Sustaining the Pacific Northwest

Food, Farm, & Natural Resource Systems

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In This Issue

COOPERATIVE EXTENSION
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Tracking and Managing the Cherry Bark Tortrix

Beverly Gerdeman & Lynell Tanigoshi, WSU Vancouver Research & Extension Unit

Containing or slowing the spread of cherry bark tortrix (CBT) through biological control and other pest management methods is important to the greenhouse and nursery industries that rank number one within Oregon ($600 million per year) and seventh within Washington ($288 million per year, 2000). CBT was first found infesting ornamental cherries in British Columbia in 1989. By 1991 it had been detected in Washington. Washington State entomologist, Eric LaGasa, reported in his 1998 pheromone trap survey, that CBT had expanded its range to a site near Chehalis in western Washington. In July of 2000, the Oregon Department of Agriculture reported trapping two CBT males in Clackamas and Multnomah counties. By 2002, the number of adult moths trapped in Oregon exploded to 1020. As CBT becomes widely established in the Pacific Northwest, management costs will rise. It now poses an immediate threat to horticulture in the western states, and a potential threat to other regions of the United States that grow *Prunus* and *Malus* as nursery and fruit plants. Consequently, quarantines on rosaceous nursery products from Oregon, Washington and British Columbia could be enacted.


Adult Moth

Continued on next page

Sustaining the Pacific Northwest
Food, Farm, & Natural Resource Systems

This quarterly newsletter provides a discussion forum for people working towards community-based sustainable food, farm, and natural resource systems using interdisciplinary oriented research and practitioner knowledge.

This is a joint newsletter of the WSU *Center for Sustaining Agriculture & Natural Resources*, the *WSU Small Farms Team*, the *WSU Small Farms Program* and the *Water Quality Management Team.*

Scope of Industry and Urban Threat

CBT immediately threatens urban landscapes west of the Cascade Mountains. Vancouver, British Columbia, has already experienced loss of historically important trees that will forever change the landscape. Once CBT becomes established, communities face increased costs to manage and reduce CBT damage, to remove infested trees, and to replant with non-host plants.

CBT produces one generation annually and the adult flight period extends from May to September. While classified in the large family of leafrollers (insects that feed on a wide array of perennial plants after rolling or tying their leaves). CBT's immature larval stages are bark borers, feeding and spinning cocoons within bark and sapwood.

Experience has shown if left unchecked, CBT can cause serious damage in orchards and nurseries, as well as home gardens and public parks. All rosaceous, woody shrubs or trees are susceptible to attack by CBT. This host range includes *Crataegus, Cydonia, Malus, Photinia, Prunus, Pyracantha, Pyrus, and Sorbus* species. Members of these groups represent high cash value plants produced in nurseries and greenhouses for use in public, private, and natural landscapes, as well as orchards in the Pacific Northwest. Sour and sweet commercial cherries and ornamental flowering cherries have been hardest hit. High infestations of CBT girdle and eventually kill cherry trees. These infestations also predispose trees to attack, and often death, from other causes such as bacterial canker, bark beetles, and frost.

The Challenge to Home Gardeners and Industry

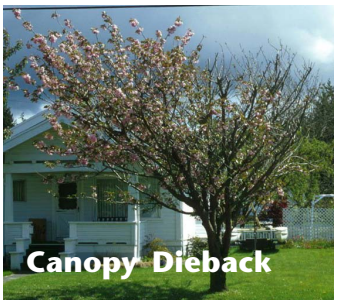
Landscapers, gardeners and homeowners need to recognize infestation symptoms in order to correctly identify CBT injury. After hatching from singly laid eggs, the first stage larva feeds on the bark and outer sapwood, while the second through fifth larval stages make tunnels between the bark and cambium without penetrating the hardwood. CBT selects trees that offer more chances for larvae to gain entrance to the inner bark such as trees with pronounced lenticels on the bark, mechanical injuries, pruning cuts, limb crotches and graft unions. Infestations are easily recognized by reddish-orange colored frass accumulations, or frass tubes, near gallery entrances.

CBT Frass Tube & Pupal Case

The European literature indicates that CBT's habit of boring under the bark makes chemical control of CBT larvae impractical. However, newer chemistries intended to control CBT in the destructive larval stage shows some promise. During the meticulous process of removing their frass and building and maintaining their externally protruding, silken frass tubes, CBT larvae become vulnerable to site specific, spot treatments of insecticides such as the pyrethroids. Since all of the life stages of larvae co-exist in the fall, this is the best time to treat these actively provisioning larvae with one ecologically and carefully targeted treatment of the frass tubes.

A Promising Control Strategy

In 1998, several 'Mt. Fuji' flowering cherries in Bellingham were found with CBT eggs parasitized by a native, solitary egg parasitoid, *Trichogramma cacoeciae*, a tiny parasitic wasp. Difficult to see with the naked eye, this fas-



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Guest Editor

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cinating natural enemy uses her needle-like ovipositor to insert an egg into the CBT egg. The immature wasp develops as it feeds on the CBT egg. An adult wasp emerges from the egg instead of the pest. These wasps are weak flyers but efficient egg searchers within their individual tree domain. In one instance, we found nearly a 100% parasitism rate of CBT eggs by *T. cacoeciae*.

Partnering with the Plant Protection & Quarantine division of the USDA's Animal and Plant Health Inspection ervice (APHIS) in Niles, MI, will enable Washington State University (WSU) entomologists to utilize APHIS staff and expertise in rearing millions of our native *T. cacoeciae*. This would provide large numbers of the parasitoid for widespread redistribution in "hotspots" and eventual self-propagation for natural dispersal and biological control. Periodic mass releases of the parasitoid were made in 2001 and 2002 at key park sites managed by the Seattle Department of Parks & Recreation, including Washington Park Arboretum and Seattle Center. In 2002, a new program of release was implemented in the City of Portland.


Gathering CBT Flight Data

Explorations to find natural parasitoids and predatory insects for CBT control continue on state, national, and international levels. Although areas of Eastern Europe experienced outbreaks of CBT in the past, CBT rarely reaches pest status in these areas now, suggesting natural enemies effectively control them. WSU entomologist, Dr. Lynell Tanigoshi, and central European entomologists are searching for these natural enemies as potential biological control candidates for release in the US. Candidate natural enemies are shipped to the WSU Biocontrol and Quarantine facility in Pullman, Washington, and screened for disease and parasites of their own. It will take at least four or five years of careful host preference testing before suitable candidates are approved for release by federal and state agricultural and wildlife authorities. The establishment of natural enemies is the most rational and economical approach to reducing CBT below damaging or aesthetic levels. No other means of control could address the multitude of wild cherry trees that could potentially act as reservoirs for CBT.

