



Cover cropping systems for organically farmed vineyards

BY Glenn McGourty,
Viticulture and Plant Science Advisor
University of California Cooperative
Extension
Mendocino and Lake Counties

Vineyard cover cropping practices have been refined in Mendocino and Lake counties over the past 15 years. When organic and sustainable winegrowing began in the late 1980s, many of the cover crop species were selected from agronomic crop farming systems. While these were well-suited for bringing “life” back into the soil, they weren’t ideal species for a vineyard. Many were simply too energy-intensive to farm; too vigorous, grew into the trellis, produced too much biomass to manage easily, or produced too much nitrogen in the soil.

Following multiple trials conducted by the author and cooperating growers, we have identified a broad “plant palette” from which to choose in

Alternate middles planted to brown mustard and Daikon radish (planted annually) and subterranean clovers (farmed non-till for three seasons.)

addressing specific cultural issues in vineyards, such as protection from soil erosion while building soil structure, organic matter, and overall soil quality.

Cover crops are now recommended that better fit the architecture of a vineyard and the farming system that growers find appropriate for their vineyards.

In Mendocino and Lake counties, both conventional, sustainable, and certified organic farming systems use cover crops. The differences between cover crop farming practices in these systems are slight.

Organic winegrowers do not use any herbicides or synthetically processed concentrated fertilizers. They rely on compost for nutrients. (Compost also makes a significant contribution to the goal of building soil carbon, as it contains fairly stable humus-like compounds.)

Under-vine weed control is done mostly with tillage tools. Both winegrowing systems use many of the same cover crop species, managed in similar ways.



Non-till cover crop sward of subterranean clover in late spring.

This report will examine how organic wine growers select cover cropping systems, and what techniques are used to grow and manage them in North Coast vineyards.

Importance of cover crops

Cover crops are a tool to help winegrowers manage their soils in multiple ways. They help to:

- **PROTECT SOIL FROM EROSION:** The foliage of cover crops reduces the velocity of raindrops before they hit the soil surface, preventing soil from splashing. This prevents slaking of soil aggregates and sealing of the soil surface. (When this occurs, runoff increases, along with soil erosion). The roots of the cover crops bind soil particles together, improving soil structure and water penetration, while preventing the soil particles from moving.
- **REGULATE VINE GROWTH:** Cover crops can be used to both invigorate vines (augmenting soil nitrogen from nitrogen-fixing legumes) and devigorate vines (root competition from non-legumes with the vines for nutrients and water).
- **IMPROVE SOIL FERTILITY:** Besides increasing soil nitrogen, decomposed cover crops increase the soil cation exchange capacity. Therefore, the ability of a soil to hold and exchange nutrients increases. Additionally, nutrients are often chelated into organic complexes, and are more readily exchanged from these substrates than from inorganic clay minerals. Since many organic growers also apply compost, this also adds to the fertility of vineyard soils.
- **IMPROVE SOIL STRUCTURE AND WATER HOLDING CAPACITY:** Initially, cover crop roots help aggregate soils as fine roots penetrate the soil profile (especially grasses). Cover crops with large tap roots help to create macropores when the plants die, and a void is left from the decomposing roots. These macropores greatly assist the movement of air and water into the soil profile.

Soil organisms using the decomposing cover crops as a food source create waxes and other sticky substances that hold the fine particles into aggregates, lowering bulk density and improving soil tilth. As organic matter increases in the soil, so does the soil's ability to hold water.

Physical improvement of the soil is important, because, large root systems are very desirable in organic winegrowing. Since soil nutrient concentrations may be lower than conventionally farmed vineyards, and since many organic winegrowers prefer not to irrigate, a root system that forages through a larger area of the soil profile is more likely to provide what a vine needs.

Many organic winegrowers feel that relying more on the soil than on a bag of soluble fertilizer applied through the drip system to provide water and nutrients will be a better expression of a vineyard site's *terroir*.

- **ENHANCE BIOