriculture, College of Agriculture and Life Sciences, Extension and Outreach, and Iowa Learning Farms; Practical Farmers of Iowa; and Rural Advantage, MN. (NIFA grant 2010–13)
- **Agroforestry Training for Upper Midwest Extension:** University of Missouri Cooperative Extension held introductory agroforestry workshops for extension and other natural resources professionals. They are also developing a series of six videos on the principles of agroforestry for farmers in the Upper Midwest that will comprise a new online agroforestry curriculum. (NAC and NIFA-SARE funding 2010–12)
- **Elderberry in Missouri:** The River Hills Elderberry Producers are developing marketing plans, investigating distribution and supply chain options, and facilitating a comprehensive elderberry workshop for elderberry producers. Meanwhile, the University of Missouri is planning to host the first international elderberry symposium (June 10–13, 2013) in Missouri. (AMS–Specialty Crop Block Grant and NIFA AFRI grant funding 2012)
- **Tribal Nursery Management in Wisconsin:** The College of the Menominee Nation hosted a workshop on producing native plant materials within agroforestry systems to support tribal economic and cultural objectives in Wisconsin. Attendees came from the College of the Menominee, Menominee Tribal Enterprises, a local tribal high school, the Oneida Tribe, the Keweenaw Bay Indian Community, the Sault Tribe of Chippewa Indians, and Redlake Band of Chippewa Indians. (Funded by NAC, Forest Service's Reforestation, Nurseries, and Genetic Resources Team and the Rocky Mountain Research Station [RMRS] 2011)
- **Agroforestry in Wisconsin:** The University of Wisconsin Extension held a workshop on windbreaks, alley cropping, silvopasture, polyculture and permaculture, multistory forest cropping, riparian buffers, integrated specialty crops (raspberries, asparagus, hazelnuts, chestnuts, etc.), and more. (SARE-PDP, NAC 2011)
- **U.S.-Canada Great Plains Windbreak Conference:** NAC and ADC, with other Federal, State, and provincial partners, jointly sponsored the Great Plains Windbreak Renovation and Innovation Conference in July 2012 at the International Peace Garden (Manitoba-North Dakota border). The workshop brought together scientists, natural resource professionals, and landowners to share science and expertise in renovating windbreaks, some which were first established to slow soil erosion during the Dust Bowl era. They also discussed ways to design windbreaks so they are truly multifunctional. Approximately 82 participants from 11 States and 3 provinces attended the conference in person, and 35 joined remotely. The conference generated considerable media attention (see appendix E). (NAC and NRCS 2012)
- **Riparian Buffers and Shelterbelts in North Dakota:** State and Federal partners in North Dakota provided training to landowners and natural resource professionals to increase

participation in shelterbelt renovation and riparian forest buffer restoration through NRCS's EQIP. (North Dakota Association of Soil Conservation Districts, North Dakota State University Extension Service, NRCS, North Dakota Forest Service [NDFS], and North Dakota State Soil Conservation Committee, with funding from NRCS & Forest Service Redesign 2011)

- **Riparian Buffer Workshop in Kansas:** Kansas State Research & Extension taught more than 55 people about riparian buffers and agroforestry at a field day. (NIFA RREA funds 2011)
- **Shiitake Mushroom Workshops in Tennessee:** Tennessee State University Cooperative Extension led workshops for 56 woodland owners, 46 of whom have adopted the production techniques and are teaching their families. Many of the participants also attended a hands-on inoculation workshop in which 900 hardwood logs were inoculated. In addition, the workshops also presented a broader prospective of forest management for woodland owners who have only recently started harvesting mushrooms. (NIFA RREA funds 2011)

West:

- **Riparian Buffers in Colorado and Wyoming:** Colorado and Wyoming agencies held two training sessions and established three demonstration sites in the Platte and Republican River Watersheds to teach landowners and natural resource professionals how to enhance riparian areas. (Colorado State Forest Service, Wyoming State Forestry Division, Conservation and Natural Resources Districts, County Weed Division Supervisors, Republican River Restoration Partnership, and Cooperative Extension Agencies, Colorado Division of Wildlife and NRCS; Forest Service Redesign funds 2011)
- **Olive Hedgerows in California:** University of California-Davis researchers demonstrated that a moderate density olive hedgerow orchard, trained on wire trellis and pruned, yields as efficiently as vase-trained trees (NIFA Hatch funds 2011). Now, two major commercial growers are planting 800 acres in such hedgerow orchards. In addition, at the Russell Ranch Sustainable Agriculture Facility Field Day, a variety of University of California-Davis researchers, students, and others launched a project to create extensive hedgerows throughout the facility.

Islands:

- **Alley Cropping and Silvopasture in Hawaii:** On the island of Molokai, an alley-cropping demonstration for native Hawaiians integrated production of understory shade-tolerant plants (ginger and kava) with high-value culturally important hardwood trees. Later on, a pastured poultry system was developed and demonstrated within the alley cropping system. To do so, forage legumes (alfalfa, lablab, and cowpea) were interplanted with the trees rather than kava and ginger (see Objective 2.2). In addition, University of Hawaii Extension provided agroforestry workshops for extension agents and small farmers in Kona, Guam, and Palau, and a survey and workshop about shade-grown coffee were conducted in Kona. This survey helped NRCS make agroforestry recommendations to new coffee farmers. After these workshops, extension agents are integrating more fruit trees, particularly avocados, into windbreaks. (NIFA RREA funding 2006–11)
- **Puerto Rico Extension Agroforestry for Climate Change:** University of Puerto Rico-Mayaguez Cooperative Extension held 12 workshops on agroforestry, soil erosion, and storm water runoff control. Of the 294 participants, 137 adopted agroforestry practices, which

greatly exceeded their target of 50 by 2016. This effort, a part of their Climate Change Program, is detailed in their plan of work. (NIFA-Smith-Lever funds 2011)

- **Cacao, Coffee, and Kava in Hawaii:** The University of Hawaii-Extension is leading workshops to help growers mitigate pest management issues caused by the coffee berry borer that was recently found in Hawaii. They are also experimenting with new varieties of cacao and have found that they can grow them from seed. They found that their 2011 Hawaii Chocolate Festival caused farmers to increase cacao production by 50 percent, with the number of cacao farms increasing by 20 percent. In addition, the 2010 Kava Festival had 1,200 participants, and several new Hawaii-grown kava products were on the market. Lastly, they are also witnessing increased demand for kava ready-to-drink relaxation products, so they are working on the marketing and production for kava. (NIFA Hatch funds 2012–17)

Case Studies

Read the following case studies in appendix D.

Title	Practice	Objective	Agencies	State
#6—Hedgerows and Riparian Zones: Tasty Enough to Eat?	R	1.1 and 1.2	NIFA, NRCS, FSA	WA
#7—Shiitake Mushrooms: A Commercial Forest Farming Enterprise	FF	1.2	NIFA	NY
#10—Hazelnuts, Hickory Nuts, and Walnuts, Oh My!	S & W	1.2 and 2.2	NIFA	OH
#13—Oregon Woodland Owners Enter a New World of Possibilities With Oregon Grape	A & R	1.2, 2.2, and 2.3	RD, NIFA, NRCS	OR
#14—Virginia Is for Lovers—and Silvopasture	S	1.2 and 3.1	NRCS	VA
A = Alley cropping. FF = Forest farming or multi-cropping. FSA = Farm Service Agency. NIFA = National Institute of Food and Agriculture. NRCS = Natural Resources Conservation Service. R = Riparian forest buffer. RD = Rural Development. S = Silvopasture. W = Windbreak or hedgerow or living snow fence.				

Next Steps**

(S1, S2, S3) **Conduct Midwest Agroforestry Academies.** USDA agencies will cooperate with the Center for Agroforestry at the University of Missouri and others in the Mid-America Agroforestry Working Group to conduct 2013–14 agroforestry academies for resource professionals in the Midwest (Nebraska, Iowa, Missouri, Minnesota, and Wisconsin). The academies are supported by a 2012 SARE grant. USDA agencies will also consider opportunities to initiate agroforestry academies in other regions (e.g., Southeast, in cooperation with 1890 land-grant universities).

(S2) **Increase Agroforestry Literacy at USDA**. The USDA Agroforestry Executive Steering Committee will consider opportunities to increase agroforestry literacy across USDA and with cooperators. Options include developing an *Agroforestry 101* training module similar to the *Organic 101* and *201* modules available at http://www.ams.usda.gov/organicinfo for the public and on AgLearn for USDA employees.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Objective 1.3: Engage Globally

Overview

USDA agencies support the exchange of agroforestry technology between the United States and other countries to increase the global knowledge and application of agroforestry practices. In 2012, the USDA signed a MOU with its Canadian counterpart to partner on several agroforestry efforts, including a windbreak conference and research on carbon sequestration. USDA also provided input to the United Nations' Food and Agriculture Organization's (FAO) agroforestry guidelines, provided expertise for at least three large international development efforts in Africa and the Middle East, and enabled three international scientific exchanges between universities in the United States and in Africa and Latin America.

Accomplishments

1. **(S1) Initiate partnerships between the U.S. agroforestry community and other international agroforestry organizations to advance global and domestic food security and economic well-being.**

    - **FAO Agroforestry Guidelines:** In January 2012, the Forest Service, with input from the members of the Interagency Agroforestry Team and Agroforestry Executive Steering Committee, provided comments and suggested edits to the United Nations FAO on their draft agroforestry guidelines. This commentary was in response to a request Forest Service Chief Tidwell received from Michelle Gauthier, Forestry Department, United Nations FAO, in Rome. The FAO Guidelines, "Advancing Agroforestry on the Policy Agenda: A Guide for Decision-Makers" were released on February 5, 2013.

    - **U.S.-Canada Partnership:** In early 2011, NAC and Canada's ADC agreed to 11 joint actions to accelerate the application of temperate agroforestry systems in the United States and Canada. The following actions have been completed:

        - MOU signed by USDA Deputy Secretary Kathleen Merrigan and AAFC Deputy Minister John Knubley in Washington, DC, on April 17, 2012.
        - Two presentations regarding the emerging role of agroforestry in national and international climate change strategies at the 12th North American Agroforestry Conference, June 2011, Athens, GA.
        - Translation of NAC's *Conservation Buffer Guide* into French for use in Canada.
        - USDA Deputy Secretary Merrigan and AAFC Assistant Deputy Minister Merchant both spoke at the opening plenary of the North American Agroforestry Conference.
        - Joint paper, "Branching out: Agroforestry as a climate change mitigation and adaptation tool for agriculture" published in *Journal of Soil and Water Conservation*, a special edition on Climate Change Conservation Practices, September/October 2012.
        - NAC and ADC shared approaches and information regarding working with tribes and First Nations communities to advance agroforestry adoption.
        - NAC and ADC partnered with other Federal, State, and provincial partners to sponsor the Great Plains Windbreak Renovation and Innovation Conference, July 2012, at the International Peace Garden (Manitoba-North Dakota border).

    - **Afghanistan:** In 2011, NAC, NRCS, and the Nebraska Forest Service jointly provided training in tree care, planting, and agroforestry design guidelines for the Nebraska Air and Army

National Guard's Agribusiness Development Team that was sent to Afghanistan. The team was in Afghanistan July 2011 through May 2012 to work with local government, university, and nongovernmental organizations personnel to improve agricultural and forestry extension efforts. NAC and NRCS also provided information and resources to NRCS employees planning to serve in Afghanistan starting in December 2012. This follows 5 week-long training sessions on natural resource management that NRCS and the FAS held previously for 145 members of National Guard Agribusiness Development Teams. These sessions included information on riparian buffers and windbreaks. (Forest Service, NRCS, NAC, and FAS 2011–12)

- **Belize/Virginia Education and Science Exchange:** Virginia Tech worked with the University of Belize to run a program that jointly trained extension agents and students about agricultural and natural resource issues emerging in the United States using Belizean examples. Part of the emphasis was on the role of NTFPs in the economies of both Belize and Virginia and issues associated with them, such as poaching. (NIFA International Science and Education grant 2008-11)

- **Costa Rica/Missouri Science and Education Exchange:** To internationalize their master's degree in agroforestry and some other aspects of their forestry degree programs, the University of Missouri has partnered with Lincoln University (1890 land-grant university), Missouri Forestry Products Association, Tropical Agricultural Research and Higher Education Centre, and EARTH University to collaborate on research, education, and extension (NIFA International Science and Education grant 2011). For more information, see the summer 2012 issue[10] of Green Horizons, a quarterly newsletter of the University of Missouri.

- **Cameroon Agroforestry Research:** A Virginia Tech graduate student is examining social aspects of the cooperative implementation of agroforestry by refugees from the Central African Republic and Cameroonians. In the past 5 years, 80,000 Central African Republic refugees have come to Cameroon and concerns exist about the future food and fiber security given the increasing populations. (Student advised by Virginia Tech Extension and partnered with the International Medical Corps and Trees for the Future and International Relief Development; NIFA Smith-Lever funds 2012)

- **Congo Basin—Central African Regional Program for the Environment:** FAS and the University of Missouri are leading an initiative to promote sustainable natural resource management in the Congo Basin forest, which is the second largest contiguous moist tropical forest in the world. The forest plays a key role in securing the livelihoods of Central African citizens across nine countries while providing critical habitat for biodiversity and supplying vital regional and worldwide ecological services. Agroforestry was advanced through a number of efforts, including a small grants program that supported several locally run agroforestry efforts aimed at enhancing food security and alleviating poverty. Partners include the World Agroforestry Center and the World Bank, which is supporting the program after the initial funding from the United States Agency for International Development (USAID) terminated in 2012. (Funded by an interagency PASA agreement with the USAID Mission in Kinshasa and the World Bank and FAS 2003–12)

- **Guinea and Sierra Leone—Sustainable and Thriving Environments for West Africa Regional Development (STEWARD):** Forest Service established 35 hectares of banana demonstration sites and 3,354 hectares of community forests in eight communities. The STEWARD program focuses on transboundary priority zones in the Upper Guinean Forest Ecosystem. (USAID and Forest Service-International Programs funds 2010–12)

[10] Stelzer, H. 2012.

- **Program in Environmental Governance in Guinea (PEGG) for Capacity Building and Biodiversity Conservation:** The Forest Service is working with the Peace Corps and the Guinea Ministries of Environment, Agriculture, and Livestock to strengthen and implement policies, laws, codes, international conventions, and better management tactics for natural resources management and biodiversity conservation in Guinea. Four community-managed Agroforestry Management Zones (461 hectare) were established in 2012. (USAID and Forest Service-International Programs funds 2012–13)
- The NAC director was interviewed and quoted in a Climate Wire article regarding how agroforestry practices are relevant to both the United States and Africa in terms of drought mitigation (see appendix E).

Case Study

Read the following case study in appendix D.

Title	Practice	Objective	Agencies	State
#8—Agroforestry Research Partnerships: From North Carolina to the World	A & S	1.3 and 2.2	ARS, NAC, and NRCS	NC
A = Alley cropping. ARS = Agricultural Research Service. NAC = National Agroforestry Center. NRCS = Natural Resources Conservation Service. S = Silvopasture.				

Next Steps**

(S1) **Implement U.S.-Canada Agroforestry Memorandum of Understanding**. The NAC will continue working with Canada's Agroforestry Development Centre and other cooperators to implement agreed-upon actions consistent with MOU's purpose: to advance the application of temperate agroforestry systems by focusing on science and tools for climate change mitigation and adaptation.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Goal 2: SCIENCE

Advance the understanding of, and tools for, applying agroforestry

Desired Outcome: Tailored science-based agroforestry tools are created and used by landowners, managers, tribes, and communities to address complex environmental, economic, and social conditions across all lands.

Introduction

What happens when you introduce trees into an agricultural system?

How can we mimic natural systems to cycle nutrients more efficiently?

What are the impacts of agroforestry systems on water, soil, air, yield, and profits?

How can we quantify the costs and benefits?

What factors currently prevent producers from adopting agroforestry practices more broadly?

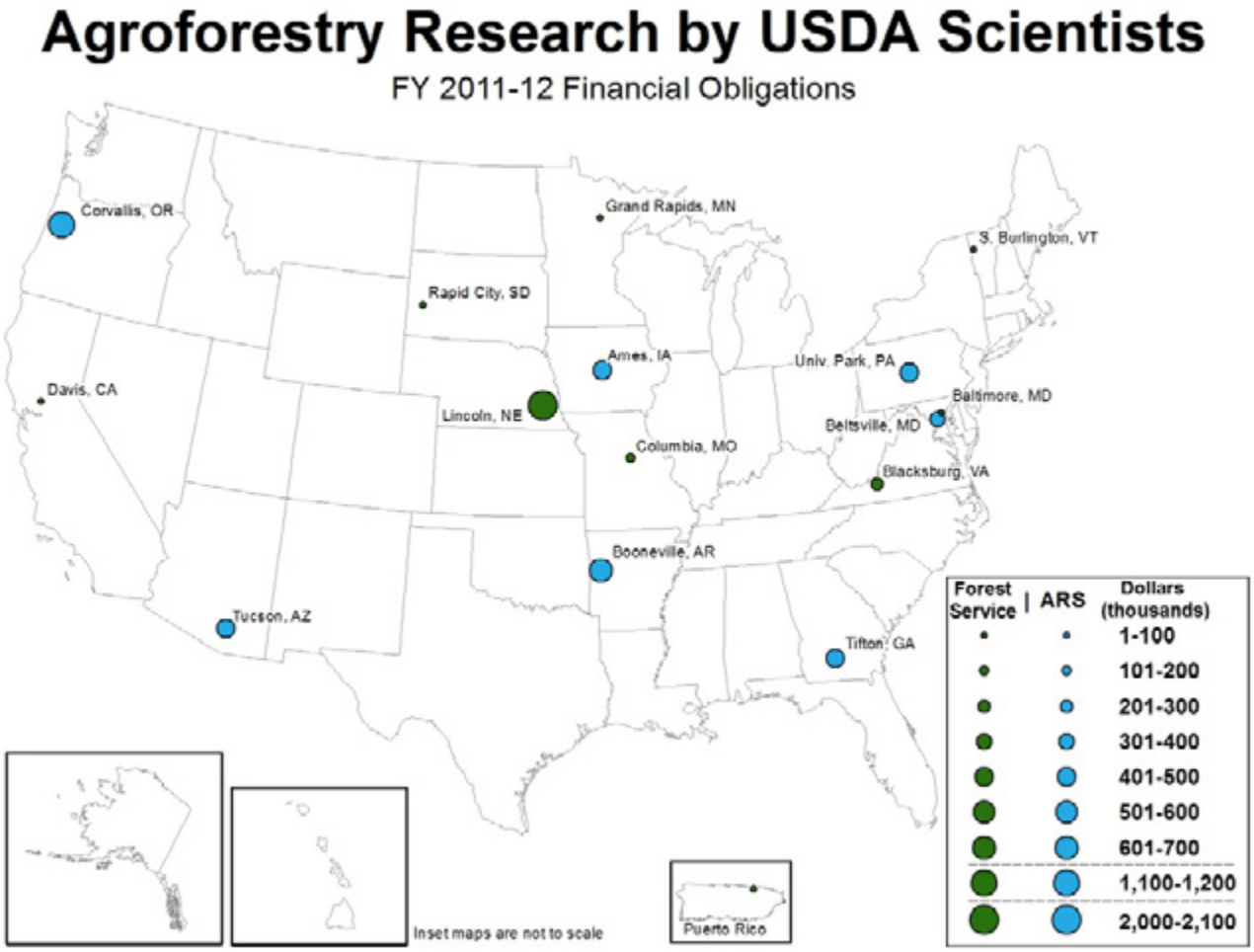
To answer these questions and many more, the U.S. Department of Agriculture (USDA) supports agroforestry-related science, both through its own intramural research and by funding scientists at institutions across the country. USDA's efforts to advance agroforestry science are organized by the three objectives of this goal: (1) plan, (2) discover (conduct research), and (3) translate findings and innovations into products and services. Those objectives correspond to the following three sections, in which we describe how USDA has made agroforestry science a priority and how scientists across the country are advancing agroforestry and creating useful tools. A few of the more noteworthy efforts are described in several case studies (see appendix D); and at the end of each section, we identify next steps.

Intramural agroforestry research and development is conducted by USDA scientists at Agricultural Research Service (ARS) and Forest Service locations across the country (see figure 12), and USDA supports scientists at colleges and universities to carry out this work as well. The main recipients of USDA research, extension, and education funds are 1862, 1890, and 1994 land-grant universities, which are identified in figure 13 along with six non-land-grant institutions (see also table 5).

During the 2-year period, USDA supported scientific activities have begun to address 8 of the 11 strategies in Goal 2. Although considerable progress was made during fiscal years (FY) 2011–12, much work remains to build agroforestry's science and delivery system to meet current and projected future demands. For example, we need to be able to account for a wide range of ecosystem services derived from agroforestry systems (e.g., water quality improvement, net carbon sequestration, and habitat) and to determine how to best establish these systems on the ground in ways that are customized for targeted audiences and regions.

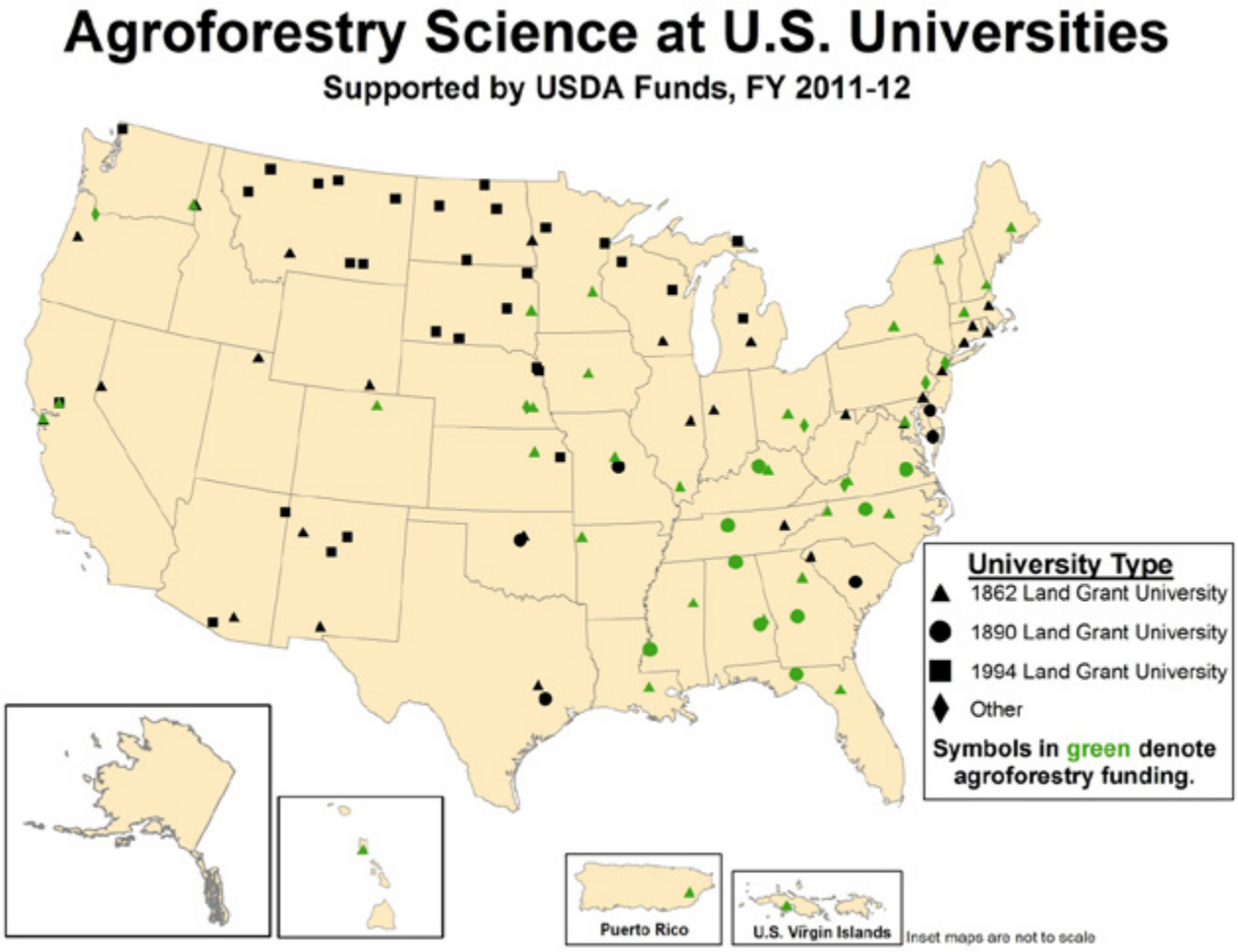
Although the number of agroforestry research and development activities has greatly increased since the 1980s, these efforts are, for the most part, disconnected, often using different sampling protocols. This lack of coordination greatly limits our ability to efficiently build the science base needed for developing local, regional, and even national guidelines for agroforestry systems. The *USDA Strategic Framework for Agroforestry, Fiscal Year 2011-2016* (*Strategic Framework*) has been instrumental in highlighting the need for increased interagency coordination among USDA research agencies; we highlight in this section several examples of cross-agency partnership activities. Building on the inventory of activities in this report, USDA will increase coordination across its agencies and programs to efficiently direct resources and accomplish the highest priority strategies of the *Strategic Framework*.

Figure 12.—USDA locations conducting agroforestry science. Symbol size corresponds to the summed total of USDA dollars obligated in both FY 2011 and FY 2012.



ARS = Agricultural Research Service.

Figure 13.—Land-grant universities and other institutions conducting agroforestry science in FY 2011–12.



Note: Land-grant universities not conducting agroforestry research are shown in black. Symbol shape refers to the type of institution.

Table 5.—Land-grant universities and other institutions conducting agroforestry science with USDA support in FY 2011–12.

Land-Grant Universities	Other Institutions
Alabama A&M University	Hocking College
Alcorn State University	Institute for Culture and Ecology
Appalachian State University	New Jersey Institute of Technology
Auburn University	Ursinus College
Colorado State University	Radford University
Cornell University	Organic Crop Improvement Association
Florida A&M University	
Fort Valley State University	
Iowa State University	
Kansas State University	
Kentucky State University	
Louisiana State University	

Land-Grant Universities	Other Institutions
Mississippi State University North Carolina A&T University North Carolina State University The Ohio State University South Dakota State University Southern Illinois University Tennessee State University Tuskegee University University of Arkansas University of California—Berkeley University of California—Davis University of Florida University of Georgia University of Hawaii University of Kentucky University of Maine University of Maryland University of Massachusetts University of Minnesota University of Missouri University of Nebraska University of New Hampshire University of Puerto Rico University of the Virgin Islands University of Vermont Virginia Polytechnic Institute and State University Virginia State University Washington State University	
A&M = Agricultural & Mechanical. A&T = Agricultural & Technological.	

Objective 2.1: Plan

Overview

The *Strategic Framework* directs USDA to "form an interagency team to identify, assess, and prioritize agroforestry science and technology needs and outcomes to improve the quality, relevancy, and performance of end-user products." Although this report begins to describe the landscape of agroforestry research, convening an interagency team to assess and prioritize the scientific needs will be a next step.

Because it falls at the intersection of agriculture and forestry, the recently chartered Agroforestry Executive Steering Committee includes three research agencies that support agroforestry: ARS, an intramural research agency that focuses on food, agriculture, and natural resources; the National Institute of Food and Agriculture (NIFA), which funds research, economics, extension, and education related to food, agriculture, natural resources, and communities; and the Forest Service, which carries out research to improve the health and use of forests and grasslands, including the agroforestry activities at the National Agroforestry Center (NAC). Until now, however, agroforestry has been a small part of their portfolio and has not been done under an overarching strategic plan.

Historically, the core of USDA's agroforestry research and development has been carried out by Forest Service scientists at NAC in cooperation with other Forest Service and land-grant university scientists and by ARS scientists at various locations across the country, including the Dale Bumpers Small Farms Research Center (Booneville, AK) and the Appalachian Farming Systems Research Center (Beaver, WV)[11]. The Natural Resources Conservation Service (NRCS) has also actively cooperated with Forest Service and ARS to describe agroforestry science and technology needs.

Agroforestry has also been featured as a component of other USDA strategic plans in the past few years. Both the cross-USDA Action Plan for Science (released in 2012) and the Action Plan for ARS's National Program on Agricultural System Competitiveness and Sustainability (ended in 2012)[12] include agroforestry as a strategic element, but agroforestry science has not been strategically coordinated across the Department.

Accomplishments

- (S1) While not a cross-USDA effort, the ARS "**Agricultural System Competitiveness and Sustainability" National Program** included agroforestry as one of their focal areas in their FY 2007-2012 Action Plan. This national program (NP 216) is one of ARS's 19 national programs, each of which operates on a 5-year planning, implementation, and evaluation cycle. In the Action Plan, they describe nine problem statements under four main components. The agroforestry-related research falls under the third component, "Integrated Whole Farm Production Systems," problem statement 3A, which states that "Whole-farm management approaches are lacking that take advantage of the complementary benefits that could be produced by combining complementary production enterprises. To assist farmers wishing to transition to more integrated whole-farm systems, research is needed to determine the relative amounts of risk of economic loss and potential trade-offs between economic and environmental outcomes for multiple-enterprise agroecosystems compared to specialized production systems." Two objectives fall

[11] The ARS Appalachian Farming Systems Research Center (Beaver, WV) closed in FY 2011.
[12] The agroforestry elements included in this action plan will not be continued because they were funded through a congressional earmark eliminated in FY 2011.

under this problem statement. They are listed below along with agroforestry-relevant anticipated products and potential benefits of the research:

Objective 3A1. Determine the important agroecosystem properties of multiple enterprises that can be used to optimize whole-farm economic and natural resource sustainability. Anticipated products and potential benefits include the following:

- Quantifying the effects of establishing and maintaining alley cropping, shelterbelts, forest farming, and riparian buffer agroforestry practices on natural resources quality at the field and whole-farm scale.
- Quantifying potential economic returns and increasing understanding of the market forces that affect new products derived from agroforestry systems.
- Assessing the economic and environmental benefits and risks associated with establishing and maintaining alley cropping, shelterbelt, forest farming, and riparian buffer agroforestry practices for low-resource farms.

Objective 3A2. Provide science-based guidelines to help landowners make sound whole-farm resource management decisions. Anticipated products and potential benefits include management recommendations for site selection, and establishment and maintenance of alley cropping, shelterbelts, forest farming, and riparian buffer agroforestry practices at the field and whole-farm scales.

The agroforestry research associated with these two objectives mainly takes place at ARS's Booneville, AR, research station and through a cooperative agreement with the Center for Agroforestry at the University of Missouri. The cooperative agreement with the University of Missouri has now ended because it was a congressional earmark that was eliminated in FY 2011, so ARS may not be able to continue this research.

- (S2, S3) The other two strategies mentioned in the *Strategic Framework* are included elsewhere in the report:
  - (S2) **"Catalog USDA agroforestry research activities and resources."** Objective 2.2 (Discover) of this report includes a list of FY 2011–12 USDA-supported research activities relevant to agroforestry, and appendix I has a list of the agroforestry publications from ARS, NIFA, and Forest Service published in 2011–12.
  - (S3) **"Incorporate agroforestry, when appropriate, into requests for proposals through existing USDA science and technology programs."** Objective 3.1 (Institutionalize) includes the plans, requests for proposals, and other ways that agroforestry has been incorporated into the way USDA does business.

Next Steps**

- (S1) **Establish USDA Agroforestry Science Working Group.** The Agroforestry Executive Steering Committee plans to establish a working group to coordinate agroforestry activities of ARS, National Agricultural Statistics Service, NIFA, NRCS, Forest Service, and other USDA science agencies to accomplish the highest priority strategies for Goal 2 in the *Strategic Framework* and to guide future agroforestry research, education, and extension.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Objective 2.2: Discover

Overview

ARS, NAC, NIFA, and Forest Service supported interdisciplinary research to advance agroforestry science and technologies in FY 2011–12. Farmers, landowners, and land managers participated in many of these research activities.

The following research accomplishments are organized by topics listed in the *Strategic Framework,* and they fall into five main categories:

1. Quantifying the impact of agroforestry practices on natural resources and ecosystem services (A below).
2. Developing productive agroforestry systems (B below).
3. Quantifying agroforestry's resilience to climate change (C below).
4. Developing bioenergy systems (D below).
5. Evaluating the profitability and economics of agroforestry (E below).

Although concepts and models can be shared widely, the specifics of the systems are most relevant to the region in which the research takes place due to the ecological constraints of soil, climate, and topography. Some agroforestry-relevant research is also included on specific crops that may be pertinent to agroforestry systems and ecological questions relevant to those systems.