In 1996, WSU's Department of Entomology, in partnership with both Oregon and Washington State Departments of Agriculture, embarked on a multidisciplinary program to manage CBT-infested tree populations. This necessitated not only a thorough knowledge of CBT biology, but also of host preference evaluation, cultural and chemical control, and natural and classical biological controls. The commercial need to slow, if not prevent, CBT's further spread into Oregon drives this interagency cooperation.

The Portland Effort

The Oregon Department of Agriculture successfully detected early infestation of CBT in Oregon. Initially, 1163 traps were placed statewide, revealing strong populations within an area of 104 square miles of East Portland. A clear epicenter emerged as the 2002 trapping season developed. WSU further defined the area of infestation by identifying individual trees harboring breeding populations of CBT, alowing for the most effective release of the parasitoid. In 2002, 2.4 million *T. cacoeciae* were released in the Portland epicenter area. Data is still being evaluated to determine the overwintering success of the parasitoid for the 2003 season. This will be followed by close monitoring of the adult CBT flight and weekly releases of *T. cacoeciae*. These massive releases of a natural enemy will provide the best hope of slowing the southward expansion of CBT.

Management Advice and Recommendations:

1. Inspect the trunk and main branches of cherry, apple and pear trees (fruit and ornamental trees) for frass tubes between April and September when the larvae are actively tunneling under the bark.
2. Protect severely infested trees with a carefully targeted bark treatment of a pyrethroid insecticide to frass tube locations in October.
3. Avoid pruning during the active adult flight period between May and August.
4. When removing CBT infested trees, strip the bark from the wood. Chip and/or burn it immediately.
5. For additional information, see: WSU Cooperative Extension Bulletin 1893 and the Pacific Northwest Insect Management Handbook.

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Farm Entrepreneurship Course Helps Established Farmers Take on New Role

Richard Hines
WSU Small Farms Program

Farmers and chefs share much in common: they both work with their hands and they both play a role in putting food on the table. But they also tend to share another common trait: the frenzied schedule. Chefs' lack of availability was a major obstacle faced by one farm couple as they looked to diversify their farm business by creating an on-farm cooking school.

Farmer Lora Lea Misterly and husband Rick operate **Quillisascut Farm**, a producer of specialty cheese in rural Stevens County, Washington. The Misterlys' goats and cows have them milking twice a day, seven days a week. And though they've been selling their cheese for 16 years, they are not getting rich. That means the couple also raises a garden, in part to help keep expenses down.

It's a level of activity that chefs can appreciate, Misterly says. Up-before-dawn mornings, regular feedings, the feeling of being tied to the business all the time. It's no wonder, she says, it was so difficult to get chefs to their

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farm for a week of learning about how food is raised. When chefs get a week off each year, Misterly says, "They want to go to Hawaii. They don't want to come here and work."

The idea for a farm culinary school was first planted in 1990, when a group of food professionals from two urban restaurants came to Quillisascut, which traces its name to an American Indian word meaning "place of the scattered

Rick feeding the kids on the lamb-bar bucket.

bushes." The visitors spent several days following the couple around, doing some farm work, and literally bringing food from field to table. "We ate a whole lamb and twelve ducks," Misterly says. "We went through the food."

In the first "farm school," participants gained a new perspective on the relationship between growing, cooking and eating. The Misterlys, too, had a lot of fun. Although Lora Lea believed such an experience was valuable for culinary professionals, she also knew they couldn't provide the service for free. It was too much work for that. She also wanted to expand the curriculum, perhaps make it a little more formal, and add more speakers—other farmers from around the community who have expertise in fruits and vegetables.

But there was this problem. They could build a farm school, but would the chefs come?

For years, it looked like the answer was no. There were professional chefs who had heard of the first farm school and expressed interest in spending a week in northeast Washington at Quillisascut. But by now, that's become something of a joke. Year after year, the chefs said they would come, but at the last minute ended up being too busy to get away. Some of these chefs still say they're planning to come, and it's been more than ten years, Misterly says with a laugh.

Not sure where to go next with the idea, Lora Lea took a class on farm entrepreneurship offered through Washington State University Extension in Stevens County. Based on the award-winning curriculum, "Tilling the Soil of Opportunity," the course gave Misterly a chance to take stock of her resources, to brainstorm about new directions for the farm, and to get her ideas down on paper.

She and Rick had been making and selling handcrafted cheese from their farm since 1987, so Misterly knew the value of directly engaging with the public. Working with instructor Al Kowitz, WSU Extension chair for Stevens County, she began fleshing out a business plan for the culinary school idea, but with a new twist.

Professional chefs are tied down, she reasoned, but what if the Misterlys could catch them before they went pro—when they were still students in culinary school? Maybe chefs-in-training would have time to get away for a week before all of their obligations set in. Based on this hunch, she sent letters to culinary schools around the Northwest, then she hit the road to pitch her idea directly in Portland and Seattle.

It has taken some effort, but Misterly was right on. Last year, a dozen students came for the first weeklong sessions, living out of tents in the yard. Comparatively speaking, participants this summer will spend their time in style. Rick is now hard at work on a new building to house Quillisascut's "Farm School of the Domestic Arts." The facility includes a commercial kitchen and central eating area on the main floor and four bedrooms and two bathrooms upstairs. Future plans include a bakery, butchery and walk-in cooler.

The farm school has already reached its limit of 48 registered students in four sessions this summer. Participants will learn how to milk goats, make fresh batches of cheese, and find the ripest peaches in the orchard. They'll learn to recognize and draw out the nuances of timing and terrain when harvesting and preparing vegetables. They'll taste the difference inherent in grass-fed meats, and bake a pizza in the new wood-fired brick oven. And they'll work firsthand with a variety of instructors who have spent decades honing their crafts of cooking and farming.

Participants are not only introduced to how food grows, but also "many of the difficulties and issues that affect the quality and sustainability of farm products," Misterly says. The cost per student is $600, which covers meals and lodging for the week. The tuition also pays the salary for a professional chef who works with the students, and helps support neighboring farmers. "We pay the farms we visit," she says. " I think that's important. They're taking time away from their harvest and their farms."

Students who participated in the 2002 farm school report that it was a life-changing experience.

"I thought I had strong convictions before going to the farm about the importance of buying locally and seasonally," says Joanna Moogk, a student at the Seattle Culinary Academy, a program of Seattle Central Commu-

nity College. "I didn't even know the half of it. Now I need to understand my ingredients, where they come from, what they taste like at their peak, how they are grown, and the controversies and politics that determine their availability and quality."

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Another Seattle Culinary student, Jenny Bright, says: "I learned a lot using the herb garden, trying new herbs, experimenting with familiar ones. Cooking from the garden raised the bar in my mind of what good food should taste like. Words like 'fresh,' 'local,' and 'organic' have new and much more personal meaning for me. This was an experience that I will carry with me throughout my career."

The value of the program is echoed by WSU's Kowitz. "You talk about a success story," he says. "Last year's students went back to their schools committed to local products. There is nothing like this farm culinary program in the U.S."

Misterly says she is grateful to WSU Extension for the support she has gotten over the years. Through WSU programs, she has learned web page design, direct marketing and even grant writing, a field she has become familiar with now that she's raising money to operate the farm school. She recommends the farm entrepreneurship course for beginning farmers and anyone who wants to take their farm in a new direction.

"It's really great for getting people to think through every step of having a business," she says. "It helped to see that it's more than just 'I like to farm.' Marketing is the key. Who are you going to market to? How?"

Adding a new line to their farm business has had challenges beyond scheduling problems. But, says Misterly, "we never really viewed the things we did as mistakes. It was an opportunity to learn what didn't work."

And now, working with culinary students gives Misterly a chance to see her own farm through new eyes, and that's one of the benefits that keeps her going.

"It's not the Waltons. We are contemporary," she said. "But we get to hear the birds sing everyday, and the crickets at night, to have a relationship with nature on a day-to-day basis, the nature that feeds us. One of the students last year said, 'This is so real.' That's the part I like."

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Lora Lee milking Crumpet

Federal Farmland Preservation Program Links Land Protection to Farm Succession

Ferd Hoefner, Sustainable Agriculture Coalition & Kathy Ruhf, Director, New England Small Farm Institute

New farmers and their advocates may celebrate new language in the just-released Final Rule for the federal Farm and Ranch Lands Protection Program (FRPP). For the first time, this federal farmland preservation program links land protection to farm succession and next-generation farmers.

Thanks to the hard work of farm succession, beginning farmer and sustainable agriculture advocates, USDA received comments on the proposed rule that urged them to take steps to help ensure that the farms saved from development remain working farms with adequate farm succession planning and a commitment to beginning farmers. Comments suggested definitions and ranking criteria to address this issue. Here are the results, as they appear in the Final Rule:

> A definition was added for "farm or ranch succession plan". "Farm or Ranch Succession Plan is a general plan to address the continuation of some type of agricultural business on the conserved land; the farm or ranch succession plan may include specific intra-family succession agreement or strategies to address business asset transfer planning to create opportunities for beginning farmers and ranchers."
>
> National and state ranking criterion was added: "…history of an eligible entity's commitment to assisting beginning farmers and ranchers, to promoting opportunities in farming and ranching, and to farm and ranch succession and transfer."
>
> Funding priority language was added: "NRCS may place a higher priority on farms or ranches that have a farm succession plan or similar plan established to encourage farm viability for future generations."

The new ranking criteria and funding priority language is all discretionary, as is the case with nearly all the other ranking criteria and funding priority language in the Rule. These provisions are advisory to NRCS State Conservationists and the State Technical Committees as they implement the program within their state boundaries. It is critical, therefore, that beginning farmers follow-up in each state with NRCS State Technical Committees to ensure this language actually gets used.

It is an important step to have this issue addressed for the first time in the farmland protection arena. Also, since NRCS regulations are equivalent to statutory language, this is the first time that "farm succession plans" are defined in federal law. The Final Rule for the FRPP was published in the Federal Register on Friday, May 16th .

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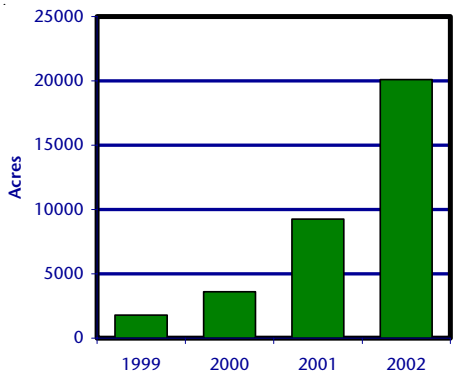
Green Manuring Mustard: Improving an Old Technology

Andy McGuire, Lauzier Agricultural Systems Educator, WSU Extension

Green manuring is the tilling of fresh plant material into the soil to improve the soil and thus the growth of the following crop. It is an old technology, used by farmers since at least the 5th century BC. Immigrants brought the practice to the USA from northern Europe and its use reached a peak in the early 1900s. Since then, most farmers have replaced green manures with synthetic inorganic fertilizers.

Recently, however, innovative farmers are giving this old technology a new look with mustard green manures (Figure 1). In contrast to the low input, low management green manures of the past, mustard green manures require fertilizer, irrigation, and intensive management. They require a current understanding of soil ecology, soil-borne pests, plant biochemistry, and breeding and screening techniques. And unlike synthetic fertilizers, they can improve the soil's physical, chemical, *and* biological qualities.

Figure 1: Mustard Green Manure Acres in WA
(Estimate Based on Seed Sales)



These multiple benefits are attracting an increasing number of farmers in the Columbia Basin of Washington. They are using mustard green manures, mainly before potatoes, to improve their soils and thereby manage soil-borne pests, control wind erosion, increase infiltration, improve crop yields, and they hope, increase profits.

On-Farm Research

Since 1999, WSU has conducted on-farm research in the upper Columbia Basin with several potato farmers using mustard green manures. These trials measure improvements in soil quality and evaluated the ability of the mustard green manures to replace the fumigant metam sodium for control of the pathogen *Verticillium dahliae*, one of the contributors to the Potato Early Dying disease.

The first trials were conducted with Dale Gies, a Moses Lake potato farmer who developed a two year, wheat/mustard-potato rotation. Like the majority of farmers using mustard green manures, Gies plants the mustard after wheat harvest, and then chops and incorporates it in late October. See details of mustard green manure management on our web site.

Increased Infiltration. Infiltration was measured on adjacent fields having similar soil textures. One field was managed under the Gies cropping system and another without green manures in a rotation more typical of the Columbia Basin.

Infiltration rates (Table 1) were generally much greater under the Gies cropping system, except after a potato harvest on the Gies field and a sugarbeet harvest on the adjacent field (2000). Infiltration rates on both fields were measured on soils that had been fluffed up during harvest. In this condition, the infiltration rate for the first inch of applied water was lower in the Gies field than in the adjacent field. However, the situation was reversed when a second inch of water was applied. This indicates that

September Mustard Growing Through Wheat Stubble

the aggregates in the field not receiving green manures were not stable in water. After the first inch of water was applied, these aggregates broke down and sealed the soil. Infiltration in the Gies soil was stable, even when a third inch of water was applied. Later measurements (data not shown) confirmed the difference in aggregate stability of the soils.

Reduced Wind Erosion. Increased soil aggregation due to green manures also reduces wind erosion. Farmers in the Columbia Basin observed this in fields receiving green manures and research to confirm their observations has begun.