Please note that publications from several of the projects are listed below the project description. See appendix I for a complete listing of all USDA-supported agroforestry-relevant publications.

Accomplishments

1. (S1) NAC, ARS, and Forest Service established regional interagency, interdisciplinary teams to frame priority issues that can be addressed by agroforestry. These teams are included under the appropriate categories under #2 below.
2. (S3) USDA and partners developed the knowledge and technologies to improve the application of agroforestry for several high-priority goals determined in the creation of the *Strategic Framework*. The research projects below are organized by those goals, which included the following:

   A. **Natural Resources, Ecosystem Services, and Environmental Markets**:
      - Protect air, water, and soil resources.
      - Expand emerging environmental markets (e.g., carbon, water quality).
      - Restore ecological services across rural urban lands and communities.

   B. **Agroforestry Systems:** Build healthy and productive farms, ranches, woodlands, and communities.

   C. **Climate Change Resiliency:** Create diversity and build landscape-level resiliency to climate change impacts.

   D. **Bioenergy:** Provide innovative and sustainable bioenergy production systems.

   E. **Economically Profitable:** Develop profitable and economically sustainable agroforestry-based systems that produce market goods.

A. Natural Resources, Ecosystem Services, and Environmental Markets.

Water:

- **Riparian Buffers for Stormwater Runoff:** The University of Nebraska-Lincoln found improved water quality with direct seeded conservation buffers that are less costly to establish and require less maintenance. They are more effective at removing sediment and pollutants. (Partners: Nebraska Department of Agriculture—Nebraska Buffer Strip Program; Lower Elkhorn Natural Resources District; Papio—Missouri River Natural Resources District; Lower Platte North Natural Resources District; Lewis and Clark Natural Resources District; NRCS; Nebraska Forest Service; PrairieLand Resource, Conservation, and Development Council; Shell Creek Watershed Improvement Group. (NIFA Hatch funds 2008–13)
- **Fruit and Nut Tree Riparian Buffers in the Chesapeake Bay Watershed:** Virginia Polytechnic Institute and State University (Virginia Tech) established native fruit and nut tree riparian buffers in a western Virginia sub-watershed of the Chesapeake Bay, and they explored (1) social and biological drivers of adoption and (2) impacts on water quality. They also did educational and extension trainings around these efforts—reported in Objective 1.2. (NAC funded 2010–12)
- **Restoring Forest Function in Mississippi Alluvial Valley:** NAC developed and presented a conceptual framework for how agroforestry can be located and designed to restore bottomland hardwood forest functions and values in the Mississippi Alluvial Valley and thereby contribute to achieving goals for ecological restoration. Agroforestry practices broaden the spectrum of forestry options that might appeal to landowners in this region, especially under the current situation of high crop prices. (NAC 2012)
    - A Role for Agroforestry in Forest Restoration in the Lower Mississippi Alluvial Valley.
- **Restoring Ecosystem Services With Agroforestry:** NAC scientists authored a chapter highlighting the role that riparian buffers can serve in restoring forest ecosystem services to agricultural landscapes. The book chapter was published in the book that resulted from an International Union of Forestry Research Organizations conference. (NAC 2012)
    - Connecting Landscape Fragments Through Riparian Zones *in Forest Landscape Restoration: Integrating Natural and Social Sciences. (2012)*
- **Riparian Buffers for Water Quality:** Southern Illinois University worked with Touch of Nature Environmental Center and NRCS to evaluate the impact of riparian buffers on water quality and to test designs for handling concentrated agricultural runoff. They found greater soil infiltration in the buffers than in the fields (NIFA McIntire-Stennis funds 2009–13). In addition, the University of Missouri's Center for Agroforestry is monitoring the runoff at eight sites for private landowners as a part of the Mississippi Basin Healthy Watershed Initiative. (NRCS 2011–14)
- **Do Riparian Buffers Compete With Crops for Water?** (ARS 2012)
    - Enhanced transpiration by riparian buffer trees in response to advection in a humid temperate agricultural landscape. ARS scientists in Iowa found that trees

next to the field and more exposed to the wind used more water than trees closer to the stream and protected from the wind by other trees. The amount of water used also differed among the tree species.

- Effects of thinning on transpiration by riparian buffer trees in response to advection and solar radiation. Because of concern in Iowa that riparian buffer trees may compete with crops for water, ARS scientists compared thinned buffers with fully stocked buffers. They found that trees on the windward side used more water than trees on the leeward side of the buffer and that thinning did not affect the water demand of the buffer.

Pollinators:

- **Hedgerows and Pollinators:** Researchers at University of California-Berkeley used NIFA Hatch funds to study the ecology of wild crop pollinators on farms and wildlands. They found that areas with hedgerows tend to have more bees/natural enemies and fewer pests, that bees tended to travel into fields from hedgerows, and that native bees were more attracted to the native restoration plantings than the invasive species. More recently, this team was awarded an Agricultural and Food Research Initiative grant to study how hedgerow restoration can provide nesting habitat for native bees to improve pollination services to crops. (funded by NIFA Hatch and AFRI programs; 2011–12)
    - Bee preference for native versus exotic plants in restored agricultural hedgerows. *Restoration Ecology* (2012).
    - Valuing Pollination Services to Agriculture. *Ecological Economics* (2011).
    - Hedgerows enhance beneficial insects on farms in California's Central Valley. *California Agriculture, 65* (2011).
    - Evaluating the Quality of Citizen-Scientist Data on Pollinator Communities. *Conservation Biology, 25* (2011).
    - Contribution of Pollinator-mediated Crops to Nutrients in the Human Food Supply. *PLoS ONE* (2011).

Soil:

- **Impacts of Forest-Grown Organic Berries on Woodland Soils:** Farmers at Bug Hill Farm are working with a fruit specialist from the University of Massachusetts to determine the impacts of experimental berry management on the soil in the two-thirds of their farm that is forested. The berries (chokeberry, elderberry, and honeyberry) are perennial plants that are common in transitional early-successional forests, and the team aims to maintain the land in early succession through varying levels of disturbance while creating habitat for wildlife and raised beds called "Hugelkultur." They are monitoring the changes in soil health, composition, and plant growth over 3 years. (NIFA SARE [Sustainable Agriculture Research and Education] funded 2012)
- **Buffers Protecting Soil:** The University of Missouri studied the impact of agroforestry buffers on soil structure and the ability of soil to filter nutrients, enable root penetration, and filter veterinary antibiotics. This study resulted in 4 publications and 17 conference presentations. (NIFA Hatch funds 2011)
    - Soil quality indicator responses to row crop, grazed pasture and agroforestry buffer management. *Agroforestry Systems* (2012).

- Agroforestry and grass buffer effects on soil quality parameters for grazed pasture and row-crop systems. *Applied Soil Ecology* (2011).
- Calibration of a water content reflectometer and soil water dynamics for an agroforestry practice *Agroforestry Systems* (2011).
- Pollutant transport in geomedia using X-ray computed tomography. *Procedia Computer Science* (2011).

- **Forested Versus Agricultural Soils:** ARS scientists evaluated the differences between the deeper original forest soils and the currently cultivated soils in Iowa. They found that the forest soils had improved soil structure, earthworm and rodent activity, and mineral accumulation and the cultivated soils had greater soil carbon. (ARS 2012)
  - ARS Scientist T. Sauer wrote the Agroforestry chapter in *Soil Management—Building a Stable Base for Agriculture.*

Air:

- **Windbreaks and Air Quality Near CAFOs:** Ohio State University researchers found that despite strong dust emissions from Concentrated Animal Feeding Operations (CAFOS: pig barns and chicken coops), only a small fraction of the aerosols interact with the windbreaks, which suggests a change in knowledge. (NIFA AFRI grant 2010–13)
  - Estimating plot-level tree structure in a deciduous forest by combining allometric equations, spatial wavelet analysis and airborne LiDAR. *Remote Sensing Letters* (2012).
  - A comparison of multiple phenology data sources for estimating seasonal transitions in deciduous forest carbon exchange. *Agricultural and Forest Meteorology* (2011).

Carbon:

- **Carbon Overview:** USDA scientists from ARS, NAC, and NRCS worked with Colorado State University to review carbon sequestration in U.S. agricultural lands. The USDA publication "Carbon Sequestration in Agricultural Lands of the United States" won 2011 Editor's Choice Award from the Journal of Soil and Water Conservation. The ARS scientists are from the Northern Plains Rangeland Resources and Soil Plant Nutrient Research Units in Fort Collins, CO, and Cheyenne, WY; South Atlantic Chemistry Research Unit in Gainesville, FL; and South Atlantic Natural Resource Conservation Center in Watkinsville, GA. (ARS, NAC, and NRCS 2011)

- **Carbon in Alley Cropping and Silvopasture:** An ARS scientist began a project to quantify the carbon sequestration and greenhouse gas emissions in alley cropping and silvopasture systems using the standard protocol employed by ARS's GRACEnet (**G**reenhouse gas **R**eduction through **A**gricultural **C**arbon **E**nhancement **net**work). To do so, he is collaborating with the USDA NAC and the Center for Environmental Farming Systems (CEFS), a partnership between North Carolina State University, North Carolina Agricultural and Technical State University, and the North Carolina Department of Agriculture. They plan to coordinate this research with other research happening around the world through the USDA-Agriculture and Agri-Food Canada Memorandum of Understanding and the Global Research Alliance on Agricultural Greenhouse Gases. For more information, see case study #8 in appendix D. (ARS, NAC, NRCS, Forest Service, and NIFA funds 2012).

- **Carbon in Agroforestry Trees:** Because trees grown in more open agroforestry plantings have quite different architecture than those grown in forests, the University of

Nebraska-Lincoln is working with NAC to synthesize the amount of potential carbon storage and indirect greenhouse gas dynamics resulting from incorporating agroforestry practices into a typical Midwest Corn Belt farm and will develop an accounting process to summarize these impacts (Forest Service Research and Development funding 2011–15). In addition, they will develop a more reliable way to estimate and predict carbon stocks in the woody components of agroforestry plantings and test this estimation in a greenhouse gas accounting tool for farms and ranches. (NAC funding 2010–13)

- **Carbon in Alley Cropping:** Tennessee State University is developing verification protocols to measure the change in soil carbon pools and fluxes, educating the public about the potential to sequester soil carbon in Tennessee small farms and forest woodlands, and helping to develop a viable soil carbon market. They also established loblolly and switchgrass research and demonstration plots (NIFA Evans-Allen funds 2011–13).

- **Shelterbelts To Sequester Carbon and Create Bioenergy:** ARS scientists in collaboration with scientists from Iowa State, NAC, and the Leopold Center are measuring (1) the soil carbon sequestration and (2) the bioenergy potential of tree plantings on marginal soils across climatic gradients in the U.S. Great Plains and Russian Central Uplands (ARS funds 2011). In addition, ARS scientists are convening focus groups and conducting surveys to determine the economic point at which the owners of marginal land will adopt these woody biomass systems. Other methods will be used to determine the most relevant tree species and soils. (NIFA North Central Region SARE Research and Education grant 2012)

- **Shelterbelts Increase Soil Carbon in Russia:** ARS scientists found that treed shelterbelts on former cultivated soils protected or restored the soil organic matter content to near precultivation levels and had high soil carbon levels as well. These results are relevant for both climate change considerations and efforts to promote biomass production in marginal areas such as shelterbelts. (ARS National Program 212 2010–15)

- **Worldwide Effects on Carbon:** University of Florida researchers are collaborating at five sites around the world (Florida: bahia/slash pine; India: multispecies plants; Brazil: shade-grown cacao; Spain: oak dehesa grazing system; Brazil: silvopasture with eucalyptus) to compare agroforestry systems with treeless systems. (NIFA McIntire-Stennis funding 2011)

  Their findings include the following:
  - Tree-based agricultural systems, compared with treeless systems, store significantly more carbon in deeper layers of soils under comparable conditions;
  - Higher soil organic carbon content is associated with higher species richness and tree density, especially in the upper 50 centimeters soil and in the < 53 micrometer soil fraction;
  - Soil near the tree, compared to away from the tree, stores more carbon; and
  - C3 plants (trees) contribute to more carbon in the silt- + clay-sized (< 53 um) fractions than C4 plants in deeper soil profile.

  The following are the publications:

  Books**:**
  - Carbon Sequestration in Agroforestry Systems (2011).

Peer-reviewed Chapters:

- Climate-change mitigation and adaptation: A low hanging fruit of agroforestry. *Agroforestry: The Way Forward* (2011).
- Soil carbon sequestration in cacao agroforestry systems: a case study from Bahia, Brazil. *Carbon Sequestration Potential of Agroforestry Systems* (2011).
- Methodological challenges in estimating carbon sequestration potential of agroforestry systems. *Carbon Sequestration Potential of Agroforestry Systems* (2011).
- Silvopasture and carbon sequestration with special reference to the Brazilian Savanna (Cerrado). *Carbon Sequestration Potential of Agroforestry Systems* (2011).
- The socioeconomic context of carbon sequestration in agroforestry: A case study from the home gardens of Kerala, India. *Carbon Sequestration Potential of Agroforestry Systems* (2011).

Refereed Journal Articles:

- Carbon sequestration studies in agroforestry systems: a reality-check. *Agroforestry Systems* (2011).
- Soil carbon storage as influenced by tree cover in the Dehesa cork oak silvopasture of central-western Spain. *Journal of Environmental Monitoring* (2011).
- Soil carbon storage in silvopastoral systems and a treeless pasture in northwestern Spain. *Journal of Environmental Quality* (2011).
- Agroforestry systems and environmental quality: Introduction. *Journal of Environmental Quality* (2011).
- Potential for greenhouse gas emissions from soil carbon stock following biofuel cultivation on degraded land. *Land Degradation and Development* (2011).
- Soil carbon storage in silvopasture and related land-use systems in the Brazilian Cerrado. *Journal of Environmental Quality* (2011).

Multiple Environmental Benefits:

- **Optimizing Conservation Practices to Produce Multiple Ecosystem Services**: NAC reviewed and assessed various approaches for developing multifunctional land use schemes. (NAC, 2012)
  - Enhancing Ecosystem Services: Designing for Multifunctionality: A feature paper for the *Journal of Soil and Water Conservation* (2012).

- **Riparian Buffers in Southeast Coastal Plain Watersheds:** ARS scientists at the Little River Experimental Watershed in Georgia are measuring the impacts of conservation practices (e.g., riparian buffers) on water quantity, water quality, and soil quality at scales ranging from the farm to the watershed to the region. They are using these measurements to calibrate and validate watershed and regional-scale models. This study is one of 42 watershed studies within the multiagency partnership called the Conservation Effects Assessment Program (CEAP). The Little River Experimental Watershed is typical of the heavily vegetated, slow-moving stream systems in the Coastal Plain Region of the United States. Land use within the watershed is approximately 50 percent woodland, 31 percent row crops (primarily peanuts and cotton), 10 percent pasture, and 2 percent water. Streamflow is around 27 percent of annual rainfall, evapotranspiration is 73 percent, and percolation to deep groundwater is negligible. Environmental concerns include low dissolved oxygen, high fecal coliform and other bacterial indicators, nutrient enrichment,

pesticides and sediment in field runoff, drought impacts on irrigation water supplies, and erosion. Many streams within the Coastal Plain are impaired by low dissolved oxygen and pesticide concerns, and preliminary assessments indicate that, on the average, a 40-percent reduction in nitrogen and phosphorous loading must be achieved in the impaired watersheds to attain dissolved oxygen standards. Although sediment and agrochemical losses from upland cultivated fields can be high, these scientists have found that filtering within the dense riparian buffers that surround the watershed streams reduces the loading to streams substantially. (ARS 2011–12)

The following publications assess riparian forest buffers:

- Hydrology and water quality of a field and riparian buffer adjacent to a mangrove wetland in Jobos Bay Watershed, Puerto Rico—Scientists in Puerto Rico found that the forested riparian zone between the farm fields and the bay should reduce surface runoff by 16 percent, subsurface flow by 67 percent, sediment yield by 24 percent, total nitrogen loading by 31 percent, and total phosphorus loading by 30 percent. Simulations indicate that tropical storm and hurricane events may account for 63 percent of total loadings to the bay primarily via surface runoff. The results of this study should aid management agencies in selecting the most effective conservation practices to reduce agricultural loading to the Jobos Bay National Estuarine Research Reserve
- Non-point source pesticide pollution in CEAP watersheds - controlling factors and mitigation strategies.
- Estimating pesticide retention efficacy for edge-of-field buffers using the Riparian Ecosystem Management Model (REMM) in a southeastern plains landscape.
- Agricultural conservation practices and wetland ecosystem services in a wetland-dominated landscape: the Piedmont-Coastal Plain Region (Forest Service/ARS partnership).
- Associations between conservation practices and ecology: ecological responses of agricultural streams and lakes.
- Excess nitrogen in the U.S. environment: Trends, risks, and solutions, mentions role of riparian forest buffers.

- **Semiarid Watersheds:** ARS scientists at the Southwest Watershed Research Center in Arizona are partnering with university scientists to study the interactions between water, climate, and semiarid ecosystems relevant for ranching in the Southwestern United States. (ARS funds 2011)

  They found the following:

  - **Climate change impacts on semiarid riparian plant water use:** Riparian plants are predicted to use more water because of longer growing seasons. This increase may lead to greater groundwater deficits and decreased streamflow in semiarid regions in the future.
  - **Carbon impacts from mesquite expansion into grassland:** Although mesquite trees take in more carbon, they also cause the soil to release more carbon dioxide, which may mean that they are not carbon sinks. Respiration was not affected by temperature as predicted.
  - **Plant-soil-tree interactions in southwestern U.S. savanna:** More plants grow under tree cover in savannas because of reduced light and heat stress, but not necessarily because of the increased water. Many are drought tolerant. Soil moisture under tree canopies is less variable but is still transient.

More information on erosion, stream monitoring, and how to use satellite imagery in watershed research can be found in their winter 2012 research summary. See **tool** developed by this group in Objective 2.3.

- **Silvopasture Effects on Water Quality and Carbon Sequestration:** University of Minnesota Extension, Soil and Water Conservation Districts and NRCS worked with a landowner to convert existing pastures into three silvopasture systems (red pine, white pine, and red oak) to evaluate impacts on water quality and carbon sequestration and to serve as a demonstration for others (NIFA Renewable Resources Extension Act Program (RREA) funds 2012–14). In addition, the above organizations will also work with the Cattlemen's Association, Leader Lions Forage Council, and three landowners to establish silvopasture research and demonstration sites that they will monitor for water quality, soil erosion, and species diversity as well as economic productivity. The goal is to assist producers who are currently not managing their livestock grazing in woodlands. (Minnesota Legislative Citizen Commission on Minnesota Resources and NIFA capacity funds 2013–16)

B. Agroforestry Systems: Building Healthy and Productive Farms, Ranches, Woodlands, and Communities.

Silvopasture:

- **Loblolly/Sheep Silvopasture:** Alabama A&M [Agricultural and Mechanical] University established a sheep/loblolly/fescue silvopasture demonstration system. They plan to determine its carrying capacity and to compare it with sheep on open pasture for the growth and health of the sheep and trees, the environmental impacts, and the economic profitability of such a system. It will also be a demonstration site for workshops and other educational activities (see Objective 1.1). (NIFA Evans-Allen funds 2011–14)

- **Pine and Pine Straw:** University of Georgia produced three publications on these systems using funds from NIFA's RREA program (2011).
  - Pine straw yields and economic benefits when added to traditional wood products in loblolly, longleaf, and slash pine stands (2011).
  - Effect of fertilization on slash pine growth and pine straw production on an old-field site in Toombs County, Georgia (2010).
  - A summary of pine straw yields and economic benefits in loblolly, longleaf and slash pine stands. *Agroforestry Systems* (2012).

- **Goat/Hardwood Silvopasture:** A 16-year goat silvopasture study by North Carolina State University researchers revealed the following tree survival percentages: Black locust (*Robinia pseudoacacia* L.)—75 percent, Honeylocust *Gleditsia triacanthos var. inermis Schneid*)—91 percent, Mimosa tree (*Albizia julibrissin Durazz*)—26 percent, and White mulberry (*Morus alba L.*)—20 percent (NIFA Hatch funds 2011). Other North Carolina State University researchers examined the effectiveness of using goats to control noxious vegetation and the long-term implications of various forage systems on the breeding herd. They plan to issue specific recommendations on management practices that will decrease the cost of production while making a positive environmental impact. (McIntire-Stennis 2008–13)

- **Goat/Pine Silvopasture:** Alabama A&M University, the Federation of Southern Cooperatives, Tuskegee University, Tennessee State University, and Alabama

Cooperative Extension Service are working together to develop and evaluate silvopastoral systems for the simultaneous production of pine sawlogs, forage, and meat goats to increase productivity, profitability, and sustainability on small- and medium-sized farms in the Black Belt soil region of the Southeastern United States. Economic results indicate that the silvopasture production system is a financially feasible investment for the limited-resource farmers in the region and that nutrient cycling from grazing improved soil fertility for sustainable forage production. (NIFA AFRI grant 2006–11)

- **Silvopasture Establishment: Hardwoods, Forage, and Soybeans:** Researchers at the University of Missouri are studying the interactions among trees and forages (herbaceous and soybean) and flood tolerance. They found that they could establish trees (loblolly pine, pitch pine, black walnut, and northern red oak) in existing pastures to provide alternative income without sacrificing forage production. Irrigation increased the pine growth, but the type of grass or fertilization did not matter. Black walnut and northern red oak grew better in Kentucky bluegrass than orchard grass or tall fescue. Irrigation increased the northern red oak but not the black walnut. (NIFA Hatch funds, 2011)

- **Silvopasture With Ruminants and Free-Range Poultry:** ARS scientists in Boonville and Fayetteville partnered with the Kerr Center, Louisiana State University, Appalachian State University, the National Center for Appropriate Technology, and farmer cooperators to determine the impacts of grazing poultry under shade and feeding tree fodder. In agroforestry systems, woody perennials cannot only be used for shade/shelter/roosts but also represent a feed resource in terms of berries, fruit, nuts, and green leaves. Thus, these scientists have planted plots with native woody beautyberry (*Callicarpa Americana*). They are also doing on-farm trials. (ARS funds and NIFA Southern SARE Research and Education grant 2010–13)
  - Survival of bristly locust (*Robinia hispida L.*) in an emulated organic silvopasture (2012).
  - Stocking rate-mediated responses of mid-rotation loblolly pine in west-central Arkansas: profitability (2011). Scientists from ARS and the University of Missouri created an Excel model to predict timber production and profitability across a production cycle by varying any of a wide array of inputs: tree spacing, growth rate, thinning intensity, discount rate, and timber yield, and they found that pine straw production could double profits.
  - Pine straw harvesting effects on vadose-zone water content of a Leadvale silt loam in western Arkansas (2012).
  - Pine straw harvesting effects on water content of a forest soil (2011). ARS scientists found that pine straw harvesting tended to decrease soil water content at depths below 20 centimeters, especially in late June, which suggests that harvesting could potentially lengthen drought-stress periods for loblolly pine during the first year after pine straw removal.
  - Effects of the establishment of a forested riparian buffer and grazing on soil characteristics (2012). ARS scientists from Booneville and Fayetteville, AR, and Bushland, TX, found that a 12-meter wide tree buffer downhill of a poultry pasture creates soil properties that decrease phosphorus runoff.
  - Short-term soil responses for an emulated loblolly pine silvopasture (2011).

- **Alley Cropping and Silvopasture in Hawaii**: University of Hawaii researchers measured the nutrients and crude protein content of forages in a pastured poultry system that was developed within an alley cropping system on Molokai. They found that soils

increased levels of phosphorus, potassium, calcium, and magnesium after poultry grazing. For more, see Objective 1.2. (NIFA RREA funds 2011)

- **Hardwood Silvopasture in the Northeast:** Because silvopasture has had less success in the Northeast thus far, North Branch Farm is testing the environmental and economic impacts of converting a northern hardwoods stand into silvopasture, compared with treating the stand as a managed forest or converting it to open pasture. In addition, six forage establishment treatments will be tested for productivity and influence on soil properties within the silvopastures and the recently cleared open pastures. (NIFA NE-SARE Farmer grant 2012)

Alley Cropping:

- **Corn and Soybeans Between Pine and Oak in North Carolina:** A 17-acre (6.9-hectare) agroforestry research and extension alley cropping trial was established at the Center for Environmental Farming Systems in Goldsboro, NC, in January 2007, with a randomized block design with five replications. The demonstration planted rows of loblolly pine (*Pinus taeda*), longleaf pine (*Pinus palustris*), and cherrybark oak (*Quercus pagoda*), with crops in alleys of 40 or 80 feet (12.2 or 24.4 meters) wide between the tree rows. Crops of soybeans (*Glycine max*) and corn (*Zea mays*) have been planted in alternating years since establishment. As of 2011, survival rates were 93 percent for cherrybark oak, 88 percent for longleaf pine, and 97 percent for loblolly pine. Loblolly pine had the largest projected internal rate of return, at 7.2 percent, followed by longleaf pine at 3.5 percent, and cherrybark oak at 2.9 percent. More loss in crop and silvopasture production might occur with loblolly, however, and production of pine straw for longleaf or game mast for cherrybark oak may offer other benefits. See also case study #8 in appendix D. (NC State University with NRCS and NIFA-Hatch funds 2007–11)
  - Early tree growth, crop yields, and estimated returns for an agroforestry trial in Goldsboro, North Carolina. Agroforestry Systems. *Agroforestry Systems* (2012).

- **High Tunnels and Agroforestry in North Carolina:** North Carolina A&T University scientists are evaluating the impact of high tunnels and trees on tomato, collard, and lettuce production in both organic and nonorganic situations. This study will also serve as a demonstration site for other farmers. (NIFA Evans-Allen funds 2009–13)

- **Stevia Between Orchard Rows in Georgia:** Fort Valley State University is developing systems for profitable stevia production in Georgia by intercropping it between fruit and tree nut crops and monitoring the success of direct seeding versus transplanting and other management practices to optimize the sweetness produced. (Agricultural Marketing Service (AMS) Specialty Crop Block Grant funds 2012)

Forest Farming:

- **Forest Mushroom Cultivation:** The University of Missouri's Horticultural & Agroforestry Research Center (HARC) is developing regional best management practices for the production of fungi, including shiitake, morels, and truffiere. (NIFA-Hatch funds 2011)

- **Log-Grown Mushrooms:** Cornell University researchers subjected conventional wisdom on forest-grown shiitake management to experimental verification. Thus far, they found that both oak and beech work for shiitake production; log-grown mushrooms tasted

better than sawdust-grown mushrooms; Lion's Mane mushrooms can be grown in sufficient quantity and quality for commercial production and local strains are better than exotic; and winter, spring, and summer are all fine times to inoculate logs (NIFA McIntire-Stennis funds 2008–11). Thanks to the success of this project, a NE-SARE (2010) project was funded for shiitake mushroom training workshops. See Objective 1.2 and case study #7 in appendix D. Two farm-based research projects grew out of that effort:

- **Optimal Fruiting:** Dana Forest Farm is working with the University of Vermont to determine optimal fruiting times/conditions for log-based shiitake mushroom cultivation. A news video about this project was aired on WCAX-TV in partnership with Seven Days. (NIFA NE-SARE Farmer grant 2011)
- **Slug Control:** Steve Gabriel is working with Cornell University Extension to integrate ducks into a 700-log shiitake growing enterprise, so that the ducks may serve as slug control. Efforts are focused on duck selection for temperament, foraging ability, and weight gain. Sanitary protocol is being followed. (NIFA NE-SARE Farmer grant 2012)

- **Sustainable Fiddlehead Fern Harvesting:** University of Maine Cooperative Extension began a multiyear study to establish a baseline of what constitutes a sustainable fiddlehead fern harvest. (NIFA RREA funds 2011)

- **Burgundy Truffle Orchard:** The Ozark Forest Mushroom, LLC, is partnering with the University of Missouri on a case study to explore how to establish a burgundy truffle orchard in the Big Springs Region of the Missouri Ozarks and provide outreach to interested landowners and natural resource professionals. (NIFA North Central Region-SARE grants 2011–12)

- **Karuk Traditional Agroforestry Systems:** University of California-Berkeley researchers are partnering with officials from the Karuk Tribe Department of Natural Resources and Forest Service to evaluate the effects of traditional land management techniques, such as prescribed burning, on the productivity and availability of traditional foods (such as salmon, deer, elk, acorns, mushrooms, and berries). The Karuk Tribe's traditional homeland is on two national forests in northern California, and the traditional management techniques are ways that their elders tended the foods of the forest, a type of forest farming. (NIFA AFRI grant 2012–13)

- **Ramps, Black Cohosh, and Other Nontimber Forest Products (NTFPs):** Forest Service Research and Development (R&D) scientists are working with the University of Georgia, Radford University, Virginia Tech, Virginia State University, and citizen scientist volunteers to document the harvest and marketing of NTFPs in the Southern United States, examine social factors leading to adoption of forest farming practices, and expand the Forest Farming Network (see Objective 1.1). (NAC and Forest Service R&D funding 2007–12)

Windbreaks:

- **Windbreaks in the Great Plains:** Researchers at the University of Nebraska are partnering with the Organic Crop Improvement Association, the Nebraska Sustainable Agricultural Society, NAC, and NRCS to research the impacts of windbreaks on long-term corn, soybean, and winter wheat yields; irrigation efficiency; and organic/diversified

production systems. They are also determining the water use by green ash windbreaks and developing biomass equations for five common windbreak species to determine potential carbon sequestration. Lastly, they will figure out why landowners in the Great Plains are reluctant to adopt windbreak practices. (NIFA McIntire Stennis funds 2006–12)

Edible Tree Crops for Use in Agroforestry:

- **Walnut:** ARS and the University of Missouri developed clonal walnut rootstock that is resistant to major soil-borne diseases, such as Thousand Canker Disease and Paradox Canker. They are partnering with commercial orchards to ensure that they receive disease-resistant rootstock and hear about emerging issues (NIFA Specialty Crop Research Initiative and ARS funds 2012–14). The University of Missouri also studied the role of the walnut curculio to determine if an insect transmits walnut kernel necrosis after pollination and how the walnut curculio responds to pheromones. They shared their research through the Northern Nut Growers Association, American Society for Horticultural Science, Entomological Society of America, and North American Agroforestry annual meetings and through field days and large public events such as the University of Missouri Center for Agroforestry Chestnut Roast. (AMS-Specialty Crop Block Grant funds 2011–12)
- **Chestnut Grafting:** The University of Missouri is working with a nearby farmer to measure the increase in chestnut yields that can be gained by grafting scion wood selected from improved chestnut cultivars to young Chinese chestnut trees established in an agroforestry operation designed to simultaneously produce chestnuts and forage. See case study #9 in appendix D. (NIFA-SARE grant 2010)
- **Chestnut Pest Management:** University of Missouri scientists are developing practical monitoring methods to determine when weevils are present to plan insecticide treatments. Information will be disseminated through four or five large chestnut workshops and the annual Chestnut Roast. Little is currently known about chestnut weevil biology. They are also determining how to disinfest gall wasp larvae when grafting without negatively affecting the plant. (AMS-Specialty Crop Block Grant funds 2012)
- **American and European Hybrid Hazelnuts** (see also Objective 1.1)**:**
  - Upper Midwest Hazelnut Development Initiative: The Universities of Minnesota and Wisconsin are working to develop a viable bush hazelnut industry in the Upper Midwest. (NIFA SCRI grant 2011–16)
  - Hybrid Hazelnut Consortium: University of Nebraska-Lincoln, Rutgers University, Oregon State University, and the Arbor Day Foundation are cooperating to produce superior hybrid hazelnut varieties, adapted to the Midwestern and Eastern United States, for integration into agroforestry production systems. (AMS Specialty Crop Block Grant 2012)
- **Rare Native Tree Propagation in the Virgin Islands:** Scientists at the University of the Virgin Islands and Extension will propagate and grow 15 native and ecologically important tree species in the fields of St. Croix. They will determine optimal growing conditions, seed viability of collected and stored seeds, effective pregerminative treatments, and how to establish the seedlings in calcareous soil in agroforestry plots. (Partners: Virgin Islands Department of Agriculture Community Forestry Program, and St George Village Botanical Gardens using NIFA-McIntire-Stennis funds 2010–13)

- **Elderberry:** University of Missouri is investigating the pests and diseases that infect elderberry trees and affect production. (AMS-Specialty Crop Block Grant 2012)
- **Black Walnut, Chinese Chestnut, and Pecan Genetic Resources:** The University of Missouri Center for Agroforestry is working with ARS National Center for Genetic Resources Preservation to establish and manage germplasm repositories for black walnut, Chinese chestnut, and pecan trees. (ARS and NIFA-Hatch funds 2011–12)
- **Pawpaws, Hazelnuts, Blackberries, and Grapes**: After hearing from the small, limited-resource farmers in Kentucky that were interested in selling high-value fruit and nut crops into local markets, Kentucky State University scientists determined that pawpaw, primocane fruiting blackberries, muscadine grapes, and eastern filbert blight-resistant hazelnuts were the highest priority crops. Thus, they have been developing varieties, researching the genetic diversity, and determining organic and conventional production methods for these crops. Kentucky State University manages the pawpaw germplasm as a partner in ARS National Germplasm Resources Program. (NIFA-Evans Allen funds 2009–13)
- **Tropical Cacao Production:** ARS scientists are developing management systems to improve cacao cultivation. They are examining genetics and tropical legume cover crops to examine impacts on soil, weeds, productivity, and resilience to stresses. They are doing this research in controlled environmental chambers, greenhouses, and field plots, and in partnership with research organizations in Peru, Brazil, Puerto Rico, and Ecuador. (ARS 2011–12)
  - Photosynthetic photon flux density, carbon dioxide concentration, and temperature influence photosynthesis in crotalaria species (2012). ARS scientists studied the effects of light, temperature, and carbon dioxide on productivity of four cover crop species to help farmers determine how to manage the shade of their cacao trees to enable the growth of understory cover crops that enhance soil fertility.
  - Dissecting genetic structure in farmer selections of *Theobroma cacao* in the Peruvian Amazon: implications for on-farm conservation and rehabilitation.
  - Nutrients and nonessential elements in soil after 11 years of wastewater irrigation.