Improved Management of Soil-Borne Pests. Much of the renewed interest in green manures centers on their potential to help control soil-borne pests, such as fungal pathogens and nematodes. Often these pests cannot be controlled

Table 1: Average Infiltration Rates (in/min)
(Consecutive 1" applications of ponded water)

Date	Point in rotation	Infiltration (in/min) 1st inch	2nd inch	3rd inch
3-Sep-99	After wheat harvest w/ mustard	1.39a*	0.48a	n.m.
	After wheat harvest w/o mustard	0.13b	0.18b	n.m.
2-Nov-00	After potato harvest w/ mustard	0.20a	0.19a	0.16
	After sugarbeet harvest w/o mustard	0.39a	0.05b	n.m.
7-Mar-01	Potatoes/winter w/ mustard	0.57a	0.10a	n.m.
	Sugarbeets/winter w/o mustard	0.06b	0.05b	n.m.
5-Mar-02	Potatoes/winter w/ mustard	0.14a	0.09a	0.08
	Fallow/winter w/o mustard	0.10a	0.05b	n.m.

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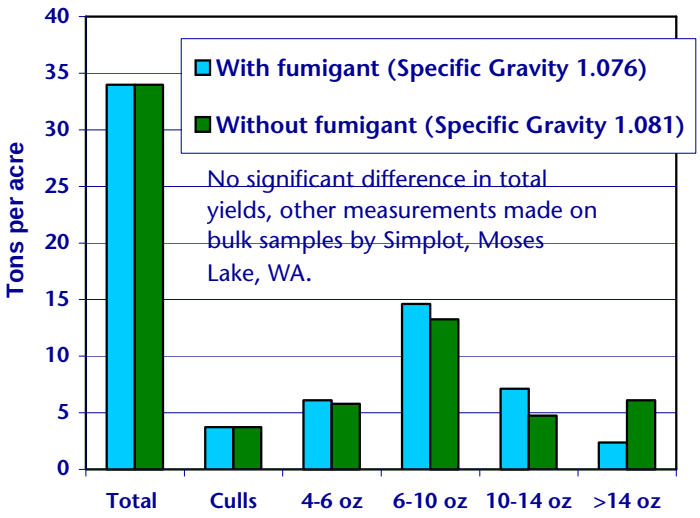
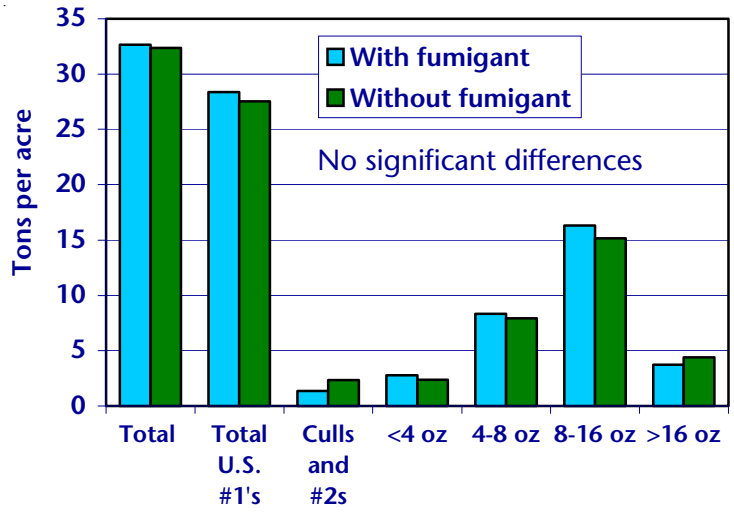
Figure 2: 2002 Russet Burbank Yields
(following 2001 mustard green manure)



well with pesticides. When they can be controlled this way, as with soil fumigants, it is expensive to do so. Columbia Basin potato production relies on the fumigant metam sodium to control *Verticillium dahliae*, a major cause of the Potato Early Dying complex. Without such control, yield losses up to 30% can be expected. Mustard green manures offer farmers an alternative management tool for some of these pests.

Three fumigant replacement trials were conducted in 1999 and 2000 to see whether such losses would occur in the Gies wheat/mustard-potato rotation on loamy sand and sandy loam soils. Mustard green manures were incorporated into the soil in the fall and potatoes (cv. Russet Norkotah), with and without metam sodium, were planted the following spring. The results (Figures 2, 3) show that the fumigant did not increase potato yields over those produced without fumigant. Gies could have saved the money spent on the fumigant and harvested the same amount of potatoes.

Figure 3: Norkotah Yields Following Mustard Green Manures (three trial average , 2000-2001)



Although the replacement of fumigant with mustard works for Gies, his system is quite different from that of other potato farmers in Washington. While Gies grows a short-season potato (Norkotah) for the fresh market, 90% of Washington's potato farmers grow longer-season potatoes for processing. Processors require farmers to grow crops other than potatoes for at least three years before growing potatoes, so the short two-year rotation that Gies uses is not feasible for them.

Therefore, research began in 2001 to investigate whether the same results could be obtained with longer-season potatoes in longer rotations. Additionally, since processors require high specific gravities to improve their product quality, data also accounted for specific gravity (shown in Figure 2), a measurement of the amount of solids in a potato.

The initial results (Figure 3) indicate that it is possible to replace metam sodium with mustard green manures in long-season potatoes. While this first trial gave positive results, other fields (unreplicated plots) on the same farm showed lower yields where the fumigant was omitted. We are now trying to determine whether these conflicting results are due to differences in initial disease pressure, soil properties, management of the mustard, or another factor.

Pest Control Mechanisms

The effects of mustard green manures are the result of multiple mechanisms. Because it is difficult to observe these mechanisms in the soil, researchers focused on identifying, to the extent possible, the primary mechanisms and the green manure attributes that enhance these mechanisms. Once identified, mustard can then be managed to produce those attributes.

Researchers have thus focused on three groups of mechanisms that stem from different aspects of the mustard green manure:

Crop rotation effects from growing the crop,

Green manure effects from tilling fresh plant material into the soil,

Biofumigation effects from the chemicals in the green manure.

Crop Rotation Effects. Before advances in soil science and microbiology, many effects of green manures were assumed to be the result of simple crop rotation. Rotating diverse crops can reduce pest problems by changing the environmental conditions in the field, such as disrupting pest life cycles. In general, rotating crops with different planting dates (spring vs. fall), different growing habits (annual vs. perennial, tall vs. short, fibrous vs. tap roots), or different susceptibility to pests (grasses vs. broadleaves), helps prevent any one pest from becoming a problem.

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The Columbia root-knot nematode, a serious pest in potatoes, can be reduced by rotating non-host crops. Mustards, depending on the study, have been classified as non-hosts, poor hosts, or moderate hosts of this nematode. Although mustard green manure probably does not grow long enough to reduce nematode number by this mechanism, a poor/non-host status would keep the nematode populations from increasing. These nematodes, however, can increase on weeds in the mustard. Therefore, some farmers choose to control volunteer wheat and other weeds in their mustard crop with selective herbicides.

Columbia Basin farmers also worry that mustard could cross-pollinate with existing Brassica seed crops. The August planting date of most mustard green manures limits this risk, but farmers growing mustard still have the responsibility to prevent cross-pollination by either incorporating or otherwise killing plants which survive in fields or field borders.

Green Manure Effects. Incorporating fresh, green plant material into soil changes the soil's biology through a transfer of energy. Energy from the sun, stored in plants, becomes available to soil microorganisms through green manuring. As these fungi and bacteria digest the plants, certain species, usually beneficial, increase in number because they are best suited to use this energy. The increased numbers of these beneficial species can then suppress pathogens through a number of mechanisms, such as the interference of chemical signaling between the plant and pathogen, predation, parasitism, and competitive exclusion. Competitive exclusion occurs when the increased number of beneficial microorganisms out-compete pathogens for location in the area around plant roots.

One of the most beneficial green manure effects can be the building of suppressive soils. "Suppressive soils" are soils that would be expected to have a disease problem, but do not because certain microorganisms suppress the disease-causing agents, whether fungi, bacteria, or nematodes (Cook and Baker, 1983). Suppressive soils can result from growing the same crop continuously for many years, where after an initial increase in disease pressure, diseases decrease and remain at low levels. Green manures may be a more practical way to build suppressive soils. Different green manure crops have been evaluated for their ability to produce soils suppressive to *Verticillium*, common scab, and other soilborne diseases (L.L. Kinkel, data not yet published). Canola, sudangrass, and buckwheat were found to be better green manures than other crops in creating suppressive soils (mustard was not tested).

Although the effects of green manures usually favor beneficial microorganisms, there can be short-term increases in disease-causing *Pythium*, *Fusarium* and other fungi immediately after incorporation. This increase does not usually last long, but farmers should wait from two to four weeks after incorporating a green manure before planting a crop.

Biofumigation Effects (Allelopathy). Biofumigation is the name coined by Kirkegaard and Sarwar (1998) to describe the effects of the chemicals produced by a *Brassica* green manure crop. It is one type of allelopathy, the chemical inhibition of one species by another. Plants in the Brassica family, such as rapeseed, broccoli, cabbage, and mustard, produce compounds called glucosinolates in their roots and shoots. They also produce the enzyme myrosinase, which is normally separated from the glucosinolates. When plant cells are damaged by an insect or by a farmer chopping a green manure crop, the glucosinolates and the myrosinase react and produce a mixture of other compounds, such as isothiocyanates. Some of these resulting compounds are toxic to soil fungi, nematodes, and weed seeds. These same chemicals make your nose burn when you eat hot Chinese mustard.

One class of these compounds, called isothiocyanates, are very similar to synthetic fumigants, hence the name biofumigation. The active compound in the fumigant metam sodium is methyl-isothiocyanate. However, biofumigation is not as simple as using metam sodium. There are over 100 different glucosinolates, which produce different degradation products that have different effects on specific soil-borne pests. Different species produce different glucosinolates. Within a species, roots may produce different glucosinolates than shoots. Finally, glucosinolate concentrations vary according to plant part, age, health, and nutrition. Despite this complexity, the potential exists to reduce pest popula-

Table 2: Management Strategies

Desired Attributes	Mechanisms	Management Decisions	Document
High biomass production	Green manure effects	Species/variety selection	1
	Biofumigation	Planting date/method	2
	Improved soil quality	Seeding rate	4
		Production inputs	3
Incorporation of fresh biomass	Green manure effects Biofumigation	Incorporation timing/methods	2 5
High conversion of glucosinolates at incorporation	Biofumigation	Incorporation timing/methods	2, 5
Poor or non-host status to Columbia root-knot	Crop rotation	Species/variety selection	2, 5
High glucosinolate concentration	Biofumigation	Species/variety selection Production inputs	5
Glucosinolates effective against targeted pests	Biofumigation	Species/variety selection	1, 2

1. Green manure variety trial results
2. Mustard fact sheet
3. Planting date trial results
4. Mustard nitrogen response trials
5. Using green manures in potato cropping systems

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tions in the soil through this mechanism (Brown and Morra, 1997).

Mustard Management Strategies

Farmers can manage mustard to enhance its effectiveness in improving soil quality and controlling pests if they have the information they need to make good decisions. Table 2 shows these desired attributes, the mechanisms that they affect, the related management decisions, and the information available to help farmers make these decisions.

Cost

The per acre cost of mustard green manure, as grown on the Gies farm, is shown in Table 3. Because a green manure is used to improve the crop that follows, its cost should be viewed as part of the production costs for that crop. Increases in crop yield and quality and potential decreases in nitrogen or pesticide needs will all be factors in determining the worth of a green manure. In addition, the value of improved soil quality, in both the short and long-term, though difficult to estimate, should be considered. The calculation is more straightforward where the mustard green manure replaces a fumigant. Where this is possible, substantial savings can be realized (Table 3).

Table 3: Estimated Mustard Green Manure Crop
(per acre, 2002)

Item	Unit	Cost/unit	Qty.	Mustard	Normal[1]
Seed	lb	$2.35	10	$23.50	$0.00
Planting	acre	$6.10	1	$6.10	$0.00
Fertilizer	lb	$0.38	100	$38.00	$0.00
Herbicide	acre	$15.00	1	$15.00	$0.00
Irrigation power	acre-in	$1.78	9	$16.02	$5.34
Chopping	acre	$6.00	1	$6.00	$6.00
Disking/packing	acre	$5.00	2	$10.00	$10.00
				$114.62	**$21.34**
metam sodium				$0.00	$140.00
				$114.62	**$161.34**
Mustard vs normal (savings/ac)				$46.72	
Mustard vs normal, minus fertilizer (savings/ac)				$76.62	

[1] Costs normally incurred following wheat harvest

Green Manures in Cropping Systems

Green manuring mustard is not an isolated practice. It must be integrated into a cropping system to produce the maximum benefits. Systems that reduce tillage, avoid compaction, rotate crops, and control erosion will help maintain soil quality gains that come through green manure use. And good management of water and soil fertility will ensure that gains in soil-borne pest control will not be lost to waterlogged soils or over-fertilization.

The Future of Green Manuring

The demand for food, and thus the need for quality soils, will only increase. Although improved synthetic fertilizers and pesticides will continue to be important, by themselves they do not build soil quality. Green manuring and other practices that increase or conserve soil organic matter will continue to be used to maintain and build our soils. What will change is the attention given to green manure.

If researchers continue to improve this old technology by applying our growing knowledge of soil ecology, plant pathology, plant breeding, biochemistry, horticulture, and agronomy, exciting possibilities include:

- Crops bred for green manure use.
- Rotation of green manure crops.
- Prescription green manure blends.
- Genetically modified green manure crops.