C. Climate Change Resiliency: Creating diversity and building landscape level resiliency to climate change impacts.

- **Mitigation and Adaptation:** The NAC collaborated with ARS and their Canadian counterpart, Agriculture and Agri-Food Canada's Agroforestry Development Center; the University of Minnesota, Center for Integrated Natural Resources and Agricultural Management (CINRAM); and the University of Nebraska-Lincoln to write an invited feature paper on the role of agroforestry in both climate change mitigation and adaptation for the *Journal of Soil and Water Conservation* (2012).
  - Branching out: Agroforestry as a climate change mitigation and adaptation tool for agriculture.
  - Canadian/United States update: Agroforestry is emerging as a national and international climate change strategy, (e.g., the Global Research Alliance for Agricultural Greenhouse Emissions). Although the scientific understanding of agroforestry required to develop reliable accounting tools and guidelines is

progressing, much work is still needed for effective implementation of agroforestry as a 'climate change integrated' landscape management strategy.

- ARS scientists also contributed to a chapter of the Handbook of Climate Change and Agroecosystems (2011) edited by world-renowned scientists Daniel Hillel and Cynthia Rocenzweig of Columbia University, who list agroforestry as both a sustainable land management practice and one of the recommended practices for greenhouse gas mitigation by creating soil sinks for carbon.

D. Bioenergy: Providing innovative and sustainable bioenergy production systems.

- **Shortleaf Pine Productivity in Agroforestry versus Plantation Systems:** Mississippi State University is evaluating different management practices on the growth of shortleaf and loblolly pines in plantation and agroforestry systems. These scientists will also evaluate potential wildlife use and biofuel production. (NIFA-McIntire-Stennis funds 2008–13)

- **Biomass Crops in Riparian Buffers:** The NAC did a literature review and three technical presentations on the potential to grow biomass crops in riparian buffers to produce bioenergy and improve water quality simultaneously. They found that the water quality benefits would be threatened if excess fertilizer were used to grow the crops, so some sort of limitation would need to exist—regulatory or otherwise. (NAC 2011)

- **Alley Cropping for Cellulosic Biofuel Feedstocks in Lower Mississippi Alluvial Valley**: Louisiana State University (LSU) AgCenter and the University of Arkansas are partnering with landowners at three different sites to grow switchgrass/cottonwood, soybean-sorghum, and conventional crops to evaluate biomass and bioenergy yields, nutrient cycling, and greenhouse gas emissions—all on degraded soils. They have produced five conference proceedings. They have also learned that switchgrass cannot grow in high-clay soils. For more information on the demonstration site, see Objective 1.1, and for associated outreach, see Objective 2.3. (Funded by NIFA's AFRI and SARE programs and a Sun Grant 2009–16). LSU is also examining the surface water quality impacts of annual fertilization by broiler litter over a range of management techniques. They published the first year's worth of results for poultry litter fertilization on switchgrass in a book chapter. (NIFA grant 2009–12)

- **Biomass Production and Ecosystem Services in Minnesota**: University of Minnesota-Extension and CINRAM established and assessed several perennial and herbaceous alley cropping systems (such as hybrid poplar-willow and red pine-willow) to provide biomass for energy and ecosystem services (water quality, carbon sequestration) and to evaluate their environmental and economic benefits. They are developing a matrix of the vegetative options that have both feedstock potential and attributes beneficial for alley cropping systems. This effort is part of a larger effort with Koda Energy, the Shakopee Mdewakanton Sioux Community, and Rahr Malting Company. For related demonstration sites, see Objective 1.1, and read case study #11 in appendix D. (Partners: NAC, NRCS, Soil & Water Conservation Districts, the Metropolitan Council of Environmental Services and Koda Energy, a combined heat and power biomass facility; NIFA-RREA and NAC funds 2012–14.) In addition, scientists are working to compare the productivity of the bioenergy crops and the system's ability to serve as a biocontrol for soybean aphid across the following systems: alley cropping (willow/herbaceous mix) versus willow monoculture versus herbaceous polyculture. (NIFA-AFRI funds 2012–16)

- **Alternative Perennials in Agroforestry**, February 2011.
- **Agroforestry Systems for Biofuel Production and Sustainable Landscapes**, Poster at the National American Agroforestry Conference, 2011.
- **Perennial Alley Cropping Systems in Riparian Soils for Biomass Production and Ecosystem Services**, Poster at the National American Agroforestry Conference, 2011.

- **Great Plains Bioenergy Feedstock and Carbon Sequestration**: To evaluate the potential of agroforestry in the Great Plains to provide bioenergy feedstocks and carbon sequestration, ARS, NAC, Iowa State University's Leopold Center for Sustainable Agriculture, NRCS, and the University of Nebraska-Lincoln are partnering. (Funded by NIFA's North Central-SARE 2012–15)

- **Pacific Northwest Bioenergy (Switchgrass and Hybrid Poplar) and Climate Change Mitigation System**: Scientists from Washington State University's Prosser Irrigated Agriculture Research and Extension Center are partnering with GreenWood Resources Tree Farm to evaluate (1) the ability of two crops to grow together and remain productive and (2) their impacts on ecosystem services (water use, carbon storage, nutrient cycling, and greenhouse gas emissions). They plan to use local animal waste for nutrients and colocate their feedstock and biofuel production facilities to reduce cost. (NIFA-AFRI 2011–15)

- **Southeastern Loblolly Pine-Switchgrass Bioenergy System:** North Carolina State University, Virginia Polytechnic Institute and State University, and Weyerhauser Company are partnering to develop regionally appropriate crops for bioenergy production and to assess the productivity of these cropping systems and their impacts on carbon, nutrient, and water cycles. They are developing these crops utilizing a randomized block design on 70 acres of the lower coastal plain of North Carolina. The crops will be grown on a 25-year rotation in order to characterize the carbon cycling over a longer timeframe. (NIFA-AFRI 2012–16)

E. EconomicallyProfitable: Developing profitable and economically sustainable agroforestry-based systems that produce market goods.

- **Buffers for Floral and Bioenergy Production:** The University of Nebraska-Lincoln found that intensive management is required for floral production with limited local market options and that hazelnuts grown in buffers may be a potential biofuel option. (Partners: Nebraska Department of Agriculture—Nebraska Buffer Strip Program; Lower Elkhorn Natural Resources District; Papio—Missouri River Natural Resources District; Lower Platte North Natural Resources District; Lewis and Clark Natural Resources District; NRCS; Nebraska Forest Service; PrairieLand Resource, Conservation, and Development Council; Shell Creek Watershed Improvement Group; NIFA Hatch funds 2008–13)

- **Economics of Agroforestry:** Researchers at the Forest Service's Southern Research Station, Virginia State University, and North Carolina State University are examining the economics affecting the adoptability of agroforestry practices. Projects were initiated in collaboration with researchers at NAC.

- **Potential economic value of agroforestry in the Lower Mississippi Alluvial Valley (LMAV):** A method was developed that enabled estimation of financial returns from

eight agroforestry systems and seven forestry systems to compare returns on agriculture on marginal lands in the LMAV. These results were used as an indicator of potential adoption. Two papers were published.

- Economic Potential of Agroforestry and Forestry in the Lower Mississippi Alluvial Valley With Incentive Programs and Carbon Payments.
- A Real Options Method for Estimating the Adoption Potential of Forestry and Agroforestry Systems on Private Lands in the Lower Mississippi Alluvial Valley, USA.

- **Versatile Alley Cropping:** The relative value of implementing versatile alley cropping systems is being compared to the value of traditional alley cropping, agricultural monocropping, and forestry systems. The findings will be used to identify products that can be produced in an alley cropping system at various stages of the system's life, determine the potential production of certain products to mitigate market downturns of other products, estimate potential increase in returns from versatile alley cropping, and assist producers in deciding what to produce in a given year and when to sell timber. (Forest Service and NAC funds 2012–14)

- **Economics of Silvopasture:** Forest Service's Southern Research Station is working with Virginia State University to analyze the relationship between the size of silvopasture operations and profitability with an emphasis on finding appropriate scales for small and limited-resource producers in Virginia. (Forest Service and NAC funds 2012–15)

- **Sustainable Management of NTFPs:** Forest Service Southern Research Service is conducting research to better understand the ecologic, economic, or social impacts of sustainably collecting and trading NTFPs. This information is currently lacking, which hinders U.S. efforts to adhere to the requirements of international agreements on forest resources. Likewise, landowners interested in alternative income opportunities lack the knowledge needed to sustainably harvest or profitably cultivate forest botanicals and other NTFPs. Information is needed on the ecology of these products and management impacts (including harvest, production, and markets) so that guidelines can be developed to increase sustainable production of these special forest products. (Forest Service 2011–12)

- **Niche Nut Processing in Southeastern Ohio:** The Wing Nuttery is working to establish a regional-scale, tree-to-table replicable model for the production, processing, and value-addition of walnuts, chestnuts, hickory nuts, and hazelnuts. All are high-nutrition, perennial crops that will benefit the region's rural economy, ecological stewardship, and food security. They are providing grafting workshops and training farmers to integrate these trees into their operations through windbreaks and silvopasture. See also case study #10 in appendix D. (NIFA North Central Region-SARE Farmer grant 2012)

- **Economic and Financial Case Studies:** The University of Missouri Center for Agroforestry is documenting detailed financial information of individuals currently using agroforestry technologies to develop a financial decision support model to analyze these practices. (NAC funds 2011–13)

Case Studies

Read the following case studies in appendix D.

Title	Practice	Objective	Agencies	State
#8—Agroforestry Research Partnerships: From North Carolina to the World	A & S	1.3 and 2.2	ARS, NAC, NRCS	NC
#9—Bringing Chestnuts Back to American Landscapes and Diets, One Graft at a Time	A	2.2	NIFA, NRCS, AMS	MO
#10—Hazelnuts, Hickory Nuts, and Walnuts, Oh My!	S & W	2.2	NIFA	OH
#11—Moving Agroforestry Into the Mainstream To Provide Energy, Water, and Jobs: Minnesota to the Gulf of Mexico	A	2.2	NAC, NIFA, Forest Service	MN
#13—Oregon Woodland Owners Enter a New World of Possibilities With Oregon Grape	A & R	1.2, 2.2, and 2.3	RD, NIFA, NRCS	OR
A = Alley cropping. AMS = Agricultural Marketing Service. ARS = Agricultural Research Service. NAC = National Agroforestry Center. NIFA = National Institute of Food and Agriculture. NRCS = Natural Resources Conservation Service. RD = Rural Development. R = Riparian forest buffer. S = Silvopasture. W = Windbreak or hedgerow or living snow fence.				

Next Steps**

- **Establish USDA Agroforestry Science Working Group** (see Objective 2.1). This group will guide further agroforestry research and development.
- (S4) **New Study: Windbreak Benefits on Crop Yields in the Great Plains.** USDA agencies will help the University of Nebraska and other cooperators identify and seek funding for a project to investigate field windbreak benefits to crop yields and how they may have changed with agriculture practices since the original studies of this issue in the 1960s.
- (S1, S2, S4) **Incorporate Agroforestry Practices Into Greenhouse Gas Assessments:** A U.S./Canadian team will collaborate with others to explore how to measure, inventory, and incorporate agroforestry practices into greenhouse gas assessments and management options. They also aim to have agroforestry recognized as a component of the Global Research Alliance on Agricultural Greenhouse Gases Croplands Research Group.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Objective 2.3: Translate

Overview

USDA has supported the production of tools and publications that move agroforestry innovations into products and services. Note: Many of these activities relate closely to those in Objective 1.2 (Educate Professionals), so please see that section for the workshops, seminars, and trainings that also serve to propel the agroforestry science into practice and application.

Accomplishments

1. USDA employees won the following **awards** for their technology transfer efforts:
    - In 2011, Research Forest Products Technologist Jim Chamberlain was chosen as the 2011 Forest Service Southern Research Station (SRS) Civil Rights Award recipient for making outreach a core objective within his NTFP research program. Chamberlain developed a variety of projects and collaborations to expand the use of NTFP to assist small, minority, and limited-resource landowners and to provide research and Forest Service experiences to diverse audiences—from faculty, students, and current natural resource professionals to the general public brought in to become citizen scientists.
    - In 2011, NAC received "special recognition" as an exemplary collaborative case study by the American Association for the Advancement of Science based on a significant record of agroforestry research accomplishments, technology transfers, and the long-standing partnership between the Forest Service (Southern Research Station and S&PF's Cooperative Forestry) and the NRCS.
    - In 2012, the *Conservation Buffers Guide* received an Honor Award in the Communication Category of the Central States Chapter of the American Society of Landscape Architects.
2. (S3 &S4) USDA developed customized **agroforestry products and services** for targeted audiences and locations, including evidence-based syntheses to provide agroforestry planning and design guidelines to address the following priorities:
    - Provide multifunctional and multiscale planning and design.
    - Address mitigation and adaptation to climate change.
    - Meet the needs of small and limited-resource landowners.
    - Protect and create critical habitat for wildlife, aquatic species, and pollinators.

Nationwide:

- **Conservation Buffers Guide:** NAC synthesized 1,400 publications to make a useful conservation buffer tool for landowners. Such a comprehensive synthesis is rarely done, and this effort won several awards. The guide has also been published in Mongolian, Chinese, Korean, Spanish, French, and Hebrew languages by a variety of partners**.** See below for user feedback. (NAC 2011)
- **Online Self-Assessment for Forest Owners:** NAC cooperated with the University of Georgia to add an online agroforestry module to the existing Forest*A*Syst Web site.

This self-assessment guide helps landowners articulate their objectives in a written management plan and encourages them to contact a resource professional for technical assistance. (NAC/Forest Service, University of Georgia 2011)

- **Conservation Buffers Protecting Water:** Scientists developed and published Geographic Information System-based tools to optimize buffers based on environmental and economic information to help planners, agencies, and landowners establish conservation buffers in the most critical areas. The tools can be used in NRCS conservation programs and potentially in environmental credit trading schemes to achieve water quality improvements. Research has been done to determine how to: (1) guide riparian restoration for aquatic health, (2) specify water quality goals, and (3) quantify how much water is used by different riparian vegetation species and management practices in the Great Plains. Scientist produced 5 tools, 5 research publications, and 12 technical presentations for natural resource professionals to explain how to use conservation buffers. (NAC, University of Nebraska, NJ Institute of Technology, University of Kentucky, and Iowa State University 2011–13)

- **Profitable Farms and Woodlands:** NAC partnered with the 1890s Agroforestry Consortium and other 1890 and 1862 land-grant universities to produce a practical guide to assist underserved and limited-resource farmers and woodland owners in adopting agroforestry best practices. (NAC funding 2012)

- **Visualization Simulation Software:** In 2004, NAC created *CanVis*, an image-editing program for creating photo-realistic images of proposed agroforestry and other conservation practices, greatly facilitating communication between resource professionals and landowners in 2011 and 2012. This program received the Two Chief's Partnership Award for an exemplary partnership between Forest Service and NRCS. Additionally, NAC partnered with the National Oceanic and Atmospheric Administration to provide training on the software. To see examples and find out more about CanVis, visit http://nac.unl.edu/simulation/products.htm#canvis.

- **Sample Windbreak Workshop Agendas:** NAC posted sample agendas on their Web site to help natural resource professionals develop local 1-, 3-, and 5-day workshops on windbreaks. These agendas could also be used for workshops on other agroforestry practices. (NAC 2011)

- **Agroforestry Technical Notes:** NAC developed and is distributing three new agroforestry technical notes. (NAC 2011–12)

  - 41, "Windbreaks: A "Fresh" Tool to Mitigate Odors from Livestock Production Facilities;"
  - 42, "Using Agroforestry to Buffer Noise;" and
  - 43, "The Human Considerations in the Adoption of Agroforestry."

- **Agroforestry Overview:** The National Center for Appropriate Technology updated its agroforestry overview publication to include discussion of all agroforestry practices, emerging opportunities, bioenergy, carbon credits, business recommendations, and planting and planning tools. This publication is located online at the Agricultural Marketing Resource Center (AgMRC)'s agroforestry profile and at the ATTRA National Sustainable Agriculture Information Service. (RD funding supports both AgMRC and ATTRA 2011–12)

- **Soil and Water Assessment Tool. The tool** is a public domain river basin scale model developed by ARS scientists in Temple, TX, to quantify the impact of land management practices in large, complex watersheds. It is open for use by anyone, and it has been combined with other models to determine optimal riparian buffer placement (ARS funding)
- **Pacific Island Agroforestry Information Service:** Publications written between 1992 and 1995 are still relevant today.

Northeast:

- **Silvopasture:** Cornell University Extension released a training publication on silvopasture as part of their forestry education. (NIFA RREA funds 2006–11)
  - Chedzoy, B.J. and Smallidge, P.J. 2011. Silvopasturing in the Northeast: An introduction to opportunities and strategies for integrating livestock in private woodlands. Cornell University Cooperative Extension Department of Natural Resources, Cornell University, Ithaca, NY.
  - Other publications on silvopasture and forest farming available online at http://www2.dnr.cornell.edu/ext/info/pubs/index.htm.
    - Chedzoy, B. (2012). Silvopasturing in New York. Cornell University Cooperative Extension; South Central New York Agriculture Team.
  - Handouts from their Silvopasture Day Course on site evaluation, economics, planning, and best practices are available at http://silvopasture.ning.com/.
- **Shiitake Mushroom Cultivation: New England:** Cornell University created several extension publications and a guide to growing mushrooms in the Northeast. For more information, see Objectives 1.2 and 2.2 and case study #7 in appendix D. (NIFA McIntire-Stennis funds 2008–11)
- **Riparian Buffers:** Pennsylvania State University Extension created a publication on the benefits of riparian buffers, how to plan and maintain them, where to go for more information, and which native trees and shrubs can be planted in the buffer. (NIFA Smith-Lever funds 2011)

Southeast:

- **Agroforestry Training Modules for Small Farmers and Woodland Owners:** North Carolina A&T Extension conducted three workshop sessions with stakeholders from government agencies and cooperative extension and small, limited-resource farmers and woodland owners to enhance five modules (silvopasture, alley cropping, riparian forest buffers, windbreaks, and forest farming) from the NAC. They also surveyed 150 owners of small farms and woodlands in North Carolina to assess what agroforestry is already in practice. Finally, they established four agroforestry demonstration sites in four counties. Farmers have already started to see economic benefits from adopting agroforestry practices. (NIFA 1890s Extension Capacity grant 2010–13)

Central:

- **Elderberry Financial Decision-Support Tool:** After completing surveys and market research nationwide, the University of Missouri worked with Landmark Bank, Wyldewood Cellars, and Eridu Farm to develop an Excel-based model designed to assist

with elderberry establishment and management decisions. It has already been used by existing landowners in their business plan development. This model lets the user select multiple options from a list of the most common establishment, management, harvesting, and marketing techniques to determine the techniques that will generate the best economic returns. (Funded by NIFA's North-Central Region SARE Research and Education grant 2011–13)

Other materials they have generated are the following publications:

- Elderberry: A Versatile, Easily-grown Shrub for the Midwest.
- Elderberry Market Research Report.
- Elderberry Market Directory—March 2011.
- Agroforestry in Action: Growing and Marketing Elderberries in Missouri.

- **Minnesota Windbreaks:** University of Minnesota Extension worked with many State, county, and Federal staff to produce a fact sheet that reviews several approved species of trees and shrubs that can be planted in Minnesota windbreaks. They shared this fact sheet with all county and State agencies. (NIFA capacity funds 2011–12)

- **Minnesota Living Snow Fences To Protect Highways:** University of Minnesota Extension surveyed landowners with living snow fences and agency staff who offer living snow fence programs to develop a payment calculator for State and local governments to pay landowners to establish living snow fences to protect highways in the winter. In the future, this calculator will be offered online. (NIFA capacity funds and Minnesota Department of Transportation 2009–12)

- **Family Forest Owner Toolbox: Great Lakes States:** The Great Lakes Forest Alliance, a nonprofit organization that enhances the management and sustainable use of forest lands in Michigan, Minnesota, Ontario, and Wisconsin, created a toolbox of resources to help landowners enhance their management and enter emerging markets. The toolbox includes 11 factsheets, including one on "Agroforestry Benefits" and others that are relevant to agroforestry, such as "Non-Timber Forest Products." (Funded by a grant from the Forest Service—Northeastern Area State and Private 2012)

West:

- **Nontimber Forest Product Market Information in the Pacific Northwest:** The Institute for Culture and Ecology provided small woodland owners with market and business information about NTFPs such as moss, floral greens, and medicinal plants. Thus far, at least six landowners have started cultivating Oregon grape on their tree farms, Extension agents at Oregon State University and WSU are disseminating the information, and a Northwest market information system is connecting buyers and sellers. They have produced three peer-reviewed journal articles, two popular journal articles, market fact sheets and reports for six NTFPs, an online Oregon NTFP industry directory, and price-tracking database for six products. (NIFA AFRI grant 2009–12)

- Jones, E. and Bultolph, L. published "Nontimber Forest Product Business Guides for Woodland Owners" in the spring issue of *Northwest Woodlands* (2011).

Islands:

- ***Pandanus* Conservation and Dissemination in the Marshall Islands:** With financial support from the Forest Service Forest Stewardship and Urban and Community Forestry Programs, the Marshall Department of Agriculture and Women United in the Marshall Islands are working to document, disseminate, and celebrate the *Pandanus* species that have edible fruits eaten by the local populations and fibers used by women to make crafts. (Forest Service 2011)

3. (S1) USDA facilitated ongoing interaction with end-users throughout the technology development cycle when NAC worked with Iowa State University to conduct a survey and interviews to see how practitioners used their Conservation Buffers Guide (see above) in order to revise future editions. They found that 79 percent found the guide to be an effective resource for planning and design, and 76 percent agreed the guide presented research in a practical manner. More than 10,000 copies of this guide have been requested. In addition, as mentioned above in several cases, surveys were done before and after product development.

Case Studies

Read the following case studies in appendix D.

Title	Practice	Objective	Agencies	State
#12—Agroforestry Consortium's Aim & Profitable Farms and Woodlands for Limited-Resource Producers	**All except T**	2.3	**NAC, NRCS, Forest Service**	**Southeast**
#13—Oregon Woodland Owners Enter a New World of Possibilities With Oregon Grape	**A & R**	1.2, 2.2, and 2.3	**RD, NIFA, NRCS**	**OR**
A = Alley cropping. NAC = National Agroforestry Center. NIFA = National Institute of Food and Agriculture. NRCS = Natural Resources Conservation Service. RD = Rural Development. R = Riparian forest buffer. T = Tropical agroforestry.				

Next Steps**

Establish USDA Agroforestry Science Working Group (see Objective 2.1). This group will guide further research and development work.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Goal 3: INTEGRATION

Incorporate agroforestry into an all-lands approach to conservation and economic development

Desired Outcome: USDA agencies understand, use, and integrate agroforestry into their policies and programs to maximize benefits and services to citizens

Introduction

Goal 3 (Integration) and its three supporting objectives are about the U.S. Department of Agriculture (USDA) taking action to (1) **incorporate** agroforestry into its policies and programs, (2) improve the **assessment and reporting** of agroforestry activities and impacts, and (3) increase **communication** with stakeholders about the many benefits of agroforestry. Although it is more focused on the innerworkings of USDA than the other two goals, Goal 3 is essential for the work that goes on in both Goals 1 and 2.

Goal 3 contains 18 of the 40 strategies in the *USDA Strategic Framework for Agroforestry, Fiscal Year 2011-2016* (hereafter referred to as the *Strategic Framework*)—or nearly one half. USDA has made significant progress by completing or substantially working on 11 of those strategies. For example, the completion of this report accomplishes Strategy #6 under Objective 3.1: "Report annually to the Secretary of Agriculture, including a review of USDA financial commitments to agroforestry, accomplishments, and outcomes."

However, the strategies that remain are not insignificant, and much work remains to be done. In particular, although the Census of Agriculture now includes its first question about agroforestry,[13] the data that it can provide is limited because it will only include the producers who do silvopasture or alley cropping, but will not differentiate between the two or describe producers who do other agroforestry practices.

In the following section, we summarize what USDA has done to integrate agroforestry into USDA and identify the next steps needed to more fully do so. We reference one case study under Objective 3.1 (#14—Virginia Is for Lovers—and Silvopasture, appendix D), which describes how NRCS in Virginia listened to the local producers' desire for silvopasture and took action to establish a conservation practice and to educate themselves about how to assist these producers in establishing silvopasture on their lands.

[13] Previous Censuses of Agriculture have asked producers to report the amount of woodland grazed, but it is not clear how much of this may be a silvopasture, which involves managing the trees, livestock, and forages together in a system that is integrated, intensive, intentional, and interactive.

Objective 3.1: Institutionalize

Overview

Because the United States has made limited use of agroforestry as a means to meet production and conservation goals—of which it has significant potential—the aim of this objective is to incorporate agroforestry into USDA policies, programs, and activities. In the 2 years of implementing the *Strategic Framework*, USDA has accomplished six of the seven strategies identified for this objective, beginning with establishing an Agroforestry Executive Steering Committee. This report (i.e., to review USDA financial commitments, accomplishments, and outcomes) addresses strategy #6 under this objective.

Accomplishments

1. (S3, S4) Following the release of the *Strategic Framework*, USDA established an **Agroforestry Executive Steering Committee** to guide its implementation. On October 20, 2011, the heads of six USDA agencies and the Deputy Under Secretary for Rural Development (RD) signed a charter to establish the committee. The committee is composed of senior executives from the Agricultural Marketing Service (AMS), Agricultural Research Service (ARS), Forest Service, Farm Service Agency (FSA), National Institute of Food and Agriculture (NIFA), Natural Resources Conservation Service (NRCS), and RD. From its inception in November 2011 through February 2013, Jimmy L. Reaves, Deputy Chief of Forest Service Research and Development chaired the committee. In March 2013, Vice Chair Franklin E. Boteler, Assistant Director for the NIFA Institute of Bioenergy, Climate, and Environment became the committee chair, and the duties of Vice Chair were assumed by Wayne Honeycutt, Deputy Chief of NRCS Science and Technology. In February 2013, the National Agricultural Statistics Service (NASS) became the eighth agency to join the committee. The **USDA Interagency Agroforestry Team**, composed of the eight agencies listed above, provides staff support to implement the *Strategic Framework* priorities set by the steering committee.

2. (S1) USDA Secretary Tom Vilsack signed a Departmental Regulation (DR 1073-002): USDA Policy for Agroforestry to establish agroforestry policy across the Department on February 26, 2013. This policy statement was developed by the steering committee during 2012 and cleared by all USDA agencies, mission areas, and offices before it was approved by the Secretary.

3. (S5, S6) This first-ever USDA-wide report on agroforestry includes a 3-year[14] budget and performance crosscut (developed in consultation with USDA's Office of Budget and Program Analysis) that can be completed by appropriate agencies annually or biennially.

4. (S7) Several USDA agencies have included agroforestry in their action and/or strategic plans:
   - ***Forest Service Action Plan for the Nation's Forests and Grasslands (2011)*:** Action 12 (1 of 16 immediate actions) states:

     "Accelerate restoration actions in high-priority watersheds that address key factors to hydrologic conditions and aquatic processes. Building on the Secretary's High Priority Performance Goal for water, these actions will increase the agency's focus on the improvement of hydrologic conditions and aquatic processes. . . Focus should include

[14] Actual FY 2013 budget figures were not available at the time the report was compiled.

increasing the environmental analyses and implementation of management plans for range allotments. The results of this work will reduce risks to important water supplies; improve watershed resiliency to climate change and other stressors, promote rural wealth through job opportunities and connect people to the outdoors, enhance the urban forest component of high-priority watersheds, **connect forests to farms through agroforestry practices,** and provide for water-based recreation."

- **USDA Action Plan for Sciences:** As described in Objective 2.1, the USDA Action Plan for Science **(2012)** has a strategy to:

  "Advance the use of agroforestry as a viable agricultural option for meeting the multiple demands of food, fiber, feed, fuel, and natural resource conservation from these lands." Under this strategy are the following actions: Develop knowledge and technologies to improve the application of **agroforestry** practices and principles in protecting water and soil resources; build landscape-level resiliency to climate change impacts; reconnect ecological services across rural-urban lands and communities; provide innovative and sustainable bioenergy production systems; create multipurpose landscapes that can protect natural resources and can produce food, fiber, and energy (ARS, NIFA, and Forest Service).

- **Renewable Resources Extension Act (RREA) Program:** NIFA's program also has a strategic plan. In the **RREA Strategic Plan** (2012–16), one of the cross-cutting strategic issues in the plan is "Forest and Rangeland Food Safety and Security" with a specific focus on agroforestry. The intent and expectation is that partners work in agroforestry with the RREA funding, where it is a good fit and local priority.

5. USDA agencies have incorporated agroforestry into their programs by establishing them as "conservation practice standards" (NRCS and FSA) and as priorities in "Requests for Proposals" and other efforts:

   - **NRCS Agroforestry Practice Standards:** The standards were established at the national level over the past 70 years. Windbreaks were established in the 1930s, forested riparian buffers in the 1990s, alley cropping in the late 1990s, silvopasture around 2000, and multi-story cropping in the mid-2000s. Subsequently, these practice standards have been incorporated into State and territory Field Office Technical Guides. As of September 2012, the numbers of States and territories that have adopted agroforestry practices (with their practice code) are as follows:
     - **Alley Cropping** (311) is in 35 States, 8 territories, and Washington, DC.
     - **Multi-Story Cropping** (379) is in 11 States and 8 territories.
     - **Riparian Forest Buffers** (391) is in 50 States, 8 territories, and Washington, DC.
     - **Silvopasture** (381) is in 24 States and 8 territories.
     - **Windbreak/Shelterbelt Establishment** (380) is in 44 States, 8 territories, and Washington, DC.
     - **Windbreak/Shelterbelt Restoration** (650) is in 35 States and 8 territories.
     - **All eight territories have all six practice standards.** These territories are American Samoa, Federated States of Micronesia, Guam, Marshall Islands, Northern Mariana Islands, Palau, Puerto Rico, and the U.S. Virgin Islands.
     - **For the full list by State/territory, see** appendix H.

- **Competitive Grant Requests:** NIFA, NRCS, and Forest Service incorporated agroforestry into their competitive grant requests for applications and proposals.
  - **NIFA:** Although the Agriculture and Food Research Initiative and 1890 Institution Teaching, Research, and Extension Capacity Building Grants mention agroforestry, only RREA emphasizes it in **National Focus Fund Projects.**

  - **NRCS State-Level Conservation Innovation Grant (CIG): Grant requests for applications that** mention agroforestry include the following (Note: Hyperlink is only to most recent RFA):
    - Pacific Islands Area CIG 2012
    - Missouri CIG 2011& 2012
    - Georgia CIG 2012 & 2011
    - Vermont CIG2012 & 2011
    - Louisiana CIG 2012 & 2011
    - Michigan CIG 2012 & 2011
    - Washington State CIG 2011
    - Hawaii CIG 2011
    - Ohio CIG 2011
    - Kansas CIG 2011

  - **Forest Service International Programs in West Africa:** This program mentions agroforestry in the following:
    - Strategic Activities Fund of the Sustainable and Thriving Environments for West African Regional Development (STEWARD) Program, Phase III 2012
    - STEWARD Strategic Activities Fund 2011

- **Federal-State Marketing Improvement Program:** AMS added agroforestry products to the list of eligible agricultural categories for applications to the program.

6. (S7) Agroforestry was included as a strategy by at least seven State forestry agencies (Alabama, Colorado, Kansas, Kentucky, Nebraska, North Dakota, and South Dakota) in their Statewide Assessments and Strategies for Forest Resources (aka Forest Action Plans). Several State Forestry Fact Sheets also mention agroforestry or specific agroforestry practices as a priority in 2011 (Federated States of Micronesia, Kansas, Nebraska, North Dakota, South Dakota, and Texas).

Case Study

Read the following case study in appendix D.

Title	Practice	Objective	Agencies	State
#14—Virginia Is for Lovers—and Silvopasture.	Silvopasture	1.2 and 3.1	NRCS	VA
NRCS = Natural Resources Conservation Service.				

Next Steps**

- (S2) **Increase Agroforestry Literacy at USDA**. See Objective 1.2.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Objective 3.2: Assess Performance

Overview

USDA does not yet have a comprehensive way to account for and monitor agroforestry impacts and applications; however, three relevant national inventory/census systems do exist: (1) the Agricultural Census conducted by NASS, which is based on responses to a questionnaire that is completed every 5 years by agricultural producers; (2) the Forest Inventory and Analysis Program (FIA), considered the Nation's Forest Census, is an ongoing effort by the Forest Service to survey and report on the status and trends in forest area, location, ownership, growth, mortality, tree health, removals by harvest, etc.; and (3) the National Resources Inventory (NRI), which is a survey of land use and natural resource conditions on non-Federal lands conducted by NRCS.

Before 2012, the USDA Agricultural Census did not include any questions relative to agroforestry. As stated under Goal 1, many agroforestry practices are too linear and/or small to qualify as forested land use and therefore are not accounted for by FIA or NRI. So, assessing the adoption and application of agroforestry practices across the country has been quite challenging. Although a question on grazed woodlands is on the Agricultural Census, grazed woodlands are not necessarily considered agroforestry because they may not be managed as a silvopasture that must meet the criteria of the four "i"s (intentional, integrated, interactive, and intensive).

Accomplishments

1. (S3) Thanks to the cooperation of NRCS, Forest Service, NASS, and the National Agroforestry Center (NAC), USDA successfully added the first-ever question on agroforestry to the 2012 Census of Agriculture. The question reads: "*At any time during 2012, did this operation practice alley cropping or silvopasture as an integrated Agroforestry system?"* This yes/no question will monitor the application of alley cropping and silvopasture by agricultural producers, provide information about those producers who have and have not adopted these practices, and enable the creation of follow-on surveys of these producers if resources are allocated to such an activity.
2. In 2011, Pennsylvania State University Extension surveyed 45 U.S. extension foresters in 32 States about their State's agroforestry work, resulting in a publication by M. Jacobsen and S. Kar in the *Journal of Extension* (in press). Key findings included the following:
    a. Extension personnel in 16 States said that they had agroforestry programs (23 have had them at some point).
    b. Although the reasons for not having such programs cannot be generalized across all States, lack of funding and extension forestry personnel were the most common reasons cited by 50 percent of the 16 States without agroforestry programs.
    c. Across the States, riparian forest buffers were the most common practice, followed by windbreaks and forest farming. Incidentally, more than 95 percent of USDA funding for agroforestry goes toward assisting producers to install and maintain riparian buffers and windbreaks.
    d. Three needs were identified to increase agroforestry extension programming:
        - Agroforestry programs need to be designed for economic and environmental benefits.

- Agroforestry needs dedicated personnel and funding resources.
- Agroforestry education and demonstrations are needed to train natural resource professionals.

3. NAC worked with Forest Service FIA staff to create the agroforestry section of the first-ever comprehensive Forest Atlas, which is expected to be published in 2013 (2011–12).

4. (S2) **Southeast: Nontimber Forest Products (NTFPs) Output Information System:** Forest Service's Southern Research Station is working with Virginia Polytechnic Institute and State University to develop a system to estimate the amount of 12 medicinal NTFPs bought in Appalachia. They are currently doing a pilot study in Virginia and North Carolina to research the volume and type of NTFPs sold, analyze the industries using the raw medicinal productions, and create a decision support system for the eXtension Forest Farming Community of Practice. They are using Forest Service FIA zones in the hope that this effort can eventually scale up to provide a nationwide inventory. (Forest Service 2011–15)

5. (S2) **National:** NAC staff, Forest Service scientists, NRCS staff, and State forestry agency cooperators have developed a **draft national USDA report, "Agricultural and Urban Forests and the Montreal Process Criteria and Indicators,"** which makes a case for a continuous national inventory of these often small, narrow forests (e.g., windbreaks, street trees) and examines several one-time inventories that could be useful models (e.g., Great Plains Initiative inventory in Kansas, Nebraska, North Dakota, and South Dakota). The report is expected to be published in 2013.

6. (S2) **Central: Windbreak Assessment:** Because erosion is a key issue on Kansas cropland, the Kansas Forest Action Plan identified sustaining and protecting forest and agroforestry ecosystems as one of seven key issues, and they identified assessing windbreaks as a key strategy. Thus, Kansas Forest Service and Colorado Forest Service partnered with NRCS, Kansas Cooperative Extension, Kansas County Conservation District, and Smoky Hills Resource Conservation District to use remote sensing to inventory and assess windbreaks established in nine high-priority counties in the two States during the 1930s. They quantified biomass, invasive species, and ash and black walnut at risk to Emerald Ash Borer and Thousand Cankers Disease, respectively. This project builds on the Great Plains Initiative inventory, a partnership effort in which State forestry agencies, Forest Service, and NRCS piloted inventory procedures for assessing windbreaks, riparian buffers, and other trees on farms and in communities (outside of classified forest land) in Kansas, Nebraska, South Dakota, and North Dakota. (Forest Service Redesign and NRCS CCPI funds 2010–15)

7. **USDA Tracking Its Progress:** Each goal in the *Strategic Framework* includes a note saying that "Performance indicators, baselines, metrics, and targets will be developed in the implementation phase." These indicators have yet to be developed. For this report, however, a budget and performance crosscut was developed with the USDA Office of Budget and Program Analysis (see appendixes A, B, and C). The indicators in this report, while at the output level (number of publications, number of workshops and educational visits, number of Web site hits, acres of silvopasture applied, etc.) begin to quantify USDA's investment in agroforestry over time.

Next Steps**

(S2) **Publish National Report: *Agricultural and Urban Forests and the Montreal Process Criteria and Indicators***. NAC scientists and other Forest Service scientists and cooperators are coauthoring a national Forest Service report that will help make the case for a national continuous

inventory of urban and agricultural forests, including agroforestry plantings. Many of these "linear forests" are too narrow and small to be classified as forest land and thus are missed by Forest Service and NRCS natural resource inventories. The report is expected to be published in late 2013.

(S4) **Add Agroforestry Question(s) to the National Woodland Owners Survey.** The USDA NAC will work with a National Woodland Owners Survey manager to develop agroforestry question(s) for inclusion in the next national survey and/or pilot in one or more State surveys.

(S3) **Assess Responses to Agroforestry Question in 2012 Census of Agriculture.** The Agroforestry Executive Steering Committee will work with NASS to examine the data regarding the producers who have and have not adopted alley cropping and silvopasture.

**Note: To review all next steps in the report, go to the final section on Next Steps.

Objective 3.3: Communicate Results

Overview

USDA agencies have promoted awareness and appreciation of agroforestry within USDA and with partners and the public by (1) creating a USDA Agroforestry Communication Plan, (2) developing a variety of publications (brochures, posters, newsletters, and technical notes), and (3) making presentations at key conferences. They will also be creating an Internet presence with the USDA Web site. Newspaper articles over the past 2 years have featured the *Strategic Framework*, U.S.-Canada collaborations on a July 2012 windbreak conference, forest farming, and agroforestry's role in increasing resilience to climate change both domestically and in Africa.

Accomplishments

1. (S1) USDA has conducted a wide range of activities to **communicate the economic, environmental, and social benefits of agroforestry** to the full spectrum of land users, tribes, communities (urban to rural), minority landowners/limited-resource producers, natural resource professionals, and other stakeholders.

    - **Plan:** The Agroforestry Executive Steering Committee completed a USDA Agroforestry Communications Plan in August 2012 and transmitted it to the USDA Office of Communications for review and concurrence. The plan includes numerous actions, including enhanced USDA agroforestry Web pages and "This Is Agroforestry" posters that will illustrate the outcomes from applying agroforestry practices (e.g., cleaner water, healthier soil).
    - **Web site:** In 1 year (2011), the NAC's Web site registered more than 82,000 unique visitors with more than 1.3 million hits from 85 countries. Germany, Canada, Brazil, India, Australia, Indonesia, Mexico, the United Kingdon, France, Poland, and Italy all had more than 3,900 hits each.
    - **Brochure:** NAC created and updated six "Working Tree-Info" brochures in FY 2011–12. These brochures explain how agroforestry is the right tree in the right place for the right reason to support energy, communities, wildlife, water quality, agriculture, and more.
    - **Posters:** Twenty-one "This Is Agroforestry" posters have been developed by AMS with review and input from the Interagency Agroforestry Team. They are in draft.
    - **Banners:** NAC developed two new 7- by 3-foot pop-up banners: "Working Trees for **Wildlife** and Working Trees for **Water Quality**." These and the other banners are available on a first-come, first-serve basis. Displays and banners are shipped free of charge; the only cost is shipping it back to NAC or to the next user (2011).
    - **Newsletters:** In 2011 and 2012, NAC developed and distributed four *Inside Agroforestry* newsletters (Volumes 19 and 20, Issues 1 and 2) titled "**Riparian Forest Buffer**: 'apps' for your smart farm"; "**Alley Cropping**: a relic from the past or a bridge to the future?"; "Scoring Big with **Silvopasture**"; and "**Windbreaks**: these aren't your grandfather's shelterbelts." They were distributed to 6,500 people.

- **Conference presentations:** In 2011, NAC sponsored exhibits and/or gave presentations to more than 2,000 people regarding the *Strategic Framework*, agroforestry income opportunities for small landowners, NTFP, and about NAC's mission, science, tools, and services:
    - National Society of American Foresters Convention.
    - Tri-State Forest Stewardship Conference.
    - Celebrating America's Forests event.
    - National Women in Agriculture Association meeting.
    - North American Agroforestry Conference.
    - Professional Agricultural Workers Conference.
    - Minority Landowner Magazine 5th Anniversary Conference.
    - American Indian Higher Education Council was briefed by Forest Service and NRCS on agroforestry and the opportunity for NAC to assist Tribal Colleges/Universities (March 2012).
- **Other presentations:** NAC gave 53 scientific presentations and 17 presentations to the general public (e.g., in partnership with the Lower Platte South Natural Resources District, NAC presented "Managing Tree Resources" to an audience of more than 250 elementary students and professors in Nebraska) (2011).

2. (S2) **USDA agroforestry efforts have been featured by the media** as a means to support sustainable agricultural systems, including increased resilience to the impacts of climate change (e.g., drought, floods, storms). See appendix E for a full list.
    - *Climate Wire* and the *Athens Banner-Herald* featured USDA Deputy Secretary Merrigan's remarks on agroforestry when she publicly announced the *Strategic Framework* at the North American Agroforestry Conference (June 2011).
    - Agroforestry was the cover story in *CSA News magazine* (November 2011).
    - *The New York Times* published *"A Quiet Push to Grow Crops Under Cover of Trees"* (November 2011).
    - *The Journal of Forestry* featured a lead/cover story, "A role for agroforestry in forest restoration in the lower Mississippi alluvial valley" (February 2012).
    - The Associated Press featured an article in the *The Washington Post, The Telegraph, Huffington Post*, and *The Advertiser*, "With Agroforestry, Woodlands can also yield crops such as mushrooms, leeks" (April 2012).
    - The joint windbreak restoration conference held by USDA and their Canadian counterparts at Agriculture Agri-Food Canada garnered interest from reporters at *Farm World* (May 2012) and *The Western Producer* (September 2012).
    - NAC Director Andy Mason was interviewed for and quoted in a Climate Wire article about how agroforestry practices are relevant to both the United States and African countries in terms of drought mitigation (July 2012). Grist published an article, "The giving tree: agroforests can heal food systems and fight climate change" (December 2012).

3. In addition to the publications mentioned in #2 above, USDA has used the following newsletters, blogs, and other publications to highlight the practice of agroforestry and its

contribution to improving and diversifying agricultural production, enhancing environmental and economic resiliency, building vibrant communities, and conserving private working lands.

- The *NACD Forestry Notes* included numerous agroforestry stories in 2011–12.
- Agroforestry is mentioned in the Know Your Farmer, Know Your Food Compass (see p. 38 of the "Read" portion of the Compass, Stewardship), released February 29, 2012.
- Agroforestry is described in the USDA Organic Resource Guide (p. 38), released October 2012.
- Agroforestry was highlighted in USDA's blog more than 10 times in 2011–12.
  - Harnessing NRCS Programs To Support Local and Regional Food Systems.
  - Forest Service Trains Nebraska Guard Members for Afghanistan Deployment.
  - A New Roadmap to Sustainable Agriculture.
  - Urban Fruit for Urban Communities.
  - How 'Eco' is Friendly to Agriculture and Food Systems.
  - Specialty Crop Grants Make a Difference for Farmers and Businesses.
  - A Clear Answer to Clean Water.
  - Tenth-Generation South Carolina Farm Family Raise Organic Livestock.
  - Colorado Communities Benefit from Protection of Living Snow Fences.
  - Kake Forests Provide More than Just Trees.
  - The Island of Pohnpei Rediscovers its Agroforestry Roots (also case study #15 in appendix D of this report).

4. The other two strategies mentioned in the *Strategic Framework* are included under Objective 1.1 of this report, which focuses on partnering for increased adoption through the creation of communities of practice and demonstration sites**:**

   - (S3) **Foster public-private partnerships** that increase understanding, acceptance, and increased application of agroforestry.
   - (S4) Publicize and increase use of **demonstration sites** that increase acceptance and understanding of agroforestry.

Next Steps**

(S1) **Enhance USDA Communication About Agroforestry.** The Agroforestry Executive Steering Committee will implement the USDA Agroforestry Communication Plan, including these high-priority actions: (1) establish enhanced USDA Web pages, (2) finalize and release the first set of "This Is Agroforestry" posters, and (3) cross-publish the case studies included in appendix D of this report on the USDA blog and in widely circulated agency publications. The committee will also consider implementing other priority actions in the plan (e.g., an agroforestry application aimed at younger, more tech-savvy audiences).

(S6) **Invite Feedback on This Report and USDA's Role in Agroforestry.** The Agroforestry Executive Steering Committee established an email address (agroforestry@USDA.gov) that invites feedback on the report. The committee will ensure that the report is widely distributed, including to stakeholders who met in May 2010 in Washington, DC, to provide input to the development of the *Strategic Framework*.

**Note: To review all next steps in the report, go to the final section on Next Steps.

NEXT STEPS

USDA plans to implement the following next steps to advance agroforestry.

Note that each next step is also listed at the end of the appropriate objective throughout the report.

Goal 1: Adoption

1. **Establish a Tribal Relations Agroforestry Working Group.** The Agroforestry Executive Steering Committee plans to establish a working group to use results from the survey of Tribal Conservation Districts and expand outreach with tribal organizations.

2. **Increase Silvopasture Application in the Southeast United States.** The Agroforestry Executive Steering Committee is exploring funding opportunities for this initiative, which will focus on limited-resource and minority landowners in the Southeast United States with pine plantations and expiring Conservation Reserve Program contracts that are (1) engaged in livestock production and (2) interested in restoring the longleaf pine ecosystem. The initiative will emphasize cooperation with 1890 land-grant universities including those in the 1890 Agroforestry Consortium.

3. **Increase Pacific Islands Agroforestry Extension and Research Capacity.** The U.S. Department of Agriculture (USDA), State agencies, and university cooperators will continue to pursue funding and other support needed to establish two positions: (1) a regional agroforestry extension agent in Guam to help producers deal with new pests, diseases, and invasive plants affecting agroforests throughout the Pacific Islands; and (2) an agroforestry research scientist to synthesize and deliver agroforestry-related science to help Pacific Island people mitigate and adapt to climate change in the western Pacific, where strand forests and atoll islands are already experiencing the impacts of sea-level rise.

4. **Expand Agroforestry Learning Partnerships.** USDA agencies and cooperators will continue to pursue opportunities to initiate and establish other regional agroforestry working groups, peer-to-peer learning networks, demonstration sites, communities of practice, and on-farm/action research.

5. **Conduct Midwest Agroforestry Academies.** USDA agencies will cooperate with the University of Missouri Center for Agroforestry and others in the Mid-America Agroforestry Working Group to conduct 2013–14 agroforestry academies for resource professionals in the Midwest (Nebraska, Iowa, Missouri, Minnesota, and Wisconsin). The academies are supported by a 2012 Sustainable Agriculture Research and Education grant. USDA agencies will also consider opportunities to initiate agroforestry academies in other regions (e.g., Southeast, in cooperation with 1890 land-grant universities).

6. **Increase Agroforestry Literacy at USDA.** The Agroforestry Executive Steering Committee will consider opportunities to increase agroforestry literacy across USDA and with cooperators. Options include developing an *Agroforestry 101* training module similar to the *Organic 101* and *201* modules available at http://www.ams.usda.gov/organicinfo for the public and on AgLearn for USDA employees.

7. **Implement U.S.-Canada Agroforestry Memorandum of Understanding.** The USDA National Agroforestry Center will continue working with Canada's Agroforestry Development Centre and other cooperators to implement agreed-upon actions consistent with Memorandum of Understanding's purpose: to advance the application of temperate agroforestry systems by focusing on science and tools for climate change mitigation and adaptation.

Goal 2: Science

8. **Establish USDA Agroforestry Science Working Group.** The Agroforestry Executive Steering Committee plans to establish a working group to coordinate agroforestry activities of Agricultural Research Service, National Agricultural Statistics Service, National Institute of Food and Agriculture, Natural Resources Conservation Service, Forest Service, and other USDA science agencies to accomplish the highest priority strategies for Goal 2 in the *USDA Strategic Framework for Agroforestry, Fiscal Year 2011-2016* (hereafter referred to as the *Strategic Framework*) and to guide future agroforestry research, education, and extension.

9. **New Study: Windbreak Impacts on Crop Yields in the Great Plains.** USDA agencies will help the University of Nebraska and other cooperators identify and seek funding for a project to investigate field windbreak benefits to crop yields and how they may have changed with agriculture practices since the original studies of this issue in the 1960s.

10. **Incorporate Agroforestry Practices Into Greenhouse Gas Assessments.** A U.S./Canadian team will collaborate with others to explore how to measure, inventory, and incorporate agroforestry practices into greenhouse gas assessments and management options. They also aim to have agroforestry recognized as a component of the Global Research Alliance on Agricultural Greenhouse Gases' Croplands Research Group.

Goal 3: Integration

11. **Publish National Report: *Agricultural and Urban Forests and the Montreal Process Criteria and Indicators*.** USDA National Agroforestry Center and Forest Service scientists and other cooperators are coauthoring a national Forest Service report that will help make the case for a national continuous inventory of urban and agricultural forests, including agroforestry plantings. Many of these "linear forests" are too narrow and small to be classified as forest land and thus are missed by Forest Service and Natural Resources Conservation Service natural resource inventories. The report should be published in late 2013.

12. **Add Agroforestry Question(s) to the National Woodland Owners Survey**. Staff at the National Agroforestry Center will work with the National Woodland Owners Survey manager to develop agroforestry question(s) for inclusion in the next national survey and/or pilot in one or more State surveys.

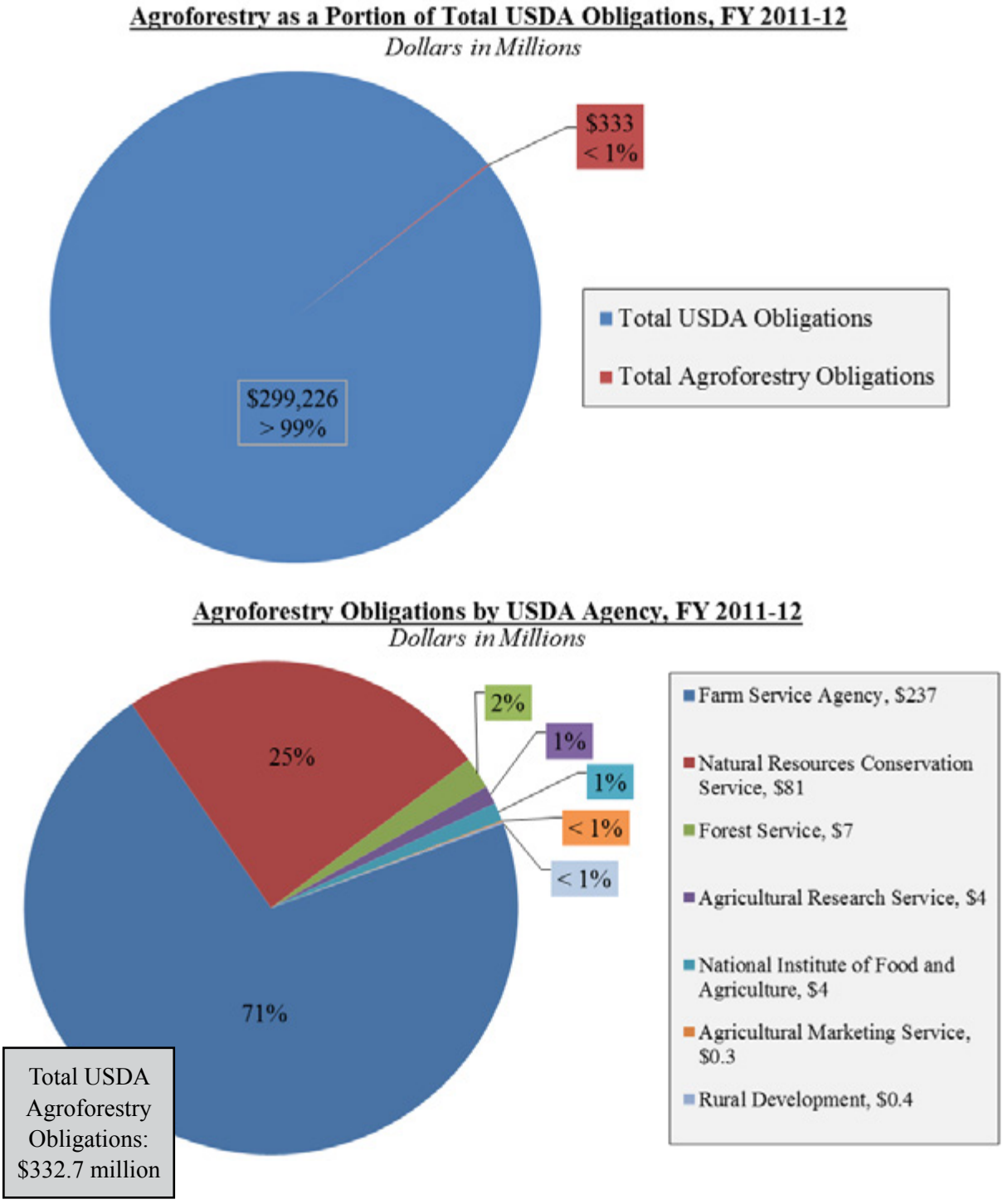
13. **Assess Responses to Agroforestry Question in 2012 Census of Agriculture.** The Agroforestry Executive Steering Committee will work with the National Agricultural Statistics Service to examine the data regarding the producers who have and have not adopted alley cropping and silvopasture.

14. **Enhance USDA Communication About Agroforestry.** The Agroforestry Executive Steering Committee will implement the USDA Agroforestry Communication Plan, including these high-priority actions: (1) establish enhanced USDA Web pages, (2) finalize and release the first set of "This Is Agroforestry" posters, and (3) cross-publish the case studies included in appendix D of this report on the USDA blog and in widely circulated agency publications. The committee will also consider implementing other priority actions in the plan (e.g., an agroforestry "app" aimed at younger/tech savvy audiences).

15. **Invite Feedback on This Report and USDA's Role in Agroforestry.** The Agroforestry Executive Steering Committee established an email address (agroforestry@USDA.gov) that invites feedback on the report. The committee will ensure that the report is widely distributed, including to stakeholders who met in May 2010 in Washington, DC, to provide input to the development of the *Strategic Framework.*

Appendix A: Budget Crosscut[15]

Figure A1.—USDA financial obligations to agroforestry.
Top: Portion of total USDA funds obligated to agroforestry activities in FY 2011-12. Bottom: USDA financial obligations to agroforestry divided by agency in FY 2011-12. Obligations from *USDA FY 2014 Explanatory Notes*.



[15] Only FY 2011-12 budget figures were included because FY 2013 information was not available when the report was compiled.

Table A1.—*Quick Reference: USDA agency financial obligations.* ***Dollars in Thousands.***

USDA Agency	FY 2011 Obligations	FY 2012 Obligatios
Agricultural Marketing Service (AMS)*	102	222
Agricultural Research Service (ARS)	1,945	2,074
Forest Service	3,150	3,560
Farm Service Agency (FSA)	117,560	118,986
National Institute of Food and Agriculture (NIFA)	3,868	**
Natural Resources Conservation Service (NRCS)	29,074	51,779
Rural Development (RD)	257	195
USDA Total	**$155,917**	**$176,816**

Table A2.—*Full Budget Crosscut: USDA agency financial obligations.* ***Dollars in Thousands.***

	FY 2011 Obligations	FY 2012 Obligations
Agricultural Marketing Service (AMS) Total	**102**	**222**
Specialty Crop Block Grants*	102	222
Federal-State Marketing Improvement Program	0	0
Agricultural Research Service (ARS) Total	**1,945**	**2,074**
Appropriated funds	1,945	2,074
Forest Service Total	**3,150**	**3,560**
National Agroforestry Center (NAC) Total	**1,522**	**1,552**
Research & Development (BASE – FRRE)	891	1,021
Special Projects (FRRE)	50	50
State & Private Forestry (BASE – SPST)	423	423
State & Private Forestry (BASE – SPUF)	58	58
Special Projects (SPST)	40	0
Special Projects (SPCH)	30	0
Special Projects (SPS2)	30	0
Research & Development Total, including NAC	**1,261**	**1,533**
WO R&D	0	5
International Institute of Tropical Forestry	62	25
Forest Products Laboratory	0	0
Forest Inventory & Analysis	100	0
Northern Research Station	158	164
Pacific Northwest Station	0	0
Pacific Southwest Station	0	59
Rocky Mountain Research Station	0	9
Southern Research Station	0	200

(continued from previous page)	FY 2011 Obligations	FY 2012 Obligations
State and Private Forestry Total, including NAC	**1,889**	**2,027**
Northeastern Area	557	594
Intermountain and Northern Regions	148	177
Pacific Northwest and Alaska Regions	0	0
Pacific Southwest Region	289	518
Rocky Mountain Region	98	149
Southern Region	216	105
Southwestern Region	0	0
International Institute of Tropical Forestry	0	0
Office of Tribal Relations	0	3
Farm Service Agency (FSA) Total * **	**117,560**	**118,986**
Conservation Programs (CRP and CREP)		
Field Windbreaks (CP5)	10,324	10,145
Shelterbelts (CP16)	3,631	3,645
Living Snow Fences (CP17)	648	675
Forested Riparian Buffers (CP-22)	93,986	93,648
Bottomland Hardwoods (CP31)	8,971	10,873
National Institute of Food and Agriculture (NIFA) Total	**3,868**	**
Capacity Funds	**1,824**	**
Evans-Allen	52	**
Hatch	486	**
McIntire-Stennis	456	**
Renewable Resources Extension Act		**
Smith-Lever	830	**
Grants	**2,044**	**
1890 Capacity Building Grants Program	28	**
Agriculture Food Research Initiative (AFRI)	1,004	**
Peoples Garden Grant Program	11	**
Extension Indian Reservation Program	9	**
Specialty Crop Research Initiative (SCRI)	904	**
Other	88	**

(continued from previous page)	FY 2011 Obligations	FY 2012 Obligations
Natural Resources Conservation Service (NRCS) Total	**29,074**	**51,779**
Alley Cropping (311)	49	17
Multi-Story Cropping (379)	281	454
Riparian Forest Buffer (391)	4,197	13,150
Silvopasture (381)	275	121
Windbreak/Shelterbelt Establishment (380)	14,588	26,246
Windbreak/ Shelterbelt Renovation (650)	3,276	5,533
Hedgerow Planting (422)	6,408	6,109
Extending riparian forest buffers (ANM05)	****	9
Multi-story cropping, sustainable (PLT05)	****	5
Renovation of a windbreak (PLT06)	****	82
Riparian forest buffer (ANM33)	****	48
Increasing on-farm food production (PLT18)	****	5
Rural Development (RD) Total	**257**	**195**
USDA Total	**$155,956**	**$176,816**

Notes—Tables A1 and A2:

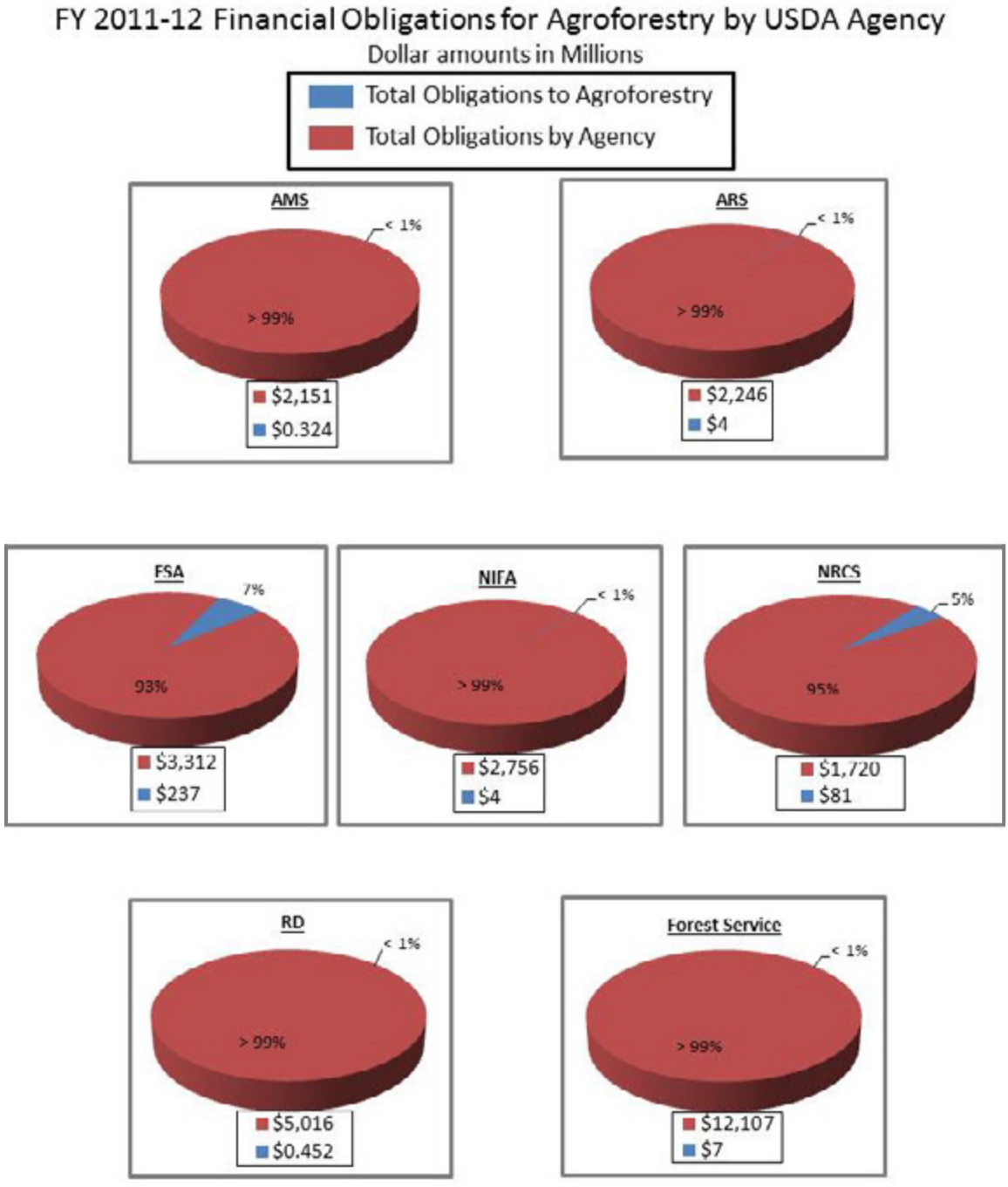
* **AMS** provides funds to the State Departments of Agriculture for specialty crop projects under the Specialty Crop Block Grant Program. Agroforestry has been identified under this program as a specialty crop and possible recipient of grant funds. Each year, the States identify their priorities and award the final grants after AMS has approved their plans.