In 1927, Pieters wrote, "Much is known of what goes on in the soil when organic matter is added, but much still remains to be learned." (Pieters, 1927) While we have added much to our cumulative knowledge since then, the same could be said today. The soil still has secrets and there are still processes within plants that we do not understand. If we continue to increase our knowledge of both the soil and plants, using green manure could again become a common practice.

Note: A more detailed article can be viewed in the June 2003 edition of Agrichemical and Environmental News, Issue No. 206 http://aenews.wsu.edu. *Andy can be reached at 509-754-2011.*

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Vanquishing the Vole

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Meadow voles, sometimes known as "orchard mice" or "field mice", are one of those little problems we just don't think much about – until they start nibbling away at our crops and ornamentals. When populations are high, these native rodents cause a great deal of damage to a wide variety of plants. Three common species live in western Washington and cause big headaches for growers: the Townsend vole (*Microtus townsendii*), the Oregon vole (*M. oregoni*) and, occasionally, the Longtailed vole (*M. longicaudus*). Typically small-eared, small-eyed, burrowing animals, 5 to 9 inches long from nose to tail-tip, these rodents occasionally undergo huge increases in population, reaching as many as 500 per acre or more. Voles cause the most damage during these population peaks.

How can you tell if you have a vole problem? Often, the first signs of vole trouble are bulbs and seeds that don't sprout, or trees that begin to look "off color" and feel loose in the ground. Other indications of high vole populations are the appearance of many quarter-size tunnel entrances in the turf, and trails meandering under boards or tarps that have been left on the ground. Actual feeding damage to plants can be identified by the multitude of criss-crossing 1/8-inch wide tooth marks made by the rodents' two incisors. Most damage occurs underground, so you will need to clear away the soil from the base of the plants in order to find vole damage. Above-ground feeding happens when you allow tall grass to grow around plants. Also, if there is a blanket of snow that lasts for several days, the voles will often tunnel through the snow and feed on above-ground plant parts. When the snow melts this damage is easily visible. Girdling damage to trees usually occurs in fall and winter, but field crops may be severely damaged at any time of year.

What can you do to minimize vole damage? Sanitation is the key! Keep the grass mowed and, where practical, eliminate it completely. Around trees, try to keep grasses at least three feet away from the trunks either by cultivation or by using an approved herbicide. If you use an herbicide, remove the dead plant material so it does not provide cover for vole activity. If you use thick mulches around trees to reduce weeds, be aware that you may be providing a nice, loose cover for invading voles. To reduce this problem, mulch with crushed rock instead of organic material or place vole guards of ¼-inch mesh hardware cloth around the tree trunks. If you use a vole guard, bury the bottom edge of the guard at least a few inches deep to protect the crown as well as the trunk. If you must use organic mulches, keep the layer no more than an inch thick so that voles will not find it too attractive. Also avoid the use of weed-barrier cloth: voles love to tunnel under this stuff.

Mow around the edges of fields as much as possible to reduce vole cover. Pick up loose boards, tarps, or debris that can provide hiding places. Tilling the soil effectively reduces vole populations because it removes food and cover, and destroys existing runways and tunnels. Tilled fields generally have fewer vole problems, but voles are still capable of invading and damaging annual crops, especially those crops that provide good cover for extended periods of time.

Repellents. Repellents can provide initial reductions in vole populations, but they are relatively expensive and provide only short-term protection. Repellents must be reapplied after each rain event, and when food is in short supply the voles will generally feed on the repellent-treated plants anyway. Repellents containing thiram, garlic oil, castor oil, capsaicin, and putrescent egg solids are registered for vole management in Washington. Read the labels to determine if individual products can be used around your home or in your production system.

Predators. Encouraging predators can also help keep vole populations down. Hawks, owls, weasels, coyotes, etc. will not eliminate vole problems, but they may help keep rodent numbers below damaging levels. Strategically place owl houses around your farm to encourage the birds to hunt among your plants. Terrier dogs, such as Jack Russell's, Rat Terriers, and Patterdales, were bred for rodent control, but be aware that these "domestic predators" may also kill beneficial weasels, snakes, and shrews. However, it is possible to train dogs to kill only rodents or other small pests.

Trapping. Trapping, though labor-intensive and probably not economically feasible for a large farm, may be adequate for small farms and/or organic operations. The common "break-back" mousetrap is the best tool for the job unless you have an extra-large Townsend vole infestation, in which case you may need rattraps. Trapping is most effective in the fall when other desirable foods are less plentiful. It is best to reduce rodent populations before winter, when damage to woody plants is the greatest.

Traps should be placed in or near active tunnels and can be covered with curved cardboard or roofing shingles to reduce non-target catches. Use at least one trap per 100 square feet (10 foot by 10 foot area) in smaller infested areas, and at least 80 traps per acre fields. In order to make traps last longer, dip them in hot wax before use, but make sure the wax does not clog the mechanism.

After setting traps, check them every few hours for the first day, remove voles, and reset traps as needed. When handling dead rodents and traps, wear disposable gloves and wash your hands well afterwards. Always treat

Continued on next page

dead rodents and traps as possible disease carriers and bury dead rodents immediately. After the initial catch, check traps once or twice daily for one week. After a week of intensive trapping, the number of voles caught daily should be near zero. If not, continue to trap until none are caught for several days in a row. After removing the traps, leave covers over the tunnels so they can be monitored periodically for activity. In the fall and early spring, recheck for voles by placing apple slices in the tunnels. If toothmarks appear on the apples, repeat the trapping process.

Pitfall traps are an alternative to snap traps. Sink an 8-inch tall can, a deep glass mason jar, or a similar type of "pitfall" container, into a tunnel floor with the container mouth level with the tunnel floor. Voles will drop into the "pit", and if it is deep enough, they will be unable to escape. Covering the trap with a board or piece of tarpaper will make the pitfall more attractive. Pitfall trapping is labor-intensive and you must dispose of the live rodents captured.

Poison Baits. So, what if you have done all this and vole problems persist? Once a vole population is established, poison baits or rodenticide treatments are the quickest and most cost-effective means to control them. Most of the rodenticides registered for vole control in Washington contain zinc phosphide, an acute, fast-acting stomach poison. There are also formulations of the slow-acting anticoagulant rodenticides, chlorophacinone (Rozol) and diphacinone (Ramik Brown). When using these or any other pesticides, always carefully follow the instructions on the label to avoid injury to yourself, other people, pets, and wildlife.

A successful poison-bait program requires good timing. The optimum times to apply rodenticides are after the fall harvest, in the winter, and in the early spring. During the fall, bait acceptance increases and baiting becomes more effective. Late fall bait applications reduce vole populations just before winter, when these pests do the most damage to perennial crops. Winter is an ideal time to deliver bait because it is the time when most pest damage occurs and bait acceptance is greater as a result of natural food shortages. Spring applications can reduce populations before the breeding season begins, but vole populations can quickly bounce back before the next winter. As spring progresses and more attractive foods become abundant, baiting becomes less effective.