** **NIFA:** Totals include all data in the Current Research Information System - Knowledge Area 125 (Agroforestry). Projects are coded by the principal investigator for each project (non-USDA employee), and thus not all projects within this coding actually qualify as agroforestry while some agroforestry projects may not be captured within this coding. In addition, no final numbers were available for FY 2012 at the time that this report was prepared.

*** **FSA:** 2011 and 2012 obligations data include all payments made in those years (rental, cost-share, incentives) for all contracts in effect during each of the 2 years.

**** **NRCS:** Obligations for Conservation Stewardship Program practices were not available for FY 2011.

Figure A2.—USDA financial obligations to agroforestry as a percentage of each agency's FY 2011-12 total obligations (dollars in millions).
Obligations from FY 2014 Explanatory Notes (http://www.obpa.usda.gov/FY14explan_notes.html). AMS = Agricultural Marketing Service. ARS = Agricultural Research Service. FSA = Farm Service Agency. NIFA = National Institute of Food and Agriculture. NRCS = Natural Resources Conservation Service. RD = Rural Development. FS = Forest Service.



Appendix B: Performance Crosscut[16]

Table B1.—*USDA agroforestry performance metrics by agency.*

	FY 2011	FY 2012
Agricultural Marketing Service (AMS)		
Agroforestry-related grants awarded	5	6
Agricultural Research Service (ARS)		
Agroforestry-related publications*	39	19
Forest Service		
Agroforestry-relevant publications*	41	30
Farm Service Agency (FSA)		
Field windbreaks (CP5)—Miles	324	338
Shelterbelts (CP16)—Miles	222	230
Living snow fences (CP17)—Miles	28	29
Forested riparian buffers (CP-22)—Acres	20,366	32,664
Bottomland hardwoods (CP31)—Acres	9,101	17,774
FSA, Total Acres* **	**29,467**	**50,438**
FSA, Total Miles* **	**574**	**597**
National Institute of Food and Agriculture (NIFA)		
Agroforestry-relevant publications*	62	5
RFAs prioritizing agroforestry	1	0
Natural Resources Conservation Service (NRCS)		
Alley cropping (311)—Acres applied	203	55
Multi-story cropping (379)—Acres applied	212	49
Riparian forest buffer (391)—Acres applied	29,214	26,312
Silvopasture (381)—Acres applied	583	333
Windbreak establishment (380)—Miles applied	1,365	1,077
Windbreak renovation (650)—Miles applied	174	69
Hedgerow Planting (422)—Miles applied	46	21
Extending riparian forest buffers for water quality protection and wildlife habitat (ANM05)—Acres planned**	698	495
Multi-story cropping, sustainable management of nontimber forest plants (PLT05)—Acres planned**	15,497	19,648
Renovation of a windbreak or shelterbelt, or hedgerow for wildlife habitat (PLT06)—Miles planned**	119	178
Riparian forest buffer, terrestrial and aquatic wildlife habitat (ANM14)—Miles planned**	775	1,064
Riparian forest buffer, terrestrial and aquatic wildlife habitat (ANM33)—Acres planned**	****	9,807
Silvopasture for wildlife habitat (ANM20)—Acres planned**	32,568	33,606
Alley cropping establishment for wildlife (PLT14)—Acres planned**	383	716
Increasing on-farm food production with edible woody buffer landscapes (PLT18)—Acres planned**	****	12
Windbreak/shelterbelt establishment (380)—Miles planned**	9	17
Riparian forest buffer (391)—Acres planned**	72	200

[16] Only FY 2011-12 performance information was included because FY 2013 accomplishments were incomplete at the time the report was compiled.

	FY 2011	FY 2012
Windbreak/shelterbelt renovation (650)—Miles planned**	2	3
NRCS, Total Acres Applied* **	**30,212**	**26,749**
NRCS, Total Miles Applied * **	**1,585**	**1,167**
**NRCS, CSP Total Acres Planned ** **	**49,218**	**64,484**
NRCS, CSP Total Miles Planned ** **	**905**	**1,262**
Rural Development (RD)		
Agroforestry-related grants awarded	4	3
USDA-wide Totals		
Total Agroforestry-Relevant Publications*	146	52
Total Agroforestry Acres Applied * **	59,679	77,187
Total Agroforestry Miles Applied * **	2,159	1,764
**NRCS, CSP Total Acres Planned ** **	49,218	64,484
**NRCS, CSP Total Miles Planned ** **	905	1,262

RFA = **requests for applications.**

Notes—Table B1:

* **Publications:** Some publications have multiple authors, but each publication was only credited to one agency. Thus, each agency's publication number is actually lower than it would be if each got credit for multiauthored papers. See appendix I for a list of publications that was compiled from the Forest Service information in the Research Information Tracking System, NIFA information in the Current Research Information System (CRIS), and ARS project Web sites.

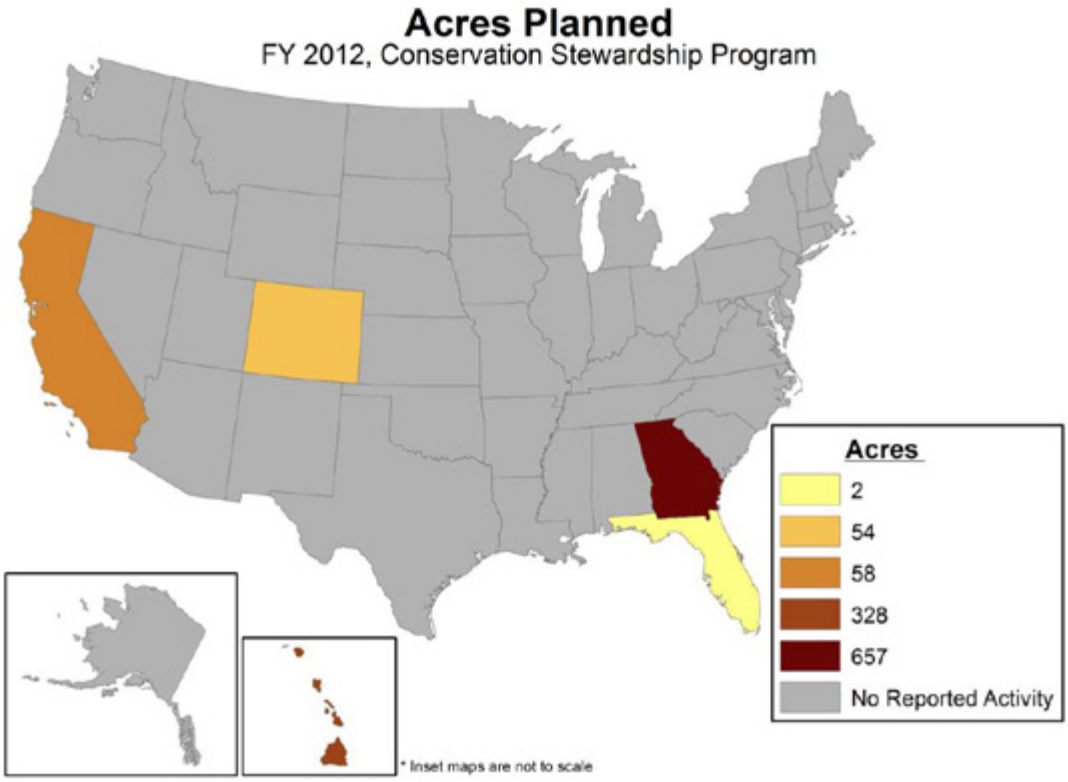
** **Planned versus applied**: Acres and Miles Planned refer to only the Conservation Stewardship Program administered by NRCS.

*** **Acres and miles:** Total Acres refers to alley cropping, forest farming, multi-story cropping, riparian forest buffers, and silvopasture. Total Miles refers to windbreaks, shelterbelts, living snow fences, and hedgerows. To convert linear feet to acres for Conservation Reserve Program practices, the following conversion factors were used: CP5 estimates 497 feet per acre; CP16, 779 feet per acre; CP17, 444 feet per acre.

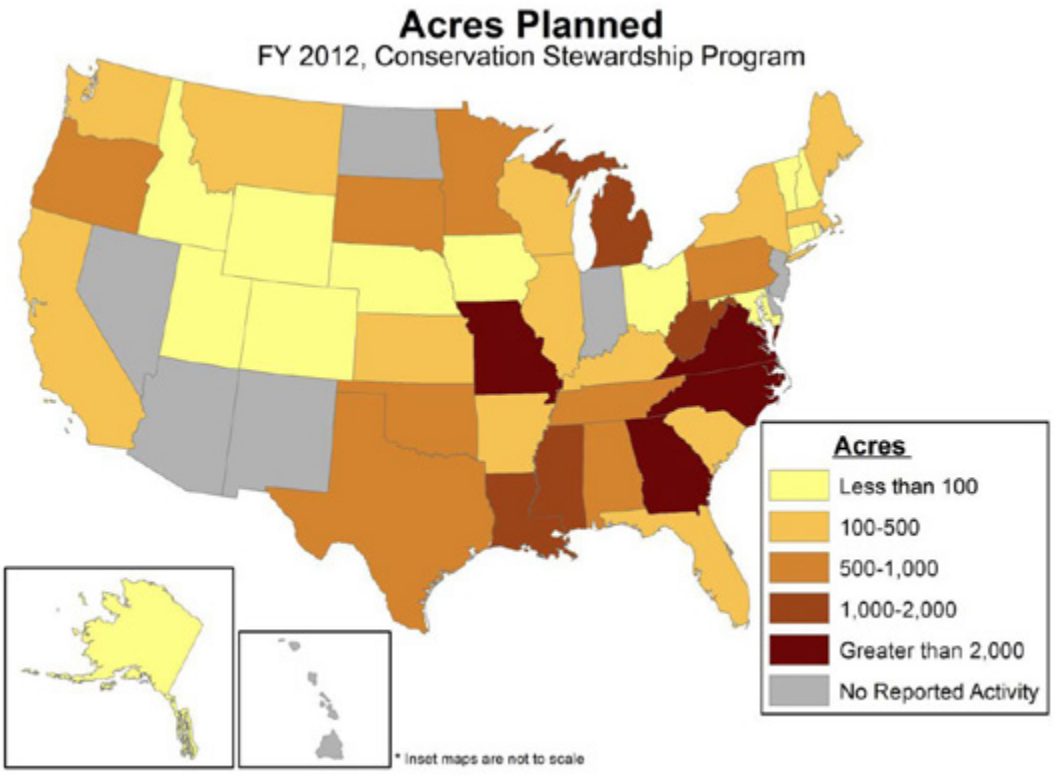
**** ANM33 and PLT18 were established in 2012, so no data for FY 2011 exist.

***Figure B1.**—Total amount (in acres and miles per State) of agroforestry planned through the Natural Resources Conservation Service Conservation Stewardship Program in FY 2012 for (a) alley cropping establishment for wildlife (PLT14); (b) riparian forest buffers (ANM05, ANM14, ANM33, 391), (c) silvopasture for wildlife habitat (ANM20), (d) windbreaks (PLT06, 380, 650), and (e) multi-story cropping (PLT05). Note: edible woody buffers (PLT18) are displayed in* Objective 1.1, *figure 9.*

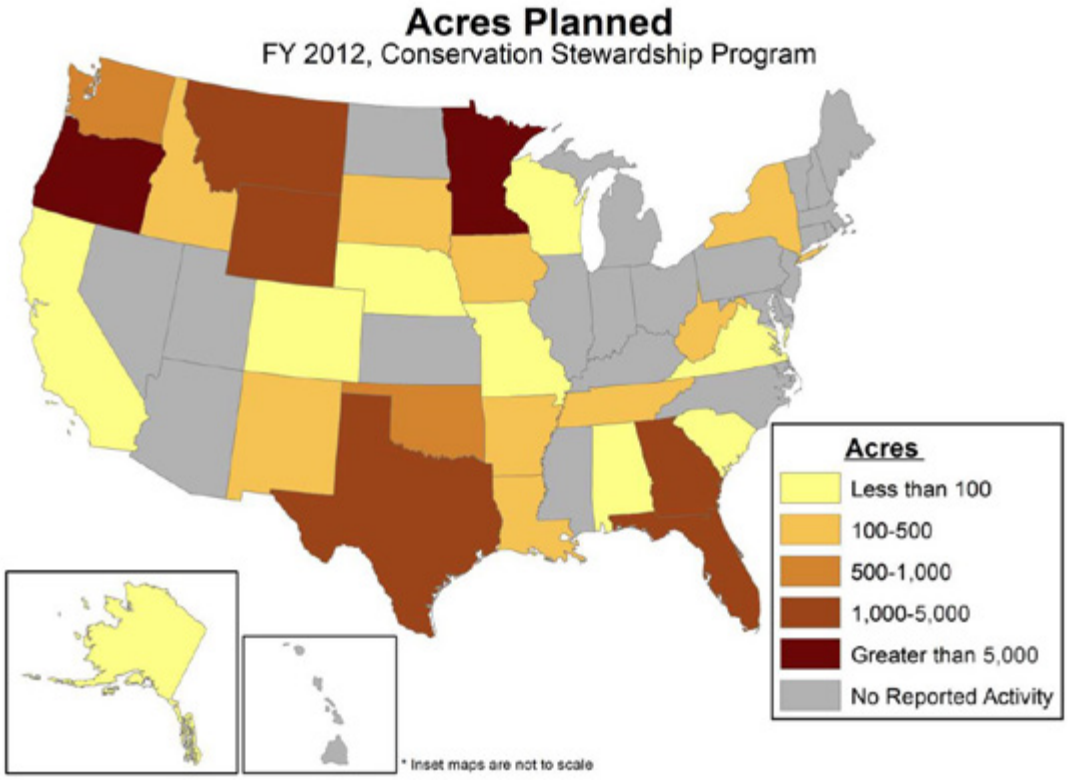
(a) Alley cropping.



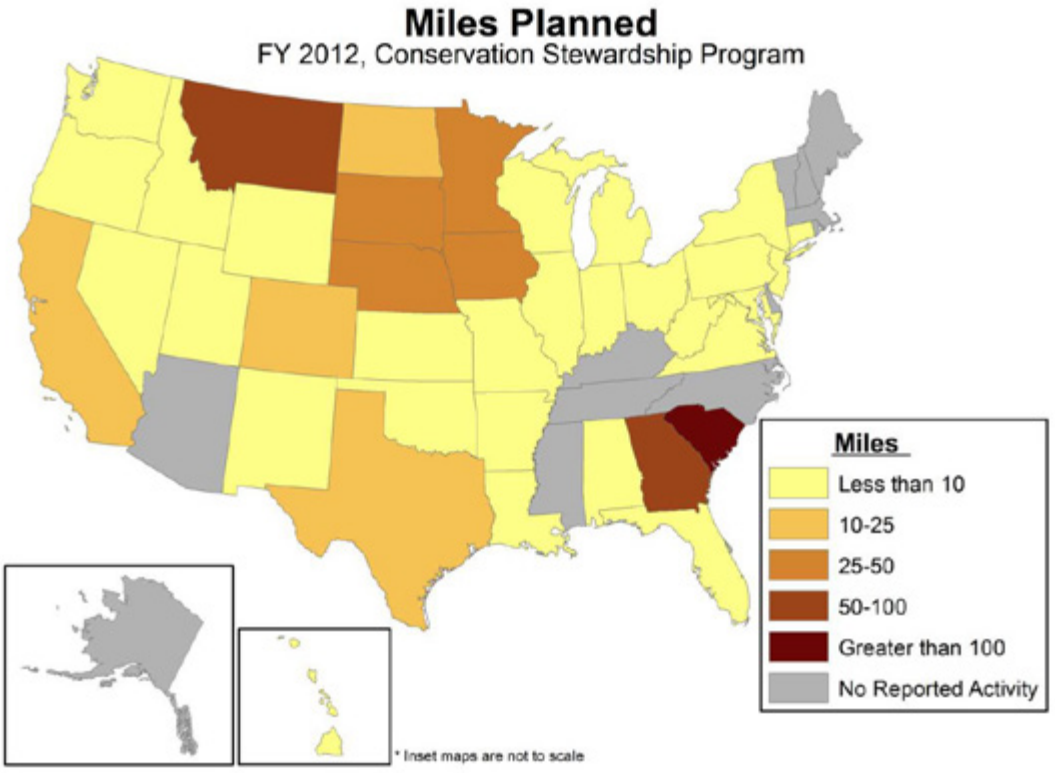
(b) Riparian forest buffers.



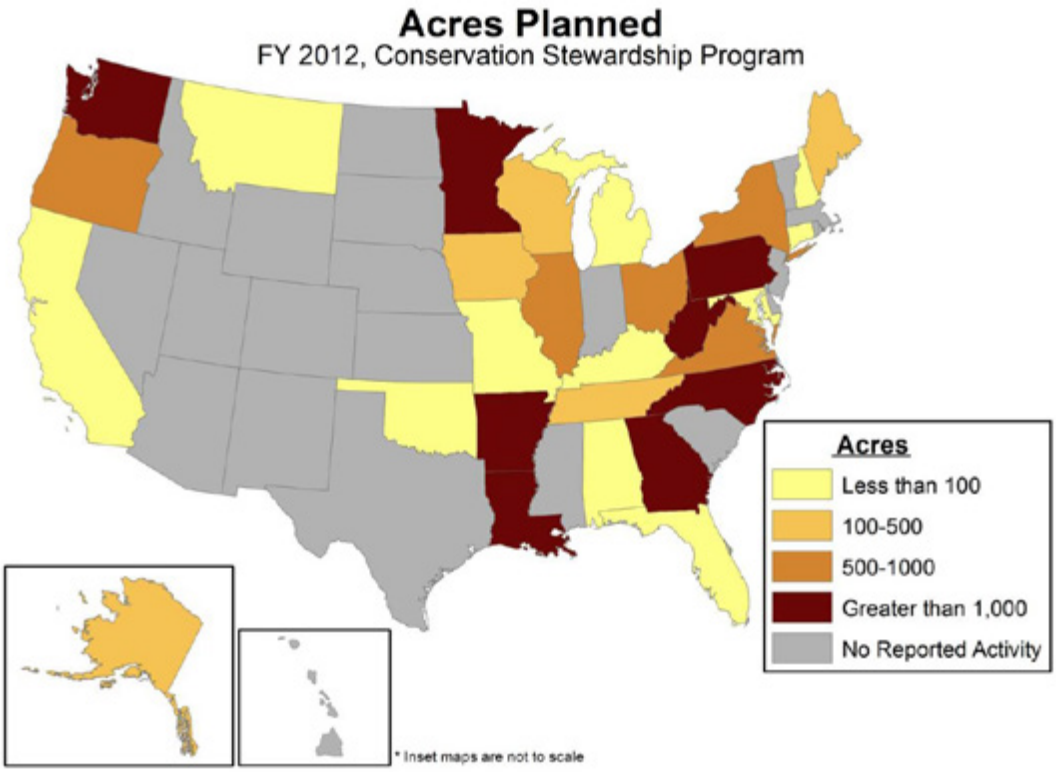
(c) Silvopasture.



(d) Windbreaks.



(e) Multi-story cropping (also known as forest farming)



Appendix C: Crosscut Guidance[17]

The following guidance was provided to USDA agencies to pull together the numbers shown in appendices A and B.

AGROFORESTRY ANNUAL BUDGET & PERFORMANCE CROSSCUT
GUIDANCE
FY 2011–13

This crosscut collects data on USDA programs and activities that contribute to agroforestry, including research, education, technical assistance, and financial assistance activities. Information is used to answer questions from other Government agencies, the media, Congress, and others.

PURPOSE
The purpose of this budget crosscut is to support the required annual report to the Secretary on Agroforestry, in support of the *USDA Strategic Framework for Agroforestry, Fiscal Year 2011-2016*, the USDA Strategic Plan, and Departmental Regulation 1073-002.

This budget crosscut will be updated periodically, as needed, to report on USDA's contributions toward agroforestry.

BASIS FOR ESTIMATES
FY 2011 and 2012 should report amounts programmed and/or obligated in those years. FY 2013 data should tie to the funding levels presented in the 2013 President's budget request. Include information on both discretionary- and mandatory-funded programs.

ACTION
Please e-mail material for the FY 2011–13 Agroforestry Crosscut to Colleen Rossier no later than November 4, 2012.

INSTRUCTIONS FOR PREPARING CROSSCUT REPORT

GUIDANCE
Eligible Agencies: This request for data applies to all USDA agencies with discretionary- and mandatory- funded activities or programs that support *USDA Agroforestry Strategic Framework.* The goals are— 1: Adoption of agroforestry, 2: Enhancing the science behind agroforestry, and 3: Integration of agroforestry into the way USDA does business.

USDA agencies with such activities, programs, or projects include, but are not limited to, the Agricultural Marketing Service (AMS), Agricultural Research Service (ARS), Farm Service Agency (FSA), Foreign Agricultural Service (FAS), Forest Service, National Institute of Food and Agriculture (NIFA), Natural Resources Conservation Service (NRCS), and Rural Development (RD). Other agencies that may have programs or activities that fall within this cross-cut include the National Agricultural Statistics Service (NASS) and the Economic Research Service (ERS).

Eligible Programs and Projects. This report should include all projects, programs, and activities that state any of the following terms in their objectives:

> agroforestry, windbreak, shelterbelt, hedgerow, "living snow fence," "forest farm," "multi-story crop," "multi-story cropping," "forest buffer," "alley crop," "alley cropping," silvopasture, "non-timber forest," permaculture, "riparian buffer"

[17] Only FY 2011-12 budget and performance information was included in the report because FY 2013 information was not available and complete at the time the report was compiled.

Agencies may search databases for the above terms to produce their report.

Terminology:

Agroforestry intentionally combines agriculture and forestry to create integrated and sustainable land-use systems that enhance productivity, profitability, and environmental stewardship. Agroforestry takes advantage of the interactive benefits from combining trees and shrubs with crops and/or livestock. The following are categories of agroforestry practices:

- **Alley Cropping:** an agricultural crop is intercropped simultaneously with a long-term tree crop to provide annual income while the tree crop matures. For more information, visit http://nac.unl.edu/alleycropping.htm.
- **Multi-Story Cropping (**also called **Forest Farming):** cultivation of high-value specialty crops under the protection of a forest canopy that has been modified to provide the correct shade level. This approach provides income while high-quality trees are being grown for wood products. For more information, visit http://nac.unl.edu/forestfarming.htm.
- **Riparian Forest Buffers:** natural or re-established streamside forests made up of tree, shrub, and grass plantings. For more information, visit http://nac.unl.edu/riparianforestbuffers.htm.
- **Silvopasture Systems:** combines trees with forage and livestock production. The trees are managed as high-value crops and, at the same time, provide shade and shelter for livestock and forage, reducing stress and sometimes increasing forage production. For more information, visit http://nac.unl.edu/silvopasture.htm.
- **Windbreaks/Shelterbelts:** linear plantings of trees and shrubs designed to enhance crop production, protect people and livestock, protect buildings, and benefit soil and water conservation. Several types exist, such as living snow fences. For more information, visit http://nac.unl.edu/windbreaks.htm.
- **Living Snow Fences:** rows of living trees strategically planted to reduce blowing and drifting snow. With an action similar to scattered rocks in a flowing stream, these barriers create eddy effects that alter wind speed and direction, causing snow to settle out. Living snow fences are more cost-effective than structural barriers and provide a wide array of benefits beyond snow control, such as longevity, reduced annual maintenance, and wildlife and pollinator habitat. For more information, visit http://nac.unl.edu/documents/workingtrees/brochures/livingsnowfenceforweb.pdf.

A complete crosscut submission will include the following:

1. A completed "Detail" spreadsheet with project information for both budget and performance in FY 2011 through FY 2013.
2. A completed "Crosscut" spreadsheet with program information for both budget and performance in FY 2011 through FY 2013.
3. Agency program and budget contact information. Include the name and contact information of budget and program contacts who will be able to answer questions about the crosscut. We expect that the program contacts will include the following Interagency Agroforestry Team members, but we welcome additions as well:

AMS:	Shayla Bailey
ARS:	Mark Walbridge
Forest Service:	Andy Mason
FSA:	David Hoge
NIFA:	Catalino Blanche and Eric Norland
NRCS:	Bruce Wight
RD:	Alan Borst

Agencies should submit crosscuts via e-mail. Submit the crosscut to Colleen Rossier with "Agroforestry Crosscut" as the subject. Do not submit hard copies. Please use the crosscut spreadsheet provided to you in this e-mail to report your data.

Questions: Please contact Colleen Rossier, Andy Mason, or Kathleen Graham. Meetings with agency budget and program offices can be scheduled in order to provide additional guidance and answer questions.

DETAILED INSTRUCTIONS

In order to uniformly and accurately complete the above required action, please carefully adhere to the following five steps in filling out the attached spreadsheet:

Step 1. Select relevant activities, programs, and projects that include any of the following terms in their objectives, titles, or keywords: agroforestry, windbreak, shelterbelt, hedgerow, "living snow fence," "forest farm," "multi-story crop," "multi-story cropping," "forest buffer," "alley crop," "alley cropping," silvopasture, "non-timber forest," permaculture, "riparian buffer"

Step 2. Report both the budget numbers and the performance metrics by project in the "Detail" spreadsheet.

Step 3. Report which of the *USDA Agroforestry Strategic Framework* goals and objectives each activity most directly supports in the "Detail" spreadsheet.

Step 4. Sum the FY 2011–13 budget (columns C, D, and E) and performance (columns J, K, and L) totals by program and report into the "Crosscut" spreadsheet. Change the associated *USDA Agroforestry Strategic Framework* goals and objectives for each program if different from the pre-populated data *(Spreadsheet Columns F, G, M, and N)*.

Step 5. E-mail final budget and performance "Detail" and "Crosscut" spreadsheets to Colleen Rossier by COB November 4, 2012.

Appendix D: Case Studies

Table D1.—*Quick reference table of the 15 case studies that follow.*

Title	Practice	Objective	Agencies	State
#1—Longleaf Pine Needle Baskets for Generations To Come	FF	1.1	NRCS, Forest Service	TX
#2—Managing Forests for Timber, Wildlife—and Organic Blueberries	FF	1.1	NRCS	AK
#3—Pioneering Producer and Supportive Agency Personnel: A Match Made in Agroforestry Paradise	S	1.1	NRCS, FSA	MS
#4—Shelterbelts and Adverse Weather in the Nebraska Panhandle	W	1.1	FSA, NRCS	NE
#5—Silvopasture: More Dollars Per Acre	S	1.1	NRCS, FSA	GA
#6—Hedgerows and Riparian Zones: Tasty Enough to Eat?	R	1.1 and 1.2	NIFA, NRCS, FSA	WA
#7—Shiitake Mushrooms: A Commercial Forest Farming Enterprise	FF	1.2	NIFA	NY
#8—Agroforestry Research Partnerships: From North Carolina to the World	A & S	1.3 and 2.2	ARS, NAC, NRCS	NC
#9—Bringing Chestnuts Back to American Landscapes and Diets, One Graft at a Time	A	2.2	NIFA, NRCS, AMS	MO
#10—Hazelnuts, Hickory Nuts, and Walnuts, Oh My!	S & W	1.2 and 2.2	NIFA	OH
#11—Moving Agroforestry Into the Mainstream To Provide Energy, Water, and Jobs: Minnesota to the Gulf of Mexico	A	2.2	NAC, NIFA, Forest Service	MN
#12—Agroforestry Consortium's Aim & Profitable Farms and Woodlands for Limited-Resource Producers	All except T	2.3	NAC, NRCS, Forest Service	Southeast
#13—Oregon Woodland Owners Enter a New World of Possibilities With Oregon Grape	A & R	1.2, 2.2 and 2.3	RD, NIFA, NRCS	OR
#14—Virginia Is for Lovers—and Silvopasture	S	1.2 and 3.1	NRCS	VA
#15—Island of Pohnpei Discovers its Agroforestry Roots	T	1.1	Forest Service	Federated States of Micronesia

A = Alley cropping. AMS = Agricultural Marketing Service. ARS = Agricultural Research Service. FF = Forest farming or multi-cropping. FSA = Farm Service Agency. NAC = National Agroforestry Center. NIFA = National Institute of Food and Agriculture. NRCS = Natural Resources Conservation Service. R = Riparian forest buffer. S = Silvopasture. T = Tropical agroforestry. W = Windbreak or hedgerow or living snow fence.

#1—Longleaf Pine Needle Baskets for Generations To Come

In east Texas, the culture and history of the Alabama-Coushatta Tribe is interwoven with the longleaf pine tree, the source of treasured needles used for generations to craft intricate handmade baskets. But longleaf pine forests have diminished over the years because of timber harvests, disease, hurricanes and drought. So, native artisans have had to travel out of Texas to find the pine needles they use to create their woven handicrafts.

In an effort to restore longleaf pine forests to the reservation's native lands, the tribe enrolled 400 acres into the Longleaf Pine Initiative through the Natural Resources Conservation Service's (NRCS) Wildlife Habitat Incentive's Program (WHIP). This effort is the first time the two groups have entered into a WHIP contract, so it was a significant historical event for the tribe and NRCS in Texas.

A member of the Alabama-Coushatta Tribe harvests longleaf pine needles.

The local NRCS District Conservationist Ronald Harris informed the Alabama Coushatta Tribal Council Chairman Kyle Williams about the Longleaf Pine Initiative, and the tribal council voted unanimously to initiate the pine tree project.

The result? In years to come, the Alabama-Coushatta Tribe of Texas will not have to travel far to gather precious longleaf pine needles for the traditional handmade baskets that serve as an important cultural touchtone, as well as a source of income and economic opportunity. Along with providing an abundant supply of needles, these new forestlands will offer an aesthetic and recreational value for the roughly 1,150 members of the tribe, 600 of which live on the reservation. As the trees grow, native grasses, plants, and wildlife habitat can be restored, and Williams said that future plans might include recreational activities, such as hiking trails through these areas.

Longleaf pines grow slowly compared to loblolly or slash pines. A year-old seedling looks like a tuft of grass and might only be a few inches tall. Rapid tree growth doesn't begin until the young sapling stage, and it can take up to 7 years for the tree to reach 10 to15 feet. This slower growth meant that longleaf took longer to produce timber than other trees and, thus, were often not replanted after mature trees were harvested, a decision that hastened their regional decline. Only 3 percent of the original 90 million acres of U.S. longleaf pine ecosystems remains, a habitat that is home to 29 species that are federally listed as threatened, endangered, or both.

Longleaf pine needle baskets. Both photos in this case study courtesy of Beverly Moseley.

As a result of this partnership, the Alabama-Coushatta Tribe planted an estimated 240,000 longleaf pine seedlings in December 2012. They planted the seedlings after 400 acres, at six different sites throughout the reservation, were cleared of brush and unwanted vegetation. This effort cost an average of $188 per acre.

NRCS continues to work alongside the tribe's forestry department and the Texas Forest Service to provide technical assistance focused on forest site preparation, tree establishment, chemical application, fire breaks, and prescribed burning.

In fact, this great partnership between NRCS, the Alabama-Coushatta Tribe of Texas, the Texas Forest Service, and the Polk-San Jacinto Soil and Water Conservation District won a 2011 Two Chiefs' Partnership Group Award from NRCS Chief Dave White and Forest Service Chief Thomas Tidwell. The award recognizes exemplary employees and projects from NRCS, Forest Service, State forestry agencies, and conservation districts who have worked collaboratively to support conservation and forest stewardship.

For more information on how to apply to the Wildlife Habitat Incentive Program or others, visit your local NRCS office.

This story was published by NRCS Public Affairs Specialist Beverly Moseley on the Texas NRCS Web site. It has been slightly modified.

#2—Managing Forests for Timber, Wildlife—and Organic Blueberries

On a typical late summer day in Kake, AK, residents prepare for the day by layering heavy-duty rain gear, protective gloves and rubber boots over jeans and fleece. Most of these Alaskans will head to work supporting the local fishing industry. A select few, however, will be bundling up for a slightly different catch: wild organic blueberries.