Bait placement is critical to the success of a rodenticide program. Read the product label to determine what types of bait placement are allowed. Broadcast baiting, scattering the bait over a wide area, is less labor intensive than hand baiting, but can be just as expensive since larger quantities of bait are required. The greatest disadvantage of broadcast baiting is the high possibility of harming nontarget species. For this reason, hand baiting or bait stations are recommended whenever the label allows.

Bait stations can be made from beverage cans, PVC pipe, split tires, or wood. Bait stations help keep the bait dry and fresh much longer and damp bait breaks down very quickly. A simple board, securely staked to the ground, makes an adequate bait station to protect the bait and attract voles. Bait stations can be made from discarded beverage cans by enlarging the opening so that it is about 1-½ inches in diameter and denting the side of the can so it will not roll. Place bait in the can and place the can dented side down in the area to be protected. Mark the bait stations with flags or stakes so you can relocate them for maintenance. Be sure to follow the label instructions for placement of your baits. Bury dead rodents when you find them.

Zinc phosphide (ZnP) baits can cause bait shyness if over-used, so do not apply ZnP-based baits more often than once every 6 months. Ideally, growers can reduce the pest population with an initial application of a zinc phosphide bait. A couple of days after setting the bait, place apple slices in the runways to check for vole activity. If toothmarks appear on the apples, then voles are still active and you will need a follow-up application with an anticoagulant bait.

Monitoring your vole population. Whether you rely on habitat management, predators, trapping, rodenticides, or a combination of techniques, it is a good idea to monitor vole numbers regularly. After bringing the vole population under control, voles can quickly reinvade from surrounding areas and cause significant winter damage, especially under snow cover. Carefully monitor vole populations at all times, but especially in the fall if you have perennial crops. The easiest way to monitor vole numbers is to determine their "activity index". Due to the explosive breeding potential of voles, an index greater than 20-25% usually indicates a potential for serious damage and a need for vole management. To calculate the activity index, place a number of apple slices in vole tunnels to monitor for activity, then divide the number of damaged/removed slices by the total number of slices that you placed in the tunnels. For example, place 25 bait stations containing one apple slice each in random vole tunnels throughout a grove. Cover the apple slices so that birds or other animals do not eat them. After 24 hours, count the apple slices eaten or removed. If ten slices were nibbled, that equals an activity index of 40% (10 divided by 25).

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Events

2003 Small Farm School

November 15th, Oregon City, OR.

Jointly sponsored by Clackamas Community College and WSU Extension Clark County, this day long session of workshops will provide two tracks: nursery production and marketing, and food production and marketing (CSAs, direct marketing, diversified production, etc.) Contact Elizabeth Howley ehowley@clackamas.cc.or.us or Doug Stienbarger.

Non-timber Forest Product Monitoring Workshop

September 4, Portland, OR.

The workshop explores how harvesters might participate in a biological monitoring program of nontimber forest product resources (such as wild mushrooms, floral greens, medicinal plants, seeds, etc.). This workshop is FREE and open to the public. ** However, pre-registration is requested. For more information and to pre-register, please contact Katie Lynch no later than August 22, 2003 (503-320-1323).

Institute for Culture and Ecology

About us Programs Contact Event

IUFRO 6th Extension Working Party Symposium

September 28 - October 3, 2003, Troutdale, OR.

This symposium will explore the many ways non-formal Extension forestry education is delivered to private non-corporate forest owners through collaborations among agencies, private companies, landowners, and non-governmental organizations. http://outreach.cof.orst.edu/IUFRO-Extension/index.htm

Forestry Cooperatives: What Today's Resource Professionals Need to Know

November 18th, 2003.

This satellite conference will be conducted for natural resource, Extension, and cooperative development professionals. Speakers will provide a framework for better understanding forestry cooperatives and their potential role in helping private forest landowners achieve their objectives. http://www.wisc.edu/uwcc/forestcoops/index.html

E-Commerce: Adding Online Sales to Your Business

August 7.

Learn how to buy and sell on-line as part of your overall business marketing program by approaching e-Commerce from the bottom-up.

Sudden Oak Death (SOD)

A one-day conference on SOD will be held on July 9th, at WSU-Puyallup, WA . RSVP deadline is July 4, 2003. To register for this free workshop, email dhanley@u.washington.edu with the subject line: *SOD Conference Registration*.

Resources

Agriculture

SAREP Newsletter

Subscribe to the University of California Sustainable Agriculture Research and Education Program newsletter.

Organic Agriculture Centre of Canada

This web site publishes a monthly survey of prices of food - organic compared to conventional, fresh and dried goods - in four Canadian cities.

The Crunch Lunch Manual: a case study of the Davis Joint Unified School District Farmers Market Salad Bar Pilot Program and A fiscal analysis model

by Brillinger, Ohmart and Feenstra, March 2003

This manual shows school districts how to pilot salad bar projects with produce from local growers. It describes the process that the Davis project went through and includes with a listing of resources for farm-to-school programs and food policy. See www.sarep.ucdavis.edu or contact Gail Feenstra at gwfeenstra@ucdavis.edu.

OrganicAgInfo On-line Database

OrganicAgInfo is an on-line database of research reports, farmer-to-farmer information, outreach publications, and more. The database can be searched by keywords, region, crop or livestock type.

The New Farm

This web zine published by the Rodale Institute, has developed an Organic Price Index (OPX). Access is free at http://www.newfarm.org/opx/index.shtml. The OPX "is a comparison of terminal market, other wholesale and selected large-scale retail prices for organic and conventional foods and sustainably raised meats. West coast data are picked up from Seattle. While the OPX compares prices for common farm products, OPX PLUS simply lists the week's prices for 24 organic crops.

11th Annual Food Safety: Farm to Table Conference

Conference presentations posted at http://safefood.wsu.edu/ProgramOverview.html. Icons in the program flyer indicate information from that presentation has been posted.

Idaho OnePlan

In Idaho, developing a farm conservation plan is now as easy as connecting to the Internet. The Web-based Idaho OnePlan consolidates all the information and forms distributed by federal, state, and local agencies into a clearinghouse for farmers to easily find the documents pertinent to their needs.

Niche Marketing

This University of Wisconsin site identifies potential niche marketing opportunities. http://www.uwex.edu/ces/agmarkets/index.html

WSU Pathology Newsletter

WSU's Vegetable Pathology Team newsletter can be found on the team's web site. The May issue focuses on new information generated by team members about Washington vegetables and vegetable diseases.

AgMRC Biweekly Update

Markets & Industries

The Growing Natural Foods Market: Opportunities and Obstacles for Mass Market Supermarkets

The Retail Food Industry Center, University of Minnesota, 2000.