Wild organic blueberries on Sealaska Native Corporation land near Kake, AK.

Although timber and fishing have historically been the town's economic mainstays, local U.S. Department of Agriculture (USDA) conservation efforts have introduced the community to new, lucrative opportunities in harvesting local fruits—efforts that resulted in the blossoming of a blueberry-based economy for a small town of 557 inhabitants.

In 2008, with financial and technical assistance from Natural Resources Conservation Service (NRCS), Sealaska, a regional Alaska Native Corporation, thinned its young-growth forests near Kake.

Harvesting wild organic blueberries on Sealaska Native Corporation land near Kake, AK.

Thinning reduced the number of trees per acre, improving the forest condition and helping the remaining trees grow faster. It also increased the amount of light and nutrients reaching the forest floor. A greater diversity of plants in the understory enhances habitat for wildlife such as black-tailed deer, so this thinning was eligible for financial assistance from NRCS's Wildlife Habitat Incentives Program and Environmental Quality Incentives Program.

One of the shrubs in the forest that benefited from more light and nutrients was the Alaskan wild blueberry.

Sealaska, which owns and manages 30,000 acres near Kake, obtained U.S. Department of Agriculture (USDA) organic certification for its forests in 2011 through the Accredited Certifying Agent, Organic Tilth. It manages the forest for timber, wildlife, and understory plants so that its shareholders—all tribal

members—can hunt, fish, and gather. This helps them meet their local food needs while also providing economic opportunities.

In 2012, prices for wild organic blueberries topped $3.10 per pound. So, in addition to the large amount of blueberries harvested for personal use, kept in tubs in freezers, and eaten by black bears and other wildlife, tribal members were able to sell some of the surplus.

Demand exists for these berries from Alaskan businesses that produce value-added health products, nutraceuticals and wine. Some residents were able to harvest 200 pounds at a time and earned more than $600 for a day's work—a significant wage in a town where the per capita income is slightly more than $22,000 per year. Selling these wild berries as organic means that not only were they not sprayed with chemicals, but they were also carefully managed with other forest products to ensure long-term viability of the crop while also protecting or enhancing the quality of the nearby soil, water, and other natural resources.

And, locals do more than just pick blueberries. They also work in a processing center, weighing and shipping the berries. The berries are stored at a revitalized fish processing plant that has been closed for several years. Alaskans manage and benefit from the entire operation—from the bush to the bottle to the belly!

Since 2006, NRCS has funded dozens of thinning projects in southeast Alaska, and also one with the Seldovia Village Tribe that produces blueberries, salmonberries, and cloudberries on the Kenai Peninsula in a similar agroforestry system. This tribe also makes jams and jellies from these berries that they sell in the Seldovia gift shop and stores throughout Alaska.

The benefits of thinning to the forest are apparent just a few years after treatment, and not just for the trees and the wildlife. Kake residents agree that this year's berry crop was better than in the past. With continued forest management, the blueberry business will continue to grow, helping to support the local community. And the indirect benefits are as sweet as blueberry pie.

Wild organic blueberry harvest. All photos in this case study courtesy of Brian Kleinhenz.

This story was originally posted by Samia Savell, NRCS Alaska, on the USDA blog in December 2012. http://blogs.usda.gov/2012/12/05/kake-forests-provide-more-than-just-trees. It has been slightly modified.

#3—Pioneering Producer and Supportive Agency Personnel: A Match Made in Agroforestry Paradise

A few years ago, Roy Barnett, a professional pharmacist and part-time land manager in Alabama, invited Tim Albritton, a Natural Resource Conservation Service (NRCS) State forester, and Sutton Gibbs, NRCS district conservationist for Perry County, to visit his farm and discuss how best to manage the pine trees on his 1,240 acres of land. Little did he know that this visit would be the day that he became a silvopasture pioneer.

At the time of the visit, Barnett had about 650 acres of loblolly pines, a 350-acre pasture for cattle, 90 acres of hardwoods, and a few ponds for "members only" commercial fishing. After examining the landscape and discussing Barnett's goals, Albritton suggested that he consider silvopasture because the pine stand already needed to be thinned. By creating silvopasture, Barnett would be able to increase the grazing acreage for his cattle while maintaining the tree canopy and timber income.


Barnett's cattle graze in the shade of his silvopasture.

After thinking it over, Barnett agreed to do just that. He worked with Gibbs to establish a conservation plan for the property and set off at a gallop. Although many producers would prefer to see an example on another producer's land first, Barnett boldly agreed to the idea based solely on NRCS's recommendations and the literature that they provided. To establish silvopasture in the 12-year-old loblolly pine stand, Gibbs helped him enroll in NRCS's Environmental Quality Incentives Program to (1) thin the tree stand while making sure to leave the highest quality trees untouched, (2) manage the understory with herbicides and prescribed burns, (3) establish a mixture of warm season grasses beneath the trees as forage for the cattle, and (4) build fences to assist Barnett in rotating his cattle through a series of paddocks, which ensured that each area of the silvopasture experiences times of disturbance and rest.

After 3 years of working with his consulting forester and following the NRCS guidance, Barnett has enjoyed great success and has even increased the number of cattle he manages to 25 cow-calf pairs. He is so pleased with the system, in fact, that on a recent visit, Barnett told Albritton that he is "satisfied enough with the silvopasture that [he] want[s] to do more on another tract."

One of the additional tracts of land that Barnett plans to convert to silvopasture contains roughly 70 acres of pine trees that he established with the aid of the Farm Service Agency's (FSA) Conservation Reserve Program (CRP). Producers cannot use land under CRP contract as pasture for their animals, so Barnett will wait until the contract expires to rotate his cattle beneath the trees. In the meantime, however, he will be able to prepare the land by thinning the trees and using FSA and NRCS assistance to administer prescribed burns and plant native grasses for forage. Transitioning former CRP land to silvopasture may be a great option financially and environmentally because it enables the producer to keep a significant number of trees on the land for a longer period of time, increasing the value of those trees while also reducing erosion, increasing water infiltration, and providing a buffer from the hot sun and cold wind.

Two ways exist to establish silvopasture. It is possible to convert either an existing tree stand (as Barnett has already done) or open pasture (such as the third tract of land that Barnett wishes to convert) to silvopasture. After speaking again to his NRCS colleagues and consulting forester, Barnett plans to use NRCS's Longleaf Pine Initiative funding under the Wildlife Habitat Incentives Program to prepare the site, plant longleaf pine seedlings in an existing pasture, establish firebreaks, administer the prescribed burns required to release the pines from dormancy, and control invasive plants. He will space the trees far enough apart initially to enable forage to grow between them so that he can use the area as silvopasture in the future. This effort is possible thanks to a partnership between the NRCS, the U.S. Department of the Interior, and the U.S. Department of Defense. The effort aims to reforest some of the 90 million acres of the southeastern North America. This region was once blanketed by biodiverse longleaf pine ecosystems; now only 3 percent remains.

Barnett's willingness to try out new ideas is invaluable in spreading the concept of silvopasture. Also invaluable is the support that NRCS, FSA, the Alabama Forestry Commission, and others have been able to provide. After seeing Barnett's incredible success, Albritton has been able to use his farm as a demonstration site for those who have not seen silvopasture in Alabama before. Recently, in fact, he brought a group of visitors from National Agroforestry Center, the Alabama Forestry Commission, and the National Association of Conservation Districts out to see the property and discuss future ideas. Barnett said that he "got some very good ideas … during the field visit from the agency personnel and is thinking about maybe adding some goats to assist with cleanup in the understory."

What a pioneer!

Cooperators discussing the transition from pasture to silvopasture. From right to left: Rich Straight (in the straw hat), Roy Barnett (back to the photographer), Tim Albritton, Sutton Gibbs (in the green shirt), Charles Holmes, and Brigetta Giles (Alabama Forestry Commission). Both photos in this case study courtesy of Sutton Gibbs.

#4—Shelterbelts and Adverse Weather in the Nebraska Panhandle

Beginner ranchers and brothers Tyson and Ryan Narjes rely on the shelterbelts (also known as windbreaks) on their operation in Nebraska to protect their livestock from adverse weather. To construct these shelterbelts, they worked with their families and staff from the Farm Service Agency (FSA) and the Natural Resources Conservation Service (NRCS) to plant Rocky Mountain Juniper, Eastern Red Cedar, and Bur Oak trees in the spring of 2002. They received financial and technical support from the Continuous Conservation Reserve Program. Since then, the windbreaks have protected their bunks and feedlots to the south from both wind and snow.

Tyson and Ryan Narjes with their weaned calves.

The brothers grew up on their family ranch, and after they each studied diversified agriculture, they started working together. Ryan Narjes began in 2008 after his studies at Southeast Community College, and Tyson Narjes joined him in 2010 after finishing his work at the University of Nebraska. They rely on each other's strengths to successfully operate and grow their cow-calf operation, in which they now calve out about 135 Angus cows and lease an additional 80 cows per year.

In addition to the windbreak support from the U.S. Department of Agriculture (USDA), Tyson Narjes has been able to use other USDA programs to help him and his brother start their operation. For one, he has used FSA's Farm Loan Programs since 2010 when he was approved for an annual operating loan that offered attractive interest rates to help get him started. He also accessed an intermediate operating loan from FSA to purchase 5 registered Angus heifers and 15 commercial cows.

Because of the extreme drought in the Nebraska Panhandle in 2012, Tyson Narjes used the Conservation Reserve Program (CRP) emergency haying and grazing authority. Because Secretary Vilsack enabled FSA to use this emergency authority, Tyson Narjes was able to graze cow-calf pairs on a neighbor's CRP acres—where grazing is normally prohibited—until the calves were weaned early on August 15, while the mother cows continued to graze on those CRP acres into the fall. Tyson and Ryan Narjes also were able to hay about 50 of another neighbor's CRP acres to supply about one-third of their weaned calves' feed as a supplement to the corn and oat/pea hay. Tyson Narjes appreciates this support because he says the drought will make feed availability and cost major challenges this fall and winter.

Tyson and Ryan Narjes stand next to a shelterbelt planted in spring 2002. Both photos in this case studay courtesy of Brad Fraass.

Both Tyson and Ryan Narjes agree that they have relied on the resources of many to start their successful cattle operation. Their experience is a great illustration of how ranchers all over the country can use agroforestry practices in their operations and how an array of USDA support can help them navigate the challenges of starting an operation and mitigating the impacts of extreme weather events, from wind to snow to drought.

#5—Silvopasture: More Dollars Per Acre

You might not think of a former IBM field engineer from New Jersey as a leader in conservation farming, but when it comes to Mack Evans of Jakin, GA, that is not all that will surprise you.

In the late 1970s, Evans purchased land that had been in his wife's family for more than 100 years and planted loblolly pine in it. "For me, it was an investment," he said. "After doing some research, I found that farmers can make more money out of saw timber."

Evans bottle-feeding his calf.

Evans thinned his pine stand in 1996 and again in 1999 and was receiving a "nice income," so in 2003, he came back to Jakin to manage his trees. Evans, who said he originally got much of his farm information from the Internet, was surfing the Web looking for information on removing understory vegetation and discovered silvopasture, an agroforestry practice that combines trees, forage plants, and livestock management. "I would go on the Web at night. I found silvopasture on a USDA [U.S. Department of Agriculture] Web site," he says.

Evans seeding his silvopasture with forage for his cattle.

When he called Joe Wilson, former Natural Resources Conservation Service (NRCS) district conservationist, Wilson said, "Mack, that's a great idea!" Steven Cleland, current district conservationist, echoed the sentiment and recommended silvopasture as a good conservation practice because it maximizes the use of the land while helping conserve the natural resources. Evans now has 43 acres of silvopasture and is hoping to add 90 more.

Evans, who bought his first herd of cattle in 2003, said that he has noticed his trees growing faster since he adopted silvopasture. He received cost-share funding through Environmental Quality Incentives Program (EQIP) to help plant pasture grass. Since 2006, he has hosted 4 field days on his farm to teach other farmers and said that, "farmers out here don't use the universities as much as they should—the researchers do the work and it just sits on the shelf."

Evans would also like to mentor new farmers. When he started, he said that "there was no farmer I could talk to about silvopasture."

Evans harvests and sells the pine straw that falls between the tree rows of his silvopasture.

Some farmers might have stopped at silvopasture, but Evans keeps finding innovative ways of maximizing his farm income. He rents land 6 months out of the year from his neighbor who is using no-till, a conservation practice that reduces soil erosion and improves soil quality. Evans came up with the idea to rent the land and graze cattle on it during the winter months. "A lot of farmers thought it was kind of weird—renting 6 months—but it's a win-win situation, using winter grazing as a cover crop," he said. As an additional source of income,

Evans said, "Harvesting longleaf pine straw is one of the best kept secrets in my silvopasture operation. It enables for an added cash flow for up to 15 years." Finally, Evans is transitioning to become a producer of organic beef cows and goats by using a silvopasture system with native grasses. NRCS also helped him with this transition through the EQIP Organic Initiative.

As if these efforts were not enough, Evans is also a Minority Advisor with the Early County Farm Service Agency (FSA) County Committee. He works to increase awareness of and participation in FSA activities, including elections, and helps develop interest and incentives for socially disadvantaged landowners.

Cleland said that he hopes other farmers will model this farming operation, saying of Evans, "He's innovative in his approach; he has really put the work in to gather information."

Evans' pine-cattle silvopasture. All photos in this case study courtesy of Mack Evans.

*This story first ran in December 2006 as "*Silvopasture Maximizes Land Use in Early County**,**" *an Early County, GA, NRCS success story. It has been updated since then.*

#6—Hedgerows and Riparian Zones: Tasty Enough to Eat?

As a certified technical service provider[18] in the Northwest Natural Resource Group, recognized by the Natural Resources Conservation Service (NRCS), Kirk Hanson works with landowners to design conservation plans that meet their forest management goals and comply with U.S. Department of Agriculture program requirements—whether they wish to improve their forest land, create and enhance habitat for wildlife, or some mix of the two. A working knowledge of agroforestry enables Hanson to create innovative designs that provide a variety of environmental, economic, and social benefits.

For example, Hanson recently worked with a landowner to restore a 70-acre clear-cut that had become an alder thicket after more than 15 years without management. Using NRCS's Environmental Quality Incentives Program funding, they thinned the alder and planted noble firs and a variety of native shade-tolerant conifers; they also added berry and nut producing trees. This diversity benefits wildlife and provides a host of ecosystem benefits. As important, it creates forest farming

[18] Technical service providers (TSPs) are individuals or businesses that have technical expertise in conservation planning and design for a variety of conservation activities. TSPs are hired by farmers, ranchers, private businesses, nonprofit organizations, or public agencies to provide these services on behalf of the Natural Resources Conservation Service (NRCS). Each certified TSP is listed on the NRCS TSP online registry, TechReg. The TSP registration and approval process involves required training and verification of essential education, knowledge, skills and abilities.

opportunities and potential supplemental income by providing the raw materials for wreaths, garlands, cedar boughs, nuts, berries, jams, and jellies.

On his own forest land, Hanson developed a project to restore native forages for the band-tailed pigeon. He planted blue elderberries, cherries, hazelnuts, service berries, huckleberries, roses, hawthorns, and bur oaks with funding assistance from the NRCS's Wildlife Habitat Incentive Program. Again achieving several goals with one creative design, he planted these forages as a 15-foot-wide hedgerow along his hay field. These hedgerows provide food for the pigeons and slow the wind, and they could function as a living fence to contain livestock when that hay field becomes a pasture. Hanson says that the blue and black elderberries have medicinal uses and can be made into wine, jams, and cold syrup, so this hedgerow is future food for humans, as well. What creative thinking!

Finally, Hanson worked with John Henrikson of Wild Thyme Farm in Oakville, WA, to restore the riparian forest along Garrard Creek, a salmon-bearing stream that drains to the Chehalis River. Hanson assisted the farm (although not in his official technical service provider capacity[19]) with applying to the Farm Service Agency's (FSA) Conservation Reserve Enhancement Program (CREP). This program provided financial assistance to establish the riparian buffer with several different native tree species that help conserve soil, protect the riparian area from sediment erosion, and shade the stream to increase salmon habitat. CREP contracts require landowners to keep their land out of agricultural production for 10 to 15 years, but during those years incidental harvest of natural products, such as berries and nuts, may be permitted if the harvests do not increase feed supplies for domestic animals, if the participant receives no economic benefit, and if the products are not used commercially.[20]

Following CREP contract termination, however, the trees some distance from the stream edge may also provide potential income opportunity, which may be helpful given the large investment that this kind of forest restoration requires. Hanson designed the CREP plantation to first and foremost restore riparian function, such as shade, large woody debris input, and nutrient input, along the banks of Garrard Creek. However, the CREP plantation also was designed with a long-term agroforestry component in mind. Once the 10- to 15-year contract expires, the farm owner will be able to harvest a wide range of products, including berries and nuts; willow and ash trees that can be coppiced for live stakes; small-diameter craft wood from cherry, alder, and ash; and timber trees, such as alder, cedar, hemlock, and Douglas-fir, which can be harvested for saw-logs. The design of this agroforestry plantation was intended to ensure that the owners would have income in the short, medium, and long term, which will enable them to stay on the land and to continue to provide salmon habitat with their trees.

In the future, Hanson hopes to teach others how to create these multifaceted designs. Great opportunity exists for this type of work in the areas of western Washington and Oregon where he works, and, over the time he has been there, the numbers of people applying for NRCS funding has increased substantially. This demand created a need for more technical expertise because, according to Hanson, the greatest barrier preventing landowners from adopting agroforestry systems that produce food and other products while also enhancing water quality and wildlife habitat is that many of these landowners need technical assistance about how to design and manage such systems.

[19] Only NRCS or Conservation Districts (not technical service providers) may provide technical assistance for CRP and CREP.

[20] For more about CREP, please contact a local FSA office or Soil and Water Conservation District office. Additional information is also available on FSA's Web site.

In fact, the Western Sustainable Agriculture Research and Education professional development program[21] recently awarded Hanson and others at Northwest Natural Resource Group funds to train other forestry consultants on how to become technical service providers. At first glance it may seem like he is training his future competitors, but Hanson says that "there is just so much work still to do." With Hanson's leadership and that of NRCS and FSA nearby, it sounds like innovative solutions will surely keep coming from the Pacific Northwest.

Riparian forest buffer on Wild Thyme Farm surviving an inundation.
Photo courtesy of John Henrikson.

#7—Shiitake Mushrooms: A Commercial Forest Farming Enterprise

According to Ken Mudge of Cornell University, any farmer with a woodlot and the drive to diversify should consider forest-cultivated shiitake mushrooms. They are well suited to the increasing demand for locally produced, healthy foods. With a retail price of $12 to $20 per pound, the demand for shiitakes is considerable throughout the Northeast, where Mudge works.

Shiitake inoculation workshop

Using freshly cut mid-sized[22] hardwood logs of oak, beech, sugar maple, hornbeam, or musclewood, Mudge says that an interested farmer or woodlot owner with a solid production plan can reliably realize ½-1 pound of mushrooms per log in two to three harvests each year for 3 to 4 years. Thus, he believes that forest cultivation of gourmet and medicinal mushrooms not only produces delicious food, but is also one of the most reliably profitable nontimber forest products grown in a forest

[21] SARE is a program of USDA's National Institute of Food and Agriculture. NIFA funds research, education, and extension at the State and local level and provides national program leadership in these areas.
[22] Logs: 3-4 ft. long and 4-6 in. diameter.

farming[23] system. As an added benefit, growing mushrooms encourages these farmers to learn more about sustainably managing their forests as a part of their whole farm system.


Forest-grown shiitake mushrooms.

After a Cornell graduate from Mudge's lab contacted Allen Matthews[24] for assistance in developing a business plan for shiitake production, Mudge and Matthews decided to hold their first shiitake inoculation workshop in 2009. Although it was an unusually cold and icy day, 40 people attended the training session. Encouraged by this interest, Mudge and Matthews applied for and received funding from U.S. Department of Agriculture's (USDA) SARE [Sustainable Agriculture Research and Education] program to work with Ben Waterman at the University of Vermont. They would also be working with four experienced commercial shiitake grower/advisors[25] to teach interested farmers and woodlot owners how to start commercial-scale shiitake mushroom farming. Unlike other one-off workshops, this effort included hands-on training over 2 years in both the mechanics of growing shiitake mushrooms and how to start a shiitake farming enterprise.

The team began with a series of workshops and on-farm visits in which they taught the basics of shiitake farming—from cutting and inoculating the appropriate logs to inducing mushroom "fruiting" to managing and marketing a commercial enterprise—to 400 participants from 8 States.[26] Then, in the second year, 23 were selected from the 60 original farmers who applied to take part in a mushroom cultivation "experiment." For this experiment, the farmers agreed to grow 100 shiitake logs on their property and keep records of their expenses, labor, yield, and income for 2 years so that Mudge and his colleagues could incorporate real-world data in a guide on best management practices for shiitake production in the Northeast. In return, the project team supplied the participants with start-up materials, technical assistance, recordkeeping templates, and a booklet on shiitake farming.


Inoculating a log with shiitake spawn.

An effort is clearly valued when it attracts 400 participants, and it is clearly successful when it catalyzes additional projects. This shiitake education project[27] did both.

One spinoff from this project, an e-mail list serve[28] initiated by Matthews, became a key way for project participants and a range of other shiitake growers throughout the Northeast to actively engage with each other, ask questions, and share lessons learned. Many of

[23] Forest farming is the cultivation of high-value specialty crops under a forest canopy, and it is recognized as one of the five types of agroforestry. For more information, see the National Agroforestry Center.
[24] Alan Matthews was originally at the University of Vermont but is now at Chatham University.
[25] These growers are considered "Farmer Advisors." They are Steve Sierigk, Julie and Steve Rockcastle, and Nick Laskovski.
[26] Maine, New Hampshire, Vermont, New York, Pennsylvania, Massachusetts, Connecticut, and West Virginia.
[27] To learn more about their project, search LNE10-298 at http://www.SARE.org. Also, the participants will share more information about this project at a workshop during the next New England Organic Farming Association (NOFA-NY) meeting in January 2013.
[28] The listserv was created while he was at the University of Vermont: mushrooms@list.uvm.edu.

these growers credit this listserv as being an "invaluable resource" for their operations, giving them "incredibly detailed information throughout the season."

In addition, several farm advisors from this project went on to successfully acquire USDA-SARE farmer grants to research key questions they confronted in their own shiitake operations and to share their findings with others. For example, farmer advisor Nick Laskovski, graduate assistant Bridgett Jameson, and advisor Matthews are using SARE funds to investigate seasonal factors affecting shiitake production, while Steve Gabriel, a project participant, is evaluating the use of ducks as pest control.

Forest-grown Lion's mane mushrooms. All photos in this case study courtesy of Ken Mudge and Allen Matthews.

Gabriel's project showcases a creative way to combine multiple agricultural products—in this case, shiitake mushrooms and duck meat—within one agroforestry system while ensuring that sanitary harvesting and handling practices are observed. The two products are synergistic because the ducks eat the slugs that would otherwise consume the valuable shiitakes, which are grown on raised platforms not frequently visited by ducks.

Finally, Mudge and Gabriel have recently obtained USDA funds[29] to diversify forest mushroom cultivators by developing reliable production methods and running on-farm trials of three types of gourmet mushrooms: Lion's Mane, Wine Cap, and Maitake. This diversity will mitigate the risk of a potential "crop-failure" and will also potentially increase consumer interest in these exotic mushrooms.

Thanks to their strong grant proposals for funding from USDA, these creative scientists and farmers are providing strategic research and outreach to catalyze a forest-grown mushroom industry in the Northeast—an industry that seems to have quite a bit of momentum these days.

#8—Agroforestry Research Partnerships: From North Carolina to the World

Are agroforestry systems more productive, profitable, and beneficial for the environment than other agricultural and forestry systems?

Can agroforestry systems make agriculture more resilient in the face of climate change and uncertain markets?

Alan Franzluebbers of Agricultural Research Service (ARS) and Michele Schoeneberger of National Agroforestry Center (NAC) are partnering with scientists from North Carolina, Canada, and around the world to address these questions and more. In a time of shrinking budgets, this partnership maximizes limited funds and brings diverse scientific experts together to address these critical questions regarding current and future agricultural production. Agroforestry is a complex production system full of intriguing questions, and answering them will require multidisciplinary efforts that yield comprehensive outcomes.

[29] Mudge obtained McIntire-Stennis (Cooperative Forestry Research) and Smith-Lever (Cooperative Extension) funds, which National Institute of Food and Agriculture administers annually to land-grant universities via statutory formulas. For more information, see http://www.csrees.usda.gov/business/awards/formula.html.

In 2007, a 17-acre agroforestry research and demonstration project was established as an alley cropping system by Paul Mueller, Fred Cubbage, and others at the Center for Environmental Farming Systems (CEFS). CEFS, a joint effort of North Carolina State University, North Carolina Agricultural and Technical State University, and the North Carolina Department of Agriculture, demonstrates how such partnerships are critical to agroforestry projects.

The agroforestry project was originally designed to evaluate an alley cropping system of corn and soybeans in rotation between rows of loblolly pines, longleaf pines, and cherrybark oaks. Cubbage, Mueller, and others measured agricultural production and economic returns from these different tree-crop combinations and found that these alley cropping systems could prosper and provide reasonable returns on poor agricultural sites in North Carolina.[30] Support for the project came from Hatch Act funds[31] and Natural Resources Conservation Service.

The scientists now plan to incorporate a significantly new avenue of research with the addition of Franzluebbers, who is a member of the ARS GRACEnet[32] program, a project that standardized methods to measure greenhouse gas emissions, carbon sequestration, and other factors in different agricultural systems around the country. Franzluebbers will assess the effect of environmental factors on the economics and production management strategies for the alley cropping systems. GRACEnet will also benefit by gaining its first agroforestry research site. Because Cubbage and Mueller established this agroforestry project in North Carolina, Franzluebbers was fortunate to find a perfect place to do his research. All early signs point to a successful partnership.

Beyond its regional significance, the project will also contribute to international research because Franzluebbers has experience with the Global Research Alliance on Agricultural Greenhouse Gases (GRA), in which GRACEnet is a key U.S. component.[33] The GRA is an international platform that coordinates and catalyzes research among 31 member countries through three main agricultural research areas: croplands, livestock, and paddy rice. Now that Franzluebbers is working to quantify greenhouse gas emissions and nutrient dynamics in agroforestry systems, the United States will be able to share data, create and evaluate robust models, and further collaborate on agroforestry research in new ways.

The NAC recently strengthened and deepened a partnership with its Canadian counterpart, Agriculture and Agri-Food Canada, by signing a Memorandum of Understanding to work together. One of their main areas of collaboration will be advancing agroforestry in the GRA as a key element in promoting climate-ready agriculture.

In the next 5 to 10 years, the CEFS research team will characterize carbon and nitrogen cycles in alley cropping and silvopasture systems in Goldsboro, NC. This research will quantify greenhouse gas emissions and investigate how agroforestry management affects soil carbon storage, soil water storage, and soil biological activity. Learning about the carbon flows in agroforestry will enable researchers to build a better carbon footprint accounting system, which will be beneficial for similar assessments around the globe.

This research will hopefully help producers more effectively manage carbon on their farms by providing information on how to sequester it in their soils and products rather than releasing it as

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[30] For more, see "Early tree growth, crop yields, and estimated returns for an agroforestry trial in Goldsboro, North Carolina" (Cubbage 2012).

[31] Hatch funds are administered by the National Institute of Food and Agriculture annually to land-grant universities according to a statutory formula.

[32] GRACEnet stands for Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network.

[33] For more information on the U.S. participation in the Global Research Alliance on Agricultural Greenhouse Gases, visit the Web site.

carbon dioxide into the air. It will also enhance recommendations to efficiently managing nutrients to increase food production while supporting healthy, diverse, and resilient ecosystems.

Partnering for greater impact with tighter Federal funding is the new name of the game.

Alley cropping of corn between rows of cherrybark oak and loblolly pine at the Center for Environmental Farming Systems in North Carolina. Photo courtesy of Fred Cubbage.

#9—Bringing Chestnuts Back to American Landscapes and Diets, One Graft at a Time

Although many know the sad story of the loss of American chestnut trees from forests across the country because of fungal disease in the early 1900s, they may not know that chestnut agroforestry systems are on the rise in the heart of the United States today—an effort that is restoring chestnut trees to part of their previous range, providing new income for producers, and producing healthy nuts for nearby consumers. The Center for Agroforestry at the University of Missouri, a center historically supported by funding from Agricultural Research Service,[34] provided expertise to spearhead this reintroduction effort.

After attending the annual chestnut roast and several other chestnut-themed events held by the center, research forester Steve Shifley became interested in growing these high-value nuts on his own small farm. To learn more, he talked with experts at the center and read as much as he could about blight-resistant Chinese chestnuts, which are well suited to the Midwest climate. Then, between 2004 and 2008, he planted 360 trees on 7 acres of land that he formerly had in crop production. By planting the trees in rows spaced far enough apart (26 feet) for his neighbor to bale hay between them, he and his neighbor have been able to split the income from the land while the trees grow.

[34] Congressionally funded until 2010.

Shifley cuts hay between his chestnut trees. He planted the trees in rows 26 feet apart to make room for his tractor.

Because this portion of his land was highly erodible, Shifley worked with Natural Resources Conservation Service (NRCS)[35] and Farm Service Agency (FSA) to plant mixed grasses and legumes in the hay lanes between the trees and create borders with warm-season grasses and forbs for quail habitat. By shifting this vulnerable section of his farmland out of intensive agricultural crops and into trees, grasses, and forbs, Shifley is restoring ecosystem function to the landscape while maintaining his ability to make money from it. Shifley says that, for a small landowner like him, NRCS's Environmental Quality Incentives Program and FSA's Conservation Reserve Program are invaluable because they have enabled him to provide habitat for wildlife while continuing to receive income on that piece of land, something that he just would not have been able to do otherwise.

Chestnut graft.

While waiting for his trees to mature, Shifley continued to learn about them by attending a chestnut production workshop series put on by the center. Then, in 2011, about 7 years after he planted them, the first 30 trees started producing chestnuts. Although he was excited to see the nuts, he also noticed that they varied in quality and amount from tree to tree. Hoping to sell these nuts into a variety of local markets and restaurants, Shifley needed his crops to be reliable, so he contacted chestnut experts Dr. Ken Hunt and Dr. Michael Gold at the center. Hunt and other scientists have been working to identify and propagate chestnut cultivars that work well in the Missouri region. In order to increase the likelihood for consistent, high-quality nut production, they recommended grafting scions from the best producing center-tested cultivars onto Shifley's saplings.

[35] Shifley credited the following people as key to getting his project underway, providing technical assistance, and helping him enroll in Environmental Quality Incentives Program and Conservation Reserve Program: Kim Reitz, Natural Resources Conservation Service (NRCS) resource conservationist; Bob Hagedorn, NRCS district conservationist; Doug Wallace, NRCS forester; and Mark McCullough, Missouri Department of Conservation private lands specialist stationed at the local NRCS office.

Much uncertainty remains about the optimal age for grafting chestnuts and about which cultivars will produce the highest quantity and quality nuts on Shifley's clay soils, which differ substantially from the richer soils at the center's research plot. So Shifley obtained a $6,000 U.S. Department of Agriculture (USDA) SARE [Sustainable Agriculture Research and Education] Farmer/Rancher grant from the USDA North-Central Region to explore answers to these questions and share what he learns with other farmers and researchers. As part of carrying out the research, Hunt grafted shoots from several different cultivars onto the oldest of Shifley's saplings, and Shifley continues to manage the system by pruning the trees, caging them to prevent deer damage, and weeding around them to minimize competition from other plants.

Chestnuts nearly ready to harvest. All photos in this case study courtesy of Steve Shifley.

Shifley has been quite impressed by the information available at the center and the support from the SARE program. He learned how to write an effective grant application and found that the SARE staff were very helpful in answering questions about the program and process. He says that the small grants are still large enough to have an impact.

Thanks to grant funding, this past August, Shifley was able to attend a chestnut-growing workshop convened by Michigan State University Extension that attracted people from across the Nation and around the world to share best practices in chestnut tree care and chestnut production, processing, harvesting, and marketing. Shifley was particularly impressed by information shared by speakers from Italy, Turkey, and China, where chestnuts have been cultivated for many centuries.

Over the next few years, Shifley, Hunt, and Gold will share their research results via articles, farm tours, demonstrations, and workshops, which will add to the growing body of knowledge about Chinese chestnut care and grafting. To complement this work, the center has also been able to secure small amounts of USDA funding from the Specialty Crop Block Grant program[36] to determine how to remove gall wasp larvae from chestnut scion wood before grafting it (in FY 2010) and to sustainably manage chestnut weevils (in FY 2011).

With support from USDA and these nearby scientists, Shifley looks forward to providing his community with chestnuts in the years ahead, turning his farm into an agritourism destination, and testing additional management techniques, such as incorporating movable chicken pens between the trees to help control those pesky chestnut weevils.

[36] They were awarded grants of $20,000 to $25,000 each from the Specialty Crop Block Grant program, which is housed at the Agricultural Marketing Service and administered by the Missouri Department of Agriculture.

#10—Hazelnuts, Hickory Nuts, and Walnuts, Oh my!

Will Ohio go nuts about one couple's regional nut production scheme?

What impact will this perennial agroforestry system have on the landscape?


Harvesting walnuts.

Although Ohio is not currently a hotbed of nut production, Kurt Belser and Marie DeMange are two entrepreneurs in southeastern Ohio who hope to change that. Rather than pecans or almonds, however, Belser and DeMange will produce hickory nuts, chestnuts, black walnuts, and hazelnuts, which are more amenable to the growing conditions in the Midwest. Because 90 percent of the woodlands in their area are owned by private landowners, and 96 percent of those do not have forest management plans, there seems to be great potential.

Belser currently has agreements with several landowners in the area to harvest the hickory nuts and walnuts growing in their pastures, on their fence lines, and in riparian areas. But as these landowners have seen his interest in their trees, they have become interested in entering the world of niche nut production themselves. Far from ruining Belser's plan for a unique enterprise, however, this fits right into his long-term goal of transitioning into nut processing—a plan in which he would rely largely on others to produce the nuts while he would manage only the trees on a 30-acre woodlot that he will soon own.


Nut harvesters.

In fact, the budding interest of these landowners in nut production has provided the perfect opportunity for Belser to teach them about the agroforestry techniques he has learned from the University of Missouri Center for Agroforestry, such as silvopastoral systems (raising both livestock and tree crops on the same piece of property) and windbreaks (employing trees to protect animals, structures, and crops from damaging winds). Belser has noticed that silvopasture practices provide shade for livestock and help wooded acreage withstand the strong gusts during wind storms that tend to blow individual, isolated trees over but leave groups of trees standing together.

The landowners' ears perk up even more, however, when Belser tells them that each nut tree could provide them about $300 of additional income per year—with walnuts selling at more than $0.60 per pound and grafted cultivars producing roughly 500 pounds each—surpassing timber prices by a long shot. According to Belser, with close management for timber quality, timber sales in his area can yield up to $4,500 per acre every 30 to 35 years, but nut crops can average that amount every few years, although management may also be required.[37] The

[37] For more information on pricing of timber and nut crops, please see the following:
- Pahl, T. (1999). "What is my timber worth?" West Virginia University Extension Service.
- The National Agricultural Statistics Service has biannual reports on Noncitrus Fruits and Nuts and annual Agricultural Statistics reports that contain chapters on agricultural conservation and forestry statistics that include timber prices.
- The Agricultural Marketing Service Fruit and Vegetable Price Portal has custom reports available by market type, location, and time period for a range of commodities.
- The Forest Service has resources for timber prices that are more specific to local conditions than National Agricultural Statistics Service's reports.


Half of the walnut harvest from one tree.

key to profitability, however, is the use of grafted nut tree varieties, because wild species yield nut meat that varies more in quality and quantity.

With Belser's guidance, several landowners have already started planting nut trees on their properties, and he has trained several in a variety of grafting techniques so that they can make use of the best available cultivars.[38] In Belser's eyes, nut production is a great opportunity for landowners to see value in their land outside of traditional uses in timber, coal, and gas.

Belser and DeMange are interested in sharing this knowledge because it was not easy to find. When they first became interested in nut production and processing, they found little published information relevant to southeastern Ohio. Four years ago, however, they found and joined the Ohio Nut Growers Association and the Northern Nut Growers Association, two organizations whose members share information on growing these nut crops in their area, experiment with cultivars to identify the ones that have the highest yield and quality, and discuss how best to manage their trees. Excited and surprised to see young people taking such an interest, members have been happy to mentor Belser and DeMange and provide them with scions of high-yielding cultivars and nuts for the new processing venture.

Belser, DeMange, and two other farmers in the area applied for and received a Sustainable Agriculture Research & Education (SARE) Farmer/Rancher grant of $22,493 to explore how to produce and process these nuts at a regional scale and to help others to do the same. This will help them propel their dream into a reality and share the knowledge that they have accumulated during the past few years working with these nut grower associations. They plan to set up a pilot project that others can replicate if it is successful. Belser says that SARE was the perfect fit for a project like theirs and almost the only grant program that could serve their needs.

The goal of this project is to keep land in the hands of rural woodland owners, so Belser and DeMange are intent on making the economics work for everyone by creating a values-based supply chain. Thus, they will not only produce shelled nuts, which could saturate the market, but also flour, oils, nut butters, and baked goods, which they will be able to sell at a greater profit. The grant enables them to experiment with different processing equipment; business models; and a variety of recipes, products, and markets for the higher value goods—options they would not be able to try otherwise. Hoping others will follow in their footsteps, Belser's team plans to share everything they learn, including the financial costs of running such an operation.


Grafting workshop for landowners. All photos in this case study are courtesy of Kurt Belser.

[38] When dealing with walnut trees, it is important to know how to spot "thousand cankers disease," a deadly illness that has not yet reached Ohio but has been found in Tennessee, Virginia, and eastern Pennsylvania. To read more, see The Ohio State University's Extension publication or see http://thousandcankers.com

For others interested in applying for SARE grants, however, Belser was quick to note that he and DeMange were not successful with their first proposal for funding 2 years ago. He now sees that as a blessing in disguise, however, because it pushed them to clarify their plan before implementing it. They ultimately did receive a smaller grant from the Northern Nut Growers Association to do a scoping study that better prepared them to apply to SARE for the second time—and succeed!

Belser says that "by initiating growers and landowners into further cultivation of perennial forest products, we hope to be a driving force behind sustaining this staple food source."

#11—Moving Agroforestry Into the Mainstream To Provide Energy, Water, and Jobs: Minnesota to the Gulf of Mexico

Since its launch in 1996, the Center for Integrated Natural Resources and Agricultural Management (CINRAM) at the University of Minnesota has worked with public and private partners to develop innovative solutions to water and land use problems.

One of these tools is agroforestry—a solution with the potential to simultaneously generate income, enhance water quality, and, as it turns out, produce bioenergy.

It all began with a 2002 grant from what is now the National Institute of Food and Agriculture (NIFA) when several partners began to research the impacts of agroforestry on water quality and storage in the Minnesota River Basin.

Over the years, CINRAM has established research and demonstration plots of woody and perennial biomass crops in an alley cropping agroforestry design to provide feedstock for bioenergy while also allowing scientists to evaluate the impact on water quality.

The alley cropping systems alternate rows of trees and perennial grasses at three different locations along waterways. Two plots are on land in an area of south-central Minnesota dominated by corn and soybeans, providing an interesting contrast. The third planting is managed by the Metropolitan Council at the Empire Sewage Treatment plant on a site where bio-solids were applied.

Alley cropping of hybrid poplar and native grasses for bioenergy on a CINRAM research plot.

Since the initial establishment of the plantings, scientists have noticed that the trees and grasses have been able to survive and thrive even when covered by water for 7 to 36 days continuously. Perhaps such systems have more resilience to flooding?

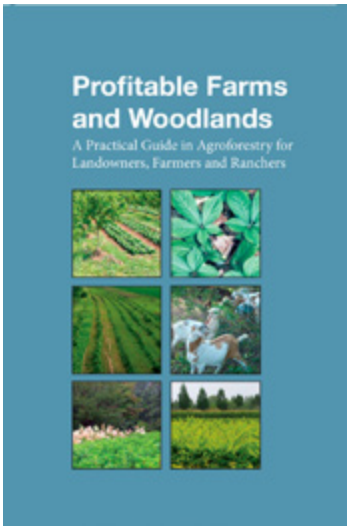
As the research has evolved, more farmers in south-central Minnesota are expressing interest about getting involved, and so are other businesses nearby.

One such business is KODA Energy, LLC, an innovative combined heat and power plant that burns agricultural byproducts, wood waste, and dedicated energy crops to generate electricity and heat through steam. The energy is then used by the Shakopee Mdewakanton Sioux Community who are a co-owner of the business. CINRAM is helping KODA explore the logistics, options, and potential environmental benefits of supplying perennial feedstocks to the facility.

With CINRAM's 15-year history partnering to develop agroforestry systems, they are able to lead the way toward a future in which rural economies are reinvigorated even as they sustain and improve the environment—and a future in which an agroforestry farm is valued for its energy production as well as the water it protects and the floods it prevents downstream.

Aerial images of the bioenergy alley cropping plots. All photos in this case study are courtesy of Josh Gamble.

#12—Agroforestry Consortium's Aim: Profitable Farms and Woodlands for Limited-Resource Producers



Are agroforestry systems a viable option for small farms and woodlands in the Southeast United States?

What research, education, and outreach activities are needed to accelerate agroforestry adoption by limited-resource producers in this region? Who should lead such an initiative?

A resounding response to these questions came in July 2012 with the release of *Profitable Farms and Woodlands*. This publication is a first-of-its-kind practical agroforestry handbook that helps agricultural producers establish, manage, and market agroforestry projects that are profitable and sustainable over time. The guidebook is written for underserved and limited-resource farmers and woodland owners living in the Southeast and includes five main agroforestry practices: alley cropping, forest farming, riparian buffer strips, silvopasture, and windbreaks.

The guide describes principles and step-by-step methods that landowners can use to develop agroforestry practices that enhance the economic and environmental benefits of farms, ranches, and woodlands. The book includes simple explanations of how growing medicinal plants, mushrooms, or bee products can help landowners join a multibillion-dollar industry.

The guide was developed by a team of agroforestry specialists from the 1890 and 1862 land-grant universities who were led by the 1890 Agroforestry Consortium in close cooperation with the National Agroforestry Center (NAC). "Resource professionals and small farmers and woodland owners in the Southeast have been yearning for a practical, easy-to-read agroforestry handbook," said Joshua Idassi, technical coordinator for the publication and natural resources specialist at North Carolina Agricultural and Technical State University. "This handbook meets that need. It will be very helpful for beginning farmers and woodland owners, especially the 'Basics' section for each of the five practices."

Limited-resource farmers and woodland owners met twice in focus groups in Birmingham, AL, and Atlanta, GA, with a team of agroforestry experts to suggest topics they would like to see covered in the publication. Their views were the guiding light that led to the publication's development. NAC published the guide, facilitated reviews of each chapter, and contracted with *Minority Landowner* magazine for the final editing to ensure the target audience would find the information relevant and applicable.

NAC has fulfilled numerous requests for *Profitable Farms and Woodlands* and has also fielded many inquiries about how to implement agroforestry from landowners and natural resource professionals in other regions of the country. The publication meets a need for agroforestry information that has never been fully realized or met before; it is a "how-to" guidebook with success stories about how to use agroforestry to produce region-specific crops and livestock.

The 1890 Agroforestry Consortium traces its roots to an inaugural 2000 workshop, "Agroforestry: Blending Agriculture and Forestry," hosted by Alabama A&M University. The workshop included faculty from 12 of the 18 universities. At that workshop, participants agreed to form the consortium, which is currently chaired by Gwen Boyd of Alcorn State University. NAC, a partnership of the Forest Service and the Natural Resources Conservation Service, works closely with the National Institute of Food Agriculture (NIFA) to support consortium activities. Since the inaugural workshop, the U.S. Department of Agriculture (USDA) has helped support six agroforestry-related workshops and made it possible for consortium participants to attend the 1st World Congress on Agroforestry in Florida in 2004. NAC and NIFA have also cooperated with consortium members through a wide range of USDA programs to develop agroforestry demonstrations and collaborate on research efforts.

The planning committee for a May 2011 agroforestry workshop in Greensboro, NC, included 1890 University faculty and USDA staff from the Forest Service, Natural Resources Conservation Service, and National Institute of Food and Agriculture.

An amendment to the McIntire-Stennis Cooperative Forestry Act in the 2008 Farm Bill provides new USDA support to 1890 universities and helps to advance the agroforestry research goals of the consortium. Each State, at the discretion of the Governor or Governor-designee, has the authority to share McIntire-Stennis Capacity funds between their 1862 and 1890 land-grant universities. As a result, thirteen 1890 universities now receive McIntire-Stennis funding, a long-standing USDA program administered by NIFA. A recently organized 1890 McIntire-Stennis Coordinating Council has established three priorities for the new funding: agroforestry, urban forestry, and recreation and tourism.

To accelerate the adoption of agroforestry is a tall order anywhere in the United States. It is especially challenging in the Southeast United States, where so many small farms and woodlands are owned by a diverse population that includes many limited-resource producers and minority landowners. The 1890 Agroforestry Consortium has truly broken new ground in this region with the *Profitable Farms and Woodlands* guidebook. This land-grant universities-USDA partnership is just the ticket for advancing the science, practice, and application of agroforestry.

#13—Oregon Woodland Owners Enter a New World of Possibilities With Oregon Grape

Tom Nygren and the roughly 70 other small-scale woodland owner-members of the Oregon Woodland Cooperative (OWC) are discovering creative ways to diversify their income streams. They are looking beyond timber to all of the other potential products in their forests, including Oregon grape, a low-growing holly-like shrub. Herbal medicine users value Oregon grape root for its berberine, which is heralded for its ability to fight infection and stimulate the immune system. To explore Oregon grape and other products, the OWC applied for and received, first, a planning grant and then two working capital grants[39] from U.S. Department of Agriculture (USDA) Rural Development's Value-Added Producer Grant (VAPG) program. The cooperative used these grants to develop a business plan and investigate several possibilities of keen interest to their members: processing and selling local firewood at upscale grocery stores, cultivating edible and medicinal plants and mushrooms native to their forests, and extracting essential oils from some of those plants.

[39] VAPG planning grant awarded in FY 2005, working capital grants awarded in FY 2007 and 2009.

These landowners are eager to diversify the products from their land because they can sell timber only about every 10 years and need a more frequent source of income to maintain ownership of their land. It is also the perfect time for the OWC to take on this mission because it has fulfilled much of its original function by teaching its small woodland owner members how to harvest and sell their timber in large markets. Although some members still rely on the cooperative for help with these timber sales, many have a greater need for the OWC to focus its efforts on research, education, marketing, labor, and aggregation to help develop additional industries for nontimber forest products. Of the products that they are currently developing, Nygren says they have had the quickest market success selling bundled firewood because many of the other products require more research and education before the landowners will be ready to successfully produce them at scale.

Sansone standing with his alley-cropping system of native plants: Oregon grape, salal, and mixed conifers. Both photos in this case study courtesy of Paul Sansone.

When the OWC inventoried the assets on their members' properties and asked how interested members were in developing the additional products, Oregon grape rose to the top of the list by those that responded. It was ubiquitous and easy to identify, but the challenges in getting it to market, however, were twofold. Herbal medicine companies were more interested in the tall variety of Oregon grape, while members had more of the low variety growing abundantly on their lands. In addition, the woodland owners did not know how best to harvest the plant for its roots in a way that would ensure continued abundance of the crop. To address these challenges, Amy Grotta, a forestry extension agent with Oregon State University, embarked on a research project with the OWC to compare the berberine content of the tall- and low-growing varieties and to determine the best ways to sustainably harvest the plants.

In her research, Grotta found little difference in the berberine content of the two varieties of Oregon grape, which suggested that they might both be equally valuable. Research characterizing the berberine content of the low-growing variety and comparing it with the tall-growing variety had simply never been done before. With this new evidence, herbal and nutraceutical companies may become just as interested in the low-growing variety as a source of berberine.

Oregon grape.

Grotta also found that little research had been done into sustainable harvesting methods. Oregon grape resprouts from its roots, but it grows slowly, and landowners expressed concern about the potential impacts of mechanical harvesting equipment that could threaten future harvests. Grotta tested several methods of harvesting and found that, after two seasons, the plots where she had harvested one-half of the plants selectively regenerated more successfully than areas where she had harvested all of the plants.

Despite the fact that the research is still ongoing, a few of the OWC members were interested in the work that Grotta was doing. They were also intrigued about what they heard from Eric Jones at the Institute for Culture and Ecology, a nonprofit organization that was awarded a USDA Agriculture

and Food Research Initiative (AFRI) grant[40] to research and provide actionable information on nontimber forest products. These members are now actively cultivating Oregon grape on their lands.

One of these landowners, Paul Sansone and his wife, Susan Vosburg, have lived in the area since the 1970s, running a plant and cut flower nursery for 25 years. In 2007, they planted a mix of Douglas-fir, red alder, western red cedar, ash, maple, oak, and ponderosa pine on 30 acres of their land. As former nursery owners and recent graduates of the Oregon State University Extension Master Woodland Manager program, they believe that as much marginal farmland as possible should go into forestry. The challenge, however, is that forestry is a multigenerational project, and trees take a long time to grow, so it is difficult to predict future markets to make a living at timber production. Thus, Sansone has found that agroforestry—growing short-term crops or livestock in a symbiotic system with the trees—is a great way to address that challenge.

In support of such multiuse land management, the Natural Resources Conservation Service (NRCS) helps landowners improve ecosystem function by planting native trees and shrubs on their land. In addition to market benefits, this vegetation can provide shade along streams—particularly desirable in the Pacific Northwest because salmon and steelhead fish need cool water to spawn, rear their young, and migrate. Thus, Sansone worked with NRCS conservationist Nathan Adelman to use Agricultural Water Enhancement Program funding to plant an array of trees and shrubs to restore the ecosystem function and meet Sansone's agroforestry objectives. Sansone planted salal and Oregon grape, both native plants, in the alleys between his timber trees. He plans to harvest both plants for their floral greens during much of the year and the Oregon grape flowers in February and March. He also noted that he could set up a harvesting cycle to sell the aboveground parts of the Oregon grape to maintain his cash flow and periodically dig up the entire plant to propagate it and sell the root for its medicinal qualities.

No research had been done on this specific alley cropping system before, so this experiment can also serve as a demonstration for other nearby landowners. From Sansone's experience in the nursery industry, he knew to first identify the plants' size and light tolerance, after which he decided how far apart to plant the trees, space the shrubs, and manage the system. Although he is planting on a small scale, Sansone spoke about how others could extend this type of intercropping design over many acres to really increase profit potential. He hopes to use the OWC network to spread this idea, gain critical mass, and create an industry that is similar to mushrooms and other specialty forest product industries in Oregon.

#14—Virginia Is for Lovers — and Silvopasture

Throughout his life, Chris Fields-Johnson has been keenly aware of the need to preserve the natural landscapes he cherishes, which provide us with clean air to breathe, water to drink, and food to eat. As a graduate student of soil science at Virginia State and Polytechnic University, a forestry undergraduate, a student of Tom Brown, Jr.'s Tracker School, and a former employee of the Virginia Department of Forestry, he also knows much of the science behind soil restoration and forestry. These experiences have given him a strong desire to turn his knowledge into action by managing land in the most beneficial way possible.

[40] AFRI grants are managed by USDA's National Institute of Food and Agriculture.

Seven years ago, to make this dream a reality, he began converting a 250-acre loblolly pine plantation in Scottsville, VA, into a goat and sheep silvopastoral system that resembles a pine savanna landscape. Since that time, he and friends have spent many weekends away from their graduate school studies and daily lives to thin and prune trees by hand, conduct controlled burns, fight invasive plants, and experiment with forage establishment while they also learn how to raise goats and sheep. Fields-Johnson and his friends face numerous challenges, however, because they are early adopters of this agroforestry system in Virginia. A lot remains to be discovered about the details of forage establishment, tree thinning, rotational grazing, restoring nutrients to the soil—and perhaps most critically, how to finance the operation as they learn.

Other farmers in the area—both beginners like Fields-Johnson and more seasoned ones—are facing similar issues. Some are interested in silvopasture to decrease heat stress in the summer by providing shade for their animals. Others are interested in combining the long-term income opportunities from the trees with the short-term income from goats or cattle in order to diversify their assets. Others are interested in the environmental benefits of trees and wish to keep them on large tracts of their property while still producing animals. Without mature silvopasture operations in the area, however, trying something new often seems risky for producers because it brings with it much uncertainty.

What is silvopasture? How can I establish it on my land? How should I manage my trees? How can I establish forage for my animals as efficiently and effectively as possible? What type of grazing rotation do I need for my animals?

This risk and uncertainty is why it is critical for Natural Resources Conservation Service (NRCS), Forest Service, and partners (including technical service providers, Cooperative Extension, and State agricultural and forestry agencies) to be able to provide technical advice and financial assistance to help farmers and ranchers make the leap to this new technology.

Fortunately for farmers in Virginia, NRCS listened to local producers, and beginning in October 2011, adopted a silvopasture establishment practice standard applicable throughout the State. This means that NRCS employees may now provide both technical and financial assistance to help producers establish silvopastoral systems on their land. Although many challenges remain, this great accomplishment demonstrates one of the three goals of the *Strategic Framework*—integrating agroforestry into the way that the U.S. Department of Agriculture (USDA) works. For it to happen, "Silvopasture Establishment" first had to be approved as a practice standard at the national level, which occurred in 2002. Then, the NRCS State office in Virginia reached out to J.B. Daniel, a grassland agronomist and grazing specialist who works in Farmville, and asked him whether the practice was appropriate for the State of Virginia. Daniel had met with a variety of landowners in various counties throughout Virginia during the past few years, so he knew that widespread interest in silvopasture existed. To assist NRCS employees as they help landowners establish silvopastoral systems, the NRCS Virginia office created a "Job Sheet" based on a national template that guides a conservation planner and a producer through the process of converting forest or pasture into silvopasture.

Silvopasture is still rather new and like other agroforestry systems, it combines many disciplines: forestry, forage management, range ecology, animal science, economics, finance, and more. To help advance silvopasture in south-central Virginia, Daniel organized a working field trip to several farms in varying stages of silvopasture establishment from unmanaged forest land to open pasture. The farms represented a diversity of operations—from large to small, from poultry to goats to cattle, and from a multigenerational farm to a high school teacher interested in converting forest land for educational purposes and beginning farmers like Fields-Johnson. Though it started out small, interest in this trip grew until it included employees from nearby NRCS county offices and Virginia Department of Forestry (who administer the forestry aspects of NRCS conservation programs), NRCS

specialists from the East National Technology Support Center in North Carolina, and professors from Virginia Polytechnic Institute and State University and Virginia State University. At each site, Daniel led a discussion focused on how to help each producer meet his goals by combining the varying expertise of the attendees.

After learning about opportunities for assistance on the tour, Fields-Johnson has followed up with his county forester and plan to pursue financial assistance through the Environmental Quality Incentives Program. He also hopes to establish partnerships with researchers, professors, and extension specialists who might wish to use the farm as a research and demonstration site. Demonstration areas are a great need because they provide scientists with a practical laboratory to discover the best ways to implement silvopasture, and they provide extension agents with visible examples to persuade others to try silvopasture.

Left: Loblolly pine plantation pre-thinning. *Right:* Fields-Johnson standing in his hand-thinned loblolly pine silvopasture. He plans to do a controlled-burn in this stand.

Fields-Johnson rotates his goats and sheep through the thinned stands to browse on honeysuckle and other understory vegetation. Photos in this case study courtesy of Tom Ward and Colleen Rossier.

The beauty of the quick tour of Virginia silvopasture operations was that the discussion not only benefitted the producers by helping them start a conservation plan with their local NRCS district conservationists, but it was educational for all because silvopasture systems are inherently multidisciplinary. Foresters learned about forage establishment and the forage specialists learned how to calculate basal area and identify which trees to keep when thinning a timber stand.

Although this effort was a fantastic example of how USDA is starting to integrate agroforestry into the way it does business, much remains to be done. Many State NRCS offices still need to adopt agroforestry practices, such as "silvopasture establishment." More educational opportunities such as this one need to be available for government employees, researchers, and producers to better understand these transformational systems. And more research must be done to learn the best ways to establish and manage these silvopasture systems in different regions of the country.

Virginia is helping to lead the way.

#15—The Island of Pohnpei Rediscovers Its Agroforestry Roots

Since the 1970s, the people of Pohnpei, an island in the Federated States of Micronesia, have seen their diets shift from traditional local foods, such as taro and bananas, to imported foods, including refined grains, sugar, and fatty meats.

The dietary shift and other lifestyle changes in the population have led to serious health problems, including a rise in diabetes and vitamin deficiencies. But, as many are learning on Pohnpei and many Pacific Islands, traditional agroforestry systems—based on thousands of years of indigenous knowledge—are part of the solution because they provide healthier local food that was once a staple of their diets.

The community organization Island Food Community of Pohnpei saw a need to reverse this trend—and local foods as a way to do it. The group launched the campaign Go Local Pohnpei to increase awareness of the nutritional values of traditional local food.

Working closely with island residents, the project promotes the production and consumption of locally grown island foods through community workshops, school visits, marketing materials, media work, community food production, and coordination with Forest Service. Island Food Community employees like to say that integrating traditional foods back into local diets has CHEEF benefits, or benefits to Culture, Health, Economy, Environment, and Food security.

The Forest Service became involved because several of the island's traditional foods, including the pandanus, breadfruit, coconut, and banana, are forest products. A grant from the agency's Forest Stewardship Program helped the Island Food Community implement traditional agroforestry—multispecies agricultural systems that include forest products, such as fruits, nuts, foliage, fiber, and medicinal plants.

The grant has also helped the Island Food Community to catalog traditional tree crops, conserve rare varieties of trees, and develop and maintain a gene bank nursery. The group's poster fruit has been the little-known red-fleshed karat banana cultivar, which has been shown to have especially high Vitamin A content. Employees also developed small-scale processing capacity using appropriate technology, such as energy-efficient ovens and solar dryers.

The results of the project have been impressive. During a 2-year period, the project's founder, originally a volunteer, was able to transition the organization to one that employed, trained, and paid local staff. The organization also worked with 500 landowners, who were given direct technical assistance, and more than 15,000 landowners were reached through the awareness campaigns.

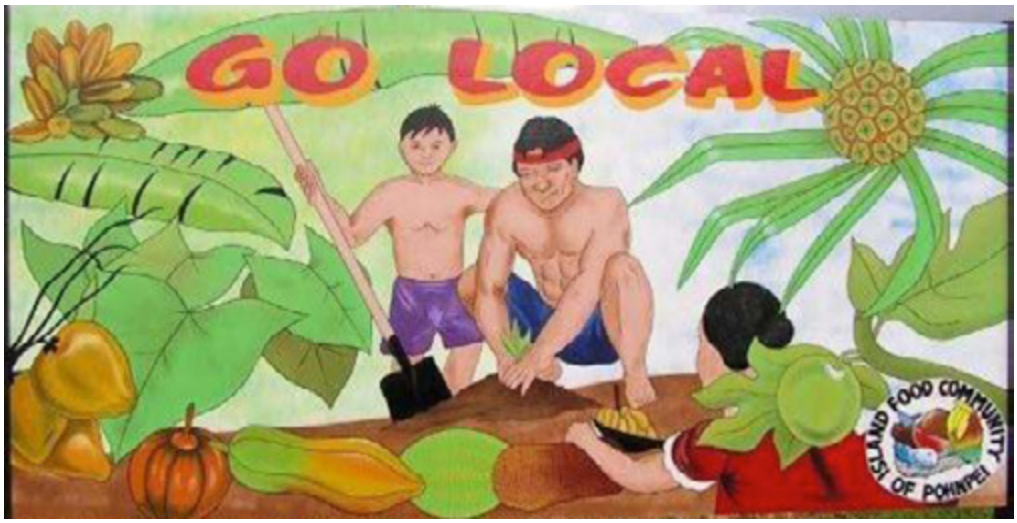
The work also resulted in 9 community agroforestry advisory committees around the island, and roughly 6,500 volunteer hours were donated to projects by local residents. The outreach has touched more than 50 percent of the islands.

"This project is exciting because it's about helping the people of Pohnpei rediscover and use knowledge they already have rather than bringing a new mainland technology to the Pacific Islands, which sometimes doesn't work," said Katie Friday, Cooperative Forester for the Forest Service's Pacific Southwest Region office in Hawaii.

Local food is now increasingly available both commercially and through garden-based projects on the island. The President of Pohnpei issued a proclamation announcing that local food would be used during all government-sponsored functions, which immediately replaced soda with iced whole coconuts. Island Food Community's work has expanded to the four States in the Federated States of Micronesia and to other U.S.-affiliated islands, including the Marshall Islands, Palau, and Guam.

In the spring of 2012, Island Food Community launched The School of Healthy Lifestyles as a pilot program to encourage students to stay healthy and teach them to cultivate traditional foods.

Increased cultivation of traditional tree crops increases nutrition while reducing direct expenditures on imported food. It also enhances the perception of the value of agroforests as a land use and reinvigorates island residents' cultural awareness of their own indigenous knowledge. All in all, the benefits of Go Local Pohnpei have been myriad—or CHEEF, as Island Food Community staff would say.



This story first ran as a USDA Know Your Farmer, Know Your Food case study: http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=KYF_Compass_Case_Studies_Pohnpei.html. It has been slightly modified.

Appendix E: Media About Agroforestry

Table E1.—News articles about USDA agroforestry in 2011–12.

Title	Author	Outlet	Date
Deputy Ag Secretary Pushing 'Agroforestry'	Merritt Melancon	*Athens Banner-Herald*	June 2011
Framework for Agroforestry to Bring the Practice 'to the Next Level'	Tiffany Stecker	*Climate Wire*	June 2011
A Quiet Push to Grow Crops Under Cover of Trees	Jim Robbins	*New York Times*	November 2011
Agroforestry: A Growing Science Seeks to Boost its Practice	Madeline Fisher	*CSA News*	November 2011
With Agroforestry, Woodlands Can Also Yield Crops Such As Mushrooms, Leeks	Associated Press	*Washington Post*	April 2012
USDA, Canada Partnering to Promote Agroforestry R&D	Linda McGurk	*Farm World*	May 2012
Could Africa Hold the Answers to America's Drought Woes?	Robert S. Eshelman	*Climate Wire*	July 2012
Some Farmers Bucking the Bush-Clearing Trend: Ecobuffers	Daniel Winters	*Manitoba Cooperator*	August 2012
Shelterbelts: A Sight for Sore Noses	Daniel Winters	*Manitoba Cooperator*	August 2012
Shelterbelts: The Bees' Knees for Pollinators	Daniel Winters	*Manitoba Cooperator*	August 2012
Tree Planting Project Popular	Karen Briere	*Western Producer*	September 2012
Shelterbelts Still Play a Valuable Role	Karen Briere	*Western Producer*	September 2012
Manitoba Pilot Program Offers Incentive to Plant Shelterbelts	Karen Briere	*Western Producer*	October 2012
Tree Buffers Suck Up Odour, Dust	Karen Briere	*Western Producer*	October 2012
Living Snow Fences Slow to Catch On	Karen Briere	*Western Producer*	October 2012
Bees Need Trees, Please	Karen Briere	*Western Producer*	October 2012
Tree Diseases a Continuous Threat	Karen Briere	*Western Producer*	October 2012
The giving tree: Agroforests can heal food systems and fight climate change	Jake Olzen	*Grist*	December 2012

Appendix F: USDA Conservation Practices

Below are descriptions of the agroforestry conservation practices that farmers can apply with technical and financial assistance from USDA. The first list includes the conservation practices applied through the Farm Service Agency's (FSA) Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP), while the second includes the conservation practices applied through the Natural Resources Conservation Service's (NRCS) conservation programs that include Environmental Quality Incentives Program (EQIP), Wildlife Habitat Improvement Program (WHIP), Conservation Stewardship Program (CSP), and others.

FSA Conservation Programs—CRP and CREP:

CP5 **Field Windbreak**

Definition: Field windbreaks**,** or hedgerow plantings, consist of a row or rows of trees, shrubs, or other plants located along crop field borders or within the field itself. Coniferous trees or a mix of coniferous and deciduous trees can be used, along with one or two rows of shrubs. Fields must be subject to serious wind erosion, and the windbreak must bring erosion to below the soil loss tolerance level.

Benefits of field windbreaks are reducing wind erosion, protecting young crops, and controlling blowing snow by acting as a snow fence. Windbreaks also conserve energy used for heating and cooling, improve crop yields, serve as a sound barrier, and provide food and habitat for wildlife. The trees and shrubs slow wind on the downwind side of the windbreak for a distance of 10 times the height of the trees.