Food, Fuel and Freeways:

An Iowa Perspective on How Far Food Travels, Fuel Usage and Greenhouse Gas Emissions, Leopold Center for Sustainable Agriculture, Iowa State University, June 2001.

Outlook for U.S. Agricultural Trade

Economic Research Service (ERS) and Foreign Agricultural Service (FSA), USDA, February 2003.

International Meat Directory

Links to companies throughout the world in all meat categories.

List of Canadian Food Brokers

From the USDA FAS.

Recent Growth Patterns in the U.S. Organic Foods Markets

Economic Research Service, September 2002.

The United States Market for Organic Food and Beverages

International Trade Center, March 2002.

Food Safety Educator

This free quarterly newsletter reports on new food safety educational programs and materials as well as emerging science concerning food safety risks.

The Food Consumer in the 21st Century:

New Research Perspectives, The Retail Food Industry Center, University of Minnesota. April 2001.

Forestry

Postharvest Technologies

Postharvest Technology Research Information Center, University of California, Davis.

4-H Virtual Forest

An interactive website for children developed by Virginia Tech.

Non-Timber Forest Products

View the Non-Timber Forest Products Demonstration Project Newsletter, *Beneath the Trees*.

Small Scale Forest Journal

See the current issue about small-scale forestry from around the world and a series of 12 articles on participatory modeling of community forest landscapes. http://www.nrsm.uq.edu.au/journal.

Small Forest Landowner Office

WA State DNR Small Forest Landowner Office **email listserv**. If you would like to subscribe to SFLO-mail, send an e-mail to: sflo-mail@wadnr.gov with the word SUBSCRIBE in the Subject line.

Non-Federal Forestlands

Facts About Non-Federal Forestlands can be found at http://pinchot.org/pic/farmbill/Facts.html

Hoofing the Heavy Stuff
Capital Press article

"…Mark Hansen, one of a growing number of loggers who work with horses in bringing timber out of environmentally soft areas." See the full article at http://www.capitalpress.com/specpages/hoofing.htm

Idaho Timber Town Reaches for New Identity
Capital Press article

"Marv Allen …uses age-old furniture-building techniques…to deftly assemble erosion control dams." See the article at http:/www.capitalpress.com/specpages/newident.htm

Fertilizing Coastal Douglas Fir Forests

This bulletin covers the detailed questions that must be considered in any forest level fertilization program.

Making Farm Forestry Pay: Selling the Environmental Services of Farm Forestry

The environment supplies important 'services ' that benefit human societies. A healthy environment provides rainfall, productive oceans, fertile soil, clean air, clean water, waste processing, buffering against extreme weather, and regeneration of the atmosphere.

Seeing the Communities Through the Trees

Rebuilding the Communities in the Northwest, An Analysis of the Northwest Economic Adjustment Initiative. The Northwest Economic Adjustment Initiative pumped $1.2 billion into Northwest communities to offset the decline in timber harvests. These projects highlight the importance of building local skills and catalyzing community efforts that lead to additional projects and that may leverage millions more for local community development. To obtain a copy, contact: Jonathan Kusel, kusel@fcresearch.org, (530) 284-1022 x12.

WA Statewide Forest Fire Information

Catalog of Federal Funding for Watershed Protection

Washington Forest Health Issues

Value-added manufacturing for Oregon forests

Information on maximizing manufacturing to "add value" from forests and create jobs and revenue. http://www.oregonsolutions.net/forestry/temple_cont.cfm

Community Forestry Resource Center

The Institute for Agriculture and Trade Policy promotes responsible forest management by encouraging the long-term health and prosperity of small, privately owned woodlots, their owners, and their communities. http://www.forestrycenter.org

The Market Connection Initiative

Ecotrust's Forestry Market Connection Initiative is connecting the growing demand for responsibly harvested wood products with a network of land managers.

Income Opportunities in Special Forest Products

Community Forestry Research Center Publications

Balancing Ecology and Economics: A Start-up Guide for Forest Owner Co-operation

This guide draws upon the experiences of over 20 established or newly forming sustainable forestry cooperatives and associations to show how private landowners, working together, can improve the ecological conditions of their lands while at the same time improving their own economic well-being and that of their communities.

Guide for Small Businesses in Washington State

Healthy Forests, Healthy Communities Partnership

This is a collaborative network dedicated to building rural economies based on forest restoration and ecosystem management, and to creating markets for the 'by-products' (such as mall diameter suppressed trees and underutilized species) of these activities into quality wood products. http://www.hfhcp.org/

Business Development

Optimal Quality Assurance Systems for Agricultural Outputs

New paper in business development, quality management systems from the Center for Agricultural and Rural Development (CARD).

A Basic Guide to Exporting

U.S. Department of Commerce, 1998.

Recipe for Export Success

An Online Tool to Assist with the Creation of an Export Marketing Plan, Foreign Agriculture Service, USDA.

Farmers Must Get in Position for Gaining Value from Value-added

Successful Farming Online, February 2003.

Innovative State Policy Options to Promote Rural Economic Development

National Governors Association, February 2003. This report looks at three general approaches that states have taken: cluster development, non-agricultural entrepreneurship, and agricultural entrepreneurship in the form of value-added agriculture and ag diversification.

Marketing beef

A web page organized into Commodity Beef, Branded/Certified/Verified, Direct Marketing, Natural and Organic. Extensive industry profiles have been written on each aspect of the beef industry and included.

The National Organic Program: Producers, Handlers, Processors

http://www.ams.usda.gov/nop/ProdHandlers/ProdHandhome.html

USDA Rural Business Co-operative Service

NW Co-operative Development Center

This is a nonprofit organization devoted to assisting new and existing co-operative businesses, from daycare centers to credit unions. http://www.nwcdc.coop/

WA State Office of Trade and Economic Development: *Small Business Resources* offers a variety of programs providing technical and financial assistance to support new and existing businesses within Washington.

WA State Small Business Development Centers

Association for Enterprise Opportunity.

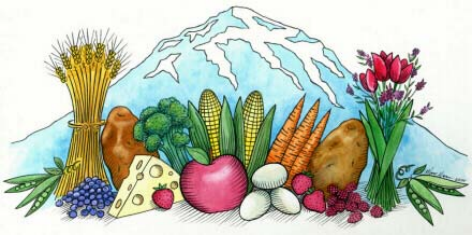
AEO provides its members with a forum, information, and a voice to promote enterprise opportunity for people and communities with limited access to economic resources.

Building Better Rural Places

Download this catalog of Federal programs for sustainable agriculture, forestry, conservation and community development.

Cascadia Revolving Fund

Cascadia is a private, nonprofit community development financial institution that provides loans and technical assistance to entrepreneurs and community building organizations in Washington and Oregon who have been unable to access traditional financing and support. http://www.cascadiafund.org/



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