CP16 **Shelterbelt**

Definition: Shelterbelts are windbreaks designed to protect farmsteads and livestock from wind and blowing snow. They can also be used to protect wildlife wintering areas. One or more rows of trees/shrubs are planted around the area to be protected, surrounding it partly (often in an L-shape) or completely, like a square-shaped belt.

Purposes:

- Enhance the wildlife habitat on the designated area.
- Save energy.
- Protect farmsteads or livestock areas.

CP17 **Living Snow Fences**

Definition: Living snow fences, a type of windbreak, are trees or shrubs planted strategically along roads to trap snow and keep it from blowing and drifting on roads or driveways.

Purposes:

- Manage snow.
- Provide living screen.
- Enhance the wildlife habitat on the designated area.

CP22 **Riparian Buffer**

Definition: Riparian buffers are strips of grass, trees, or shrubs established adjacent to streams, ditches, wetlands, or other water bodies. Riparian buffers in CRP are forested buffers and as such include tree plantings.

Benefits of riparian buffers include the filtration of nutrients and the interception and trapping of contaminants in surface runoff from both surface water and ground water before reaching a stream. Riparian buffers also provide habitat and corridors for fish and wildlife, help stabilize and restore damaged streambanks, and provide for reduced stream water temperatures.

CP31 **Bottomland Timber Establishment on Wetlands**

Definition: Bottomland timber are plantings of hardwood trees, and for CRP, must be within the 100-year floodplain and generally established in areas regularly inundated with water. Bottomland hardwood plantings minimize scour, sheet, rill, and other soil erosion, and they provide wildlife habitat, sequester carbon, and enhance wetland functions and values. Trees established can also provide timber and/or wood fiber products after contract expiration.

A minimum of three mast (fruit/nut) producing tree or shrub species must represent at least 75 percent of the planting. If needed to enhance the wetland development or wildlife habitat, a maximum of 25 percent of the planting may be pine species or bald cypress. At least one species must produce a hard mast (acorn or nut).

NRCS Programs**:**

CP22 **Alley Cropping** (reported in acres)

Definition: Trees or shrubs are planted in sets of single or multiple rows with agronomic, horticultural crops, or forages produced in the alleys between the sets of woody plants that yield additional products.

Purposes:

- Enhance microclimatic conditions to improve crop or forage quality and quantity.
- Reduce surface water runoff and erosion.
- Improve soil health by increasing use and cycling of nutrients.
- Alter subsurface water quantity or water table depths.
- Enhance wildlife and beneficial insect habitat.
- Increase crop diversity.
- Decrease offsite movement of nutrients or chemicals.
- Increase carbon storage in plant biomass and soils.
- Develop renewable energy systems.
- Improve air quality.

379 **Multi-Story Cropping** (reported in acres)

Definition: Existing or planted stands of trees or shrubs that are managed as an overstory with an understory of woody and/or nonwoody plants that are grown for a variety of products.

Purposes:

- Improve crop diversity by growing mixed but compatible crops with different heights on the same area.

- Improve soil quality by increasing use and cycling of nutrients and maintaining or increasing soil organic matter.
- Increase net carbon storage in plant biomass and soil.

391 **Riparian Forest Buffer** (reported in acres)

Definition: An area predominantly composed of trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

Purposes:
- Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms.
- Create or improve riparian habitat and provide a source of detritus and large woody debris.
- Reduce excess amounts of sediment, organic material, nutrients, and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Reduce pesticide drift entering the water body.
- Restore riparian plant communities.
- Increase carbon storage in plant biomass and soils.

381 **Silvopasture Establishment** (reported in acres)

Definition: An application establishing a combination of trees or shrubs and compatible forages on the same acreage.

Purposes:
- Provide forage for livestock and the production of wood products.
- Increase carbon sequestration.
- Improve water quality.
- Reduce erosion.
- Enhance wildlife habitat.
- Reduce fire hazard.
- Provide shade for livestock.
- Develop renewable energy systems.

380 **Windbreak/Shelterbelt Establishment** (reported in feet)

Definition: Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

Purposes:
- Reduce soil erosion from wind.
- Protect plants from wind-related damage.
- Alter the microenvironment to enhance plant growth.
- Manage snow deposition.
- Provide shelter for structures, animals, and people.
- Enhance wildlife habitat.
- Provide noise screens.
- Provide visual screens.

- Improve air quality by reducing and intercepting airborne particulate matter, chemicals, and odors.
- Delineate property and field boundaries.
- Improve irrigation efficiency.
- Increase carbon storage in biomass and soils.
- Reduce energy use.

650 **Windbreak/Shelterbelt Renovation** (reported in feet)

Definition: Replacing, releasing, and/or removing selected trees and shrubs or rows within an existing windbreak or shelterbelt, adding rows to the windbreak or shelterbelt, or removing selected tree and shrub branches.

Purposes:
- Restoring or enhancing the original planned function of existing windbreaks or shelterbelts.

422 **Hedgerow Planting** (reported in feet)

Definition: Establishing dense vegetation in a linear design to achieve a natural resource conservation purpose.

Purposes:
- Provide habitat, including food, cover, and corridors, for terrestrial wildlife.
- Enhance pollen, nectar, and nesting habitat for pollinators.
- Provide food, cover, and shade for aquatic organisms that live in adjacent streams or watercourses.
- Provide substrate for predaceous and beneficial invertebrates as a component of integrated pest management.
- Intercept airborne particulate matter.
- Reduce chemical drift and odor movement.
- Provide screens and barriers to noise and dust.
- Increase carbon storage in biomass and soils.
- Provide living fences.
- Provide boundary delineation and contour guidelines.

NRCS CSP Enhancements:

Fiscal Year 2011:

ANM05 Extending riparian forest buffers for water quality protection and wildlife habitat.
When existing buffers are used, extend them to gain more efficiency in intercepting overland flow and reducing the transport of nutrients, pesticides, and agro-chemicals.

ANM14 Riparian forest buffer, terrestrial and aquatic wildlife habitat.
When existing buffers are used, extend them to gain more efficiency in intercepting overland flow and reducing the transport of nutrients, pesticides, and agro-chemicals.
The activity consists of managing forested riparian zones to achieve streamside cover and vegetative diversity and structure to improve terrestrial and aquatic wildlife habitat.

ANM20 Silvopasture for wildlife habitat.
Silvopasture integrates trees, livestock, and forage into a single system on one site, resulting in annual forage production for grazing and long-term products from trees. Although silvopastures can provide quality habitat for some species of wildlife, not all silvopastures are designed or managed to benefit wildlife. Manipulation of both the understory and overstory plant composition can enhance wildlife values while still providing livestock and forestry benefits.

PLT05 Multi-story cropping and sustainable management of nontimber forest plants.
This activity involves the manipulation of forest species' composition, structure, and canopy cover to achieve or maintain a desired native plant community to facilitate the sustainable management of native nontimber forest plant(s) (e.g., goldenseal, ramps, mushrooms, ginseng, ferns, "sugarbush," etc.).

PLT06 Renovation of a windbreak, shelterbelt, or hedgerow for wildlife habitat.
This enhancement is for the renovation of existing sites that are declining in vigor, need additional woody plants (trees or shrubs), or otherwise no longer provide wildlife habitat benefits. Existing rows of woody plants may be thinned, removed, or replaced with new plantings. Existing woody plants may be pruned, either branches or roots or both, to improve windbreak function, health, and vigor.

PLT14 Alley cropping establishment of wildlife and beneficial insect habitats.
This enhancement involves the use of trees and/or shrubs planted in multiple rows with agronomic, horticultural crops or forages produced in the alleys between the sets of woody plants that produce additional products and provide wildlife and insect benefits.

BRC01 Cropland Enhancement Bundle #1.
This bundle of enhancement activities includes AIR04-Drift Reducing Nozzles, AIR07-Targeted Spraying, WQL11-Precision Application of Nutrients, WQL13-High Level IPM, plus one of the buffer-widening enhancements ANM04, ANM05, ANM06, or ANM07.

BRC03 Cropland Enhancement Bundle #3.
This bundle of enhancement activities includes SOE01-Continuous No-till, WQL07-Split N Application, WQL10-Cover Crop to Scavenge N, WQL13-High Level IPM, and one of the buffer-widening enhancements ANM04, ANM05, ANM06, or ANM07. If an applicant does not currently have buffers, they can install buffers to meet the requirements of the buffer-widening enhancements to qualify for this bundle.

BFO05 Forest Enhancement Bundle #5.
This bundle of enhancement activities includes ANM14 Riparian Forest Buffer, Terrestrial and Aquatic Wildlife Habitat, ENR05 Locally Grown and Marketed Farm Products, PLT05 Multi-story Cropping, Sustainable Management of Non-Timber Forest Plants, PLT13 Forest Stand Improvement for Wildfire Reduction, and SQL07 Forest Stand Improvement for Soil Quality.

Fiscal Year 2012

ANM05 Extending riparian forest buffers for water quality protection and wildlife habitat.
When existing buffers are used, extend them to gain more efficiency in intercepting overland flow and reducing the transport of nutrients, pesticides, and agro-chemicals, and for wildlife habitat.

ANM33 Riparian buffer, terrestrial, and aquatic wildlife habitat.
This activity consists of managing riparian zones by using select conservation measures (such as relocating equipment operations, trails, or livestock; establishing diverse native vegetation and controlling invasive species; fencing; and extending the width of the riparian zone to enhance wildlife habitat adjacent to riparian zones of steams, ponds, lakes, or wetlands) to achieve stream side cover and vegetative diversity and structure to improve terrestrial and aquatic wildlife habitat.

ENR11 Improving energy feedstock production using alley cropping systems with short rotation woody crops.
This enhancement involves the use of short-rotation woody plants that produce energy feedstock planted in multiple rows with crops or forages produced in the alleyways between the woody rows.

PLT05 Multi-story cropping, sustainable management of nontimber forest plants.
This activity involves the manipulation of forest species composition, structure, and canopy cover to achieve or maintain a desired native plant community to facilitate the sustainable management of native nontimber forest plant(s) (e.g., goldenseal, ramps, mushrooms, ginseng, ferns, "sugarbush," etc.).

PLT06 Renovation of a windbreak, shelterbelt, or hedgerow for wildlife habitat.
This enhancement is for the renovation of existing sites that are declining in vigor, need additional woody plants (trees or shrubs), or otherwise no longer provide wildlife habitat benefits. Existing rows of woody plants may be thinned, removed, or replaced with new plantings. Existing woody plants may be pruned, either branches or roots or both, to improve windbreak function, health, and vigor.

PLT18 Increasing on-farm food production with edible woody buffer landscapes.
This enhancement is for enhancing windbreaks, alley cropping, silvopasture, or riparian forest buffer systems with trees and shrubs that produce edible products for human or wildlife consumption.

BCR06 Improve nutrient and pesticide application techniques and widen buffers.
This bundle of enhancement activities includes AIR04-Use drift reducing nozzles, low pressures, lower boom height, and adjuvants to reduce pesticide drift; AIR07-GPS, targeted spray application (SmartSprayer), or other chemical application electronic control technology; WQL11-Precision application technology to apply nutrients; WQL13-High level IPM to reduce pesticide environmental risk; and one of the buffer widening enhancements ANM05, ANM07, or ANM32.

BFO06 Forest Bundle #6 improves wildlife habitat and soil quality.
This bundle of enhancement activities includes ANM27-Wildlife friendly fencing; ANM33-Riparian buffer, terrestrial, and aquatic wildlife habitat; PLT05-Multi-story cropping, sustainable management of nontimber forest plants; PLT15-Establish pollinator and/or beneficial insect habitat; and PLT17-Creating forest opening to improve hardwood stands.

BPA06 Pasture Grazing Bundle #6 improves wildlife habitat.
This bundle of enhancement activities includes ANM03-Incorporate Native Grasses and/or Legumes into 15 percent or more of herbage dry matter productivity; ANM05-Extending riparian forest buffers for water quality protection and wildlife habitat; WQL01-Biological suppression and other nonchemical techniques to manage brush, weeds, and invasive

species; WQL13-High level IPM to reduce pesticide environmental risk; and WQL18-Nonchemical pest management for livestock.

Appendix G: Figures Referenced in the Text

Figure G1.—Natural Resources Conservation Service regions referenced in the report.
Available online at http://www.nrcs.usda.gov/Internet/FSE_MEDIA/stelprdb1048471.jpg.

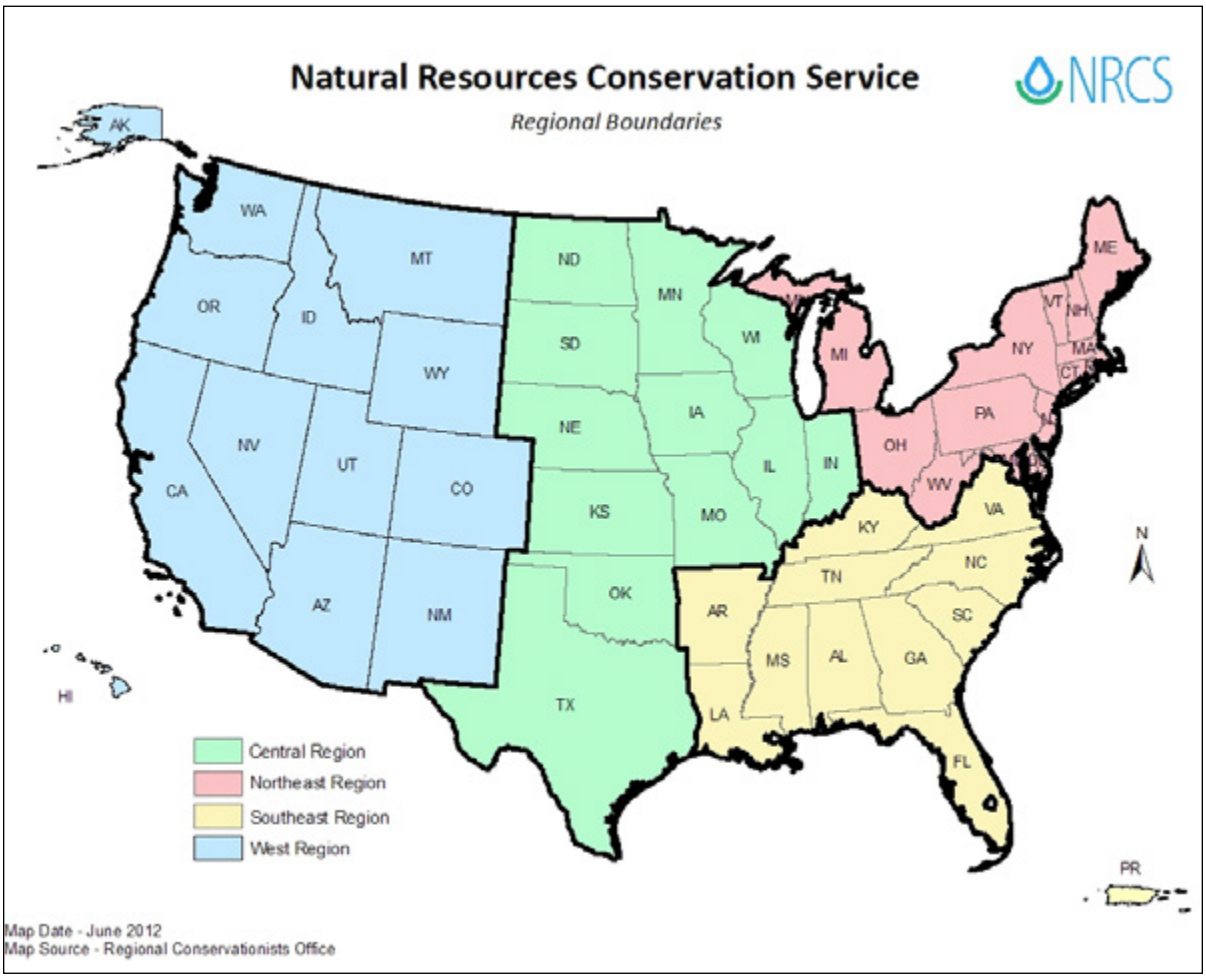


Figure G2.—Agroforestry in the Farm Service Agency's Conservation Reserve Program (CRP) in FY 2012 – as of September 2012.

Region	Water Buffer Removal Sediment	Water Buffer Removal Nitrogen	Water Buffer Removal Phosphorus
Appalachian States	4,189,871	5,162,355	2,064,754
Corn Belt	18,249,493	48,883,147	8,903,606
Delta States	19,216,077	24,630,597	6,907,152
Lake States	2,183,358	6,696,299	1,241,147
Mountain States	685,671	1,457,961	184,190
Northeast	4,313,423	11,434,999	2,656,097
Northern Plains	586,192	1,462,253	178,337
Pacific States	5,088,657	8,873,179	1,326,629
Southeast	3,782,055	6,736,119	2,225,079
Southern Plains	551,478	779,124	164,452
Total	**58,846,274**	**116,116,033**	**25,851,444**

As of September 2012, 29.5 million acres were enrolled in the Conservation Reserve Program (CRP). Landowners participating in the CRP enroll vulnerable cropland and marginal pastureland into conservation covers for 10 or 15 years. CRP covers include native and introduced grasses, hardwood and conifer stand establishment, grass filters, riparian buffers, wildlife habitat enhancement, and wetland restoration practices. In return for participating, the landowners receive technical assistance, annual payments, and cost-share payments covering 50 percent of establishing the conservation practices. As an incentive for landowners to adopt certain practices (including riparian buffers), additional benefits may be provided, including annual payment premiums, a practice incentive payments, or signing incentive payments.

As of October 2012, 877,000 acres of riparian buffers enrolled in the CRP have helped improve water quality by preventing 60 million tons of sediment, 139 million pounds of nitrogen, and 28 million pounds of phosphorus from entering waterways.[41] Of these buffers, 55 percent are located in either the Corn Belt or the Delta States.

Please note that the above figures are slightly different than the October 2012 figures as they are for September 2012.

[41] The reduced sediment, nitrogen, and phosphorus estimates are calculated using the FAPRI model developed to estimate the effect of Conservation Reserve Program. The model and its uses are described in FAPRI–UMC Report #01-07, which is available at http://www.fsa.usda.gov/Internet/FSA_File/606586_hr.pdf.

Appendix H: NRCS Practice Standards in the Field Office Technical Guide

Table H1.— Natural Resources Conservation Service State offices that have adopted agroforestry practice standards as of November 2012.

State	Alley Cropping (311) Acres	Multi-Story Cropping (379) Acres	Riparian Forest Buffer (391) Acres	Silvopasture (381) Acres	Windbreak/ Shelterbelt Establishment (380) Feet	Windbreak/ Shelterbelt Renovation (650) Feet
National Standard Update	**2011**	**2010**	**2010**	**2011**	**2011**	**2010**
Alabama			X	X		
Alaska			X		X	X
Arizona	X	X	X	X	X	X
Arkansas	X		X		X	X
California	X		X	X	X	X
Colorado	X	X	X	X	X	X
Connecticut	X		X	X		
Delaware			X		X	
District of Columbia	X		X		X	
Florida	X		X	X	X	X
Georgia			X	X	X	X
Hawaii	X	X	X	X	X	X
Idaho	X	X	X	X	X	X
Illinois	X		X		X	X
Indiana	X		X		X	X
Iowa			X		X	X
Kansas	X		X	X	X	X
Kentucky			X	X	X	X
Louisiana	X		X	X		
Maine			X		X	
Maryland	X		X		X	
Massachusetts			X		X	X
Michigan	X		X		X	X
Minnesota	X		X		X	X
Mississippi			X	X	X	

State:	Alley Cropping (311) Acres	Multi-Story Cropping (379) Acres	Riparian Forest Buffer (391) Acres	Silvopasture (381) Acres	Windbreak/ Shelterbelt Establishment (380) Feet	Windbreak/ Shelterbelt Renovation (650) Feet
National Standard Update	**2011**	**2010**	**2010**	**2011**	**2011**	**2010**
Missouri	X	X	X	X	X	
Montana	X		X	X	X	X
Nebraska	X		X		X	X
Nevada	X	X	X	X	X	X
New Hampshire			X		X	X
New Jersey	X	X	X		X	X
New Mexico	X		X	X	X	X
New York			X		X	X
North Carolina	X		X	X	X	
North Dakota			X		X	X
Ohio	X		X		X	X
Oklahoma	X	X	X	X	X	X
Oregon	X	X	X	X	X	X
Pennsylvania	X	X	X	X	X	
Rhode Island	X		X		X	X
South Carolina	X		X			
South Dakota			X		X	X
Tennessee	X		X	X		
Texas	X		X	X	X	X
Utah	X		X		X	X
Vermont			X		X	X
Virginia			X	X	X	
Washington	X	X	X	X	X	X
West Virginia	X		X		X	
Wisconsin	X		X		X	
Wyoming	X		X	X	X	X
American Samoa	X	X	X	X	X	X
Federated States of Micronesia	X	X	X	X	X	X
Guam	X	X	X	X	X	X

State:	Alley Cropping (311) Acres	Multi-Story Cropping (379) Acres	Riparian Forest Buffer (391) Acres	Silvopasture (381) Acres	Windbreak/ Shelterbelt Establishment (380) Feet	Windbreak/ Shelterbelt Renovation (650) Feet
National Standard Update	**2011**	**2010**	**2010**	**2011**	**2011**	**2010**
Marshall Islands	X	X	X	X	X	X
Northern Mariana Islands	X	X	X	X	X	X
Palau	X	X	X	X	X	X
Puerto Rico	X	X	X	X	X	X
U.S. Virgin Islands	X	X	X	X	X	X

Appendix I: USDA-Supported Agroforestry Publications, 2011–12

Table I1.—Agroforestry publications resulting from U.S. Department of Agriculture support in 2011–12.

Organized alphabetically by title, the list includes a total of 196 publications in 2011 and 2012 (141 in 2011 and 545 in 2012). To see how many were published by the Agricultural Research Service, Forest Service, and National Institute of Food and Agriculture, see the Performance Crosscut (appendix B).

Title	Authors	Year	Source
+H: the human considerations in the adoption of agroforestry	Brant, G.	2011	Agroforestry Note 43. National Agroforestry Center, Lincoln, NE.
2008 Farm Bill and agroforestry	Wallace, D.; Kellerman, T.	2011	Forest Landowners. November/ December: 20-23.
A comparison of DEM-based indexes for targeting buffer placement to improve water quality	Dosskey, M.G.; Qiu, Z.	2012	In: Proceedings of the 11th International Conference on Precision Agriculture, July 15–18, 2012, Indianapolis, IN.
A comparison of multiple phenology data sources for estimating seasonal transitions in deciduous forest carbon exchange	Garrity, S.R.; Bohrer, G.; Maurer, K.D.; Mueller, K.L.; Vogel, C.S.; Curtis, P.S.	2011	Agricultural & Forest Meteorology. 151: 1741–1752.
A design aid for sizing filter strips using buffer area ratio	Dosskey, M.G.; Helmers, M.J.; Eisenhauer, D.E.	2011	Journal of Soil and Water Conservation. 66(1): 29 –39.
A different discovery: indigenous knowledge for sustainability	Phillips, V.D.	2011	In Carat Juice: GEM Director's Commentary.
A framework for reporting tree cover attributes in agricultural landscapes	Meneguzzo; Liknes	2012	In: McWilliams, W.; Roesch, F.A.; eds. 2012. Monitoring Across Borders: 2010 Joint Meeting of the Forest Inventory and Analysis (FIA) Symposium and the Southern Mensurationists. e-Gen. Tech. Rep. SRS-157. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station: 193–194.
A role for agroforestry in forest restoration in the lower Mississippi alluvial valley	Dosskey, M.G.; Bentrup, G.; Schoeneberger, M.	2012	Journal of Forestry. 109(8): 48–55.
A snapshot of agroforestry in *Terminalia carolinensis* wetlands in Kosrae, Federated States of Micronesia	Conroy, N.K.; Fares, A.; Ewel, K.C.; Miura, T.; Zaleski, H.M.	2011	Micronesia. 41(2): 177–195.
A spatial model approach for assessing windbreak growth and carbon stocks	Hou, Q.; Young, L. J.; Brandle, J.R.; Schoeneberger, M.	2011	Journal of Environmental Quality. 40: 842–852.
Access to natural resources on private property: factors beyond right of entry	Ginger, C.; Emery, M.R.; Baumflek, M.J.; Punam, D.E.	2012	Society and Natural Resources. 25: 700–715.

Title	Authors	Year	Source
Advances in forest hydrology: challenges and opportunities	Amatya, D.M.; Douglas-Mankin, K.R.; Williams, T.M.; Skaggs, R.W.; Nettles, J.E.	2011	American Society of Agricultural and Biological Engineers (ASABE). 54(6): 2049–2056.
Agricultural conservation practices and wetland ecosystem services in the wetland-rich Piedmont coastal plain region	De Steven, D.; Lowrance, R.	2011	Ecological Applications. 21(3) Supplement, S3-S17.
Agroforestry	Sauer, T.J.; Hernandez-Ramirez, G.	2011	In: Hatfield, J.L.; Sauer, T.J.; eds. 2011. Soil Management - Building a Stable Base for Agriculture. Madison, WI: American Society of Agronomy. 351-370.
Agroforestry and GIS: meeting environmental, social, and economic demands	Kellerman, T.; Bentrup, G.; Dosskey, M.	2011	In: Ashton, S. F.; Workman, S.W.; Hubbard, W.G.; Moorhead, D.J.; eds. 2011. Proceedings of the 12th North American Agroforestry Conference, Agroforestry: A Profitable Land Use, June 4-9, 2011, Athens GA.
Agroforestry and grass buffer effects on soil quality parameters for grazed pasture and row-crop systems	Paudel, B.R.; Udwatta, R.P.; Anderson, S.H.	2011	Applied Soil Ecology. 48: 125–132.
Agroforestry application and program use with the 2008 Farm Bill	Wallace, D.; Kellerman, T.	2011	In: Ashton, S. F.; Workman, S.W.; Hubbard, W.G.; Moorhead, D.J.; eds. 2011. Proceedings of the 12th North American Agroforestry Conference, Agroforestry: A Profitable Land Use, June 4-9, 2011, Athens GA.
Assessment of soil organic carbon and total nitrogen under conservation management practices in the Central Claypan Region, Missouri, USA	Veum, K.S.; Goyne, K.W.; Holan, S.H.; Motavalli, P.P.	2011	Geoderma.167: 188–196.
Growing and marketing elderberries in Missouri	Byers, P.; Thomas, A.L.; Cernusca, M.M.; Godsey, L.D.; Gold, M.A.	2012	Agroforestry in Action AF 1017-2012. University of Missouri Center for Agroforestry, Columbia, MO.
Agroforestry landscapes and global change: landscape ecology tools for management and conservation	Pastur, G.M.; Andrieu, E; Iverson, L.R.; Peri, P.L.	2012	Agroforestry Systems. 85: 315–318.
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Title	Authors	Year	Source
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What is a windbreak?	Anon.	2012	Working Trees Info Sheet. National Agroforestry Center, Lincoln, NE.
What is alley cropping?	Anon.	2012	Working Trees Info Sheet. National Agroforestry Center, Lincoln, NE.
What is forest farming?	Anon.	2012	Working Trees Info Sheet. National Agroforestry Center, Lincoln, NE.
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Windbreak Fact Sheet	Kuhns, M.	2012	Utah State Extension.
Windbreaks: A "fresh" tool to mitigate odors from livestock production facilities	Wallace, Douglas C.	2011	Agroforestry Note 41. National Agroforestry Center, Lincoln, NE.
Windbreaks: These aren't your grandfather's shelterbelts	Anon.	2012	Inside Agroforestry Newsletter. 20(1). National Agroforestry Center, Lincoln, NE.
Woody florals for income and conservation	Trozzo, K.E.; Munsell, J.F.; Chamberlain, J.L.	2011	Virginia Cooperative Extension Fact Sheet.
Yield variation of corn-soybean as affected by agroforestry and grass buffer watersheds using GIS	Senaviratne, A.; Udawatta, R.P.; Nelson, K.; Shannon, K.; Anderson, S.	2011	University of Missouri Center for Agroforestry Program Report, 13 January, Columbia, MO: 50–55.

Appendix J: USDA Resources Supporting Agroforestry

ADOPTION

Want to apply agroforestry on your land?

Check out the following resources:

- **To develop a conservation plan** for your land or apply for **technical and financial assistance** to implement agroforestry practices, contact the Natural Resources Conservation Service (NRCS) by visiting their local office* or Web site. In the past, key programs included the Environmental Quality Incentives Program and the Conservation Stewardship Program.
- **Some NRCS programs require forest management plans**. The Forest Service supports States in providing technical assistance to landowners to write those plans, so contact your **State's department of forestry** for assistance.
- **If you wish to install riparian forest buffers and windbreaks on working farmland**, the Farm Service Agency (FSA) provides financial assistance to landowners willing to keep land out of production to implement conservation practices. Explore the Conservation Reserve Program and visit your local FSA office* or Web site.
- Find an **agroforestry demonstration site** near you and plan a visit. See figure 2 and table 2 in Objective 1.1 above.

MARKETING

Are you developing and marketing agroforestry products?

Check out the following resources:

- Are you interested in making jams, jellies, or other value-added products from your agroforest? **USDA Rural Development programs** can support business planning and provide working capital. To find out more, visit your local Rural Development office* and Web site.
- To educate consumers and market agroforestry products, apply to your State's department of agriculture for a **Specialty Crop Block Grant.**
- To scale up your small business, check out **Small Business Innovation Research** grants.

EDUCATION

Want to help others adopt agroforestry?

Check out the following resources:

- **Apply for a research, education, or extension grant from the U.S. Department of Agriculture.** Grants are available from NIFA [National Institute of Food and Agriculture]. These include the Beginning Farmer and Rancher Development Program, and the SARE [Sustainable Agriculture Research and Education] program, among others.
- **Have an idea about how an innovative practice such as agroforestry can help producers in your region conserve natural resources?** Apply for a **Conservation Innovation Grant** at either the national or State level. For more information, visit your local NRCS office* or Web site.

- If you are in your State's **Cooperative Extension System** and interested in hosting agroforestry workshops or training sessions, read Objective 1.2 to learn how capacity funds are being used to teach about agroforestry.
- **Create an eXtension community of practice** around alley cropping or silvopasture to share information and learn from others!
- **Join the Forest Farming eXtension community of practice** that already exists.

RESEARCH

Want to research agroforestry systems?

- USDA provides grants for research, education, and extension through the National Institute of Food and Agriculture. These include:
  - **Agriculture and Food Research Initiative**
  - **Specialty Crop Research Initiative**
  - **Sustainable Agriculture Research and Education**
- The Agricultural Marketing Service also provides State departments of agriculture with **Specialty Crop Block Grants**, so contact your State's agricultural department to learn how you can apply, and use this funding for research and marketing activities.

Looking for collaborators?

- USDA scientists are interested in agroforestry topics. To learn more about who is doing what, read Objective 2.2 above.
- To find scientists' contact information, visit their institutions' Web sites below:
  - Agricultural Research Service: http://www.ars.usda.gov
  - Forest Service: http://www.fs.fed.us/research
  - Economic Research Service: http://www.ers.usda.gov
  - Scientists at many land-grant universities are also working on agroforestry issues
  - Find all land-grant universities at http://www.nifa.usda.gov/qlinks/partners/state_partners.html#maps

TOOLS

Want to get started now?

See Objective 2.3 for more tools available. The following represent a sampling:

- **Agroforestry Overview**: Overview includes emerging opportunities, bioenergy, carbon credits, business recommendations, and more.
- **Conservation Buffer Guide**: A synthesis of findings from 1,400 publications on how to design your buffer.
- **Profitable Farms and Woodlands**: A practical guide to assist underserved farmers and woodland owners.
- **Agroforestry Technical Notes**: Information in a useful "how to" format on topics from erosion control to exotic mushrooms to wild turkey silvopasture.
- **Nontimber Forest Product Factsheets**: Information for small woodland owners.
- **Elderberry Financial Decision Support Tool**: A tool to assist with elderberry production and business decisions.

- **Pacific Island Agroforestry Information**: Information on agroforestry in the Pacific Islands.
- **Silvopasture Online Course**: Course teaches site preparation and canopy, cattle, and forage management. The user receives 3.0 continuing forestry education credit hours from the Society of American Foresters.

* To find your local Farm Service Agency, Rural Development, or Natural Resources Conservation Service office, visit http://offices.sc.egov.usda.gov

* To find a Cooperative Extension office near you, visit http://www.nifa.usda.gov/Extension/

Appendix K: USDA Agroforestry Points of Contact

Please contact agroforestry@usda.gov with any comments on this report or suggestions for USDA agroforestry.

Interagency Agroforestry Team:

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Program Aid 2143-B

November 2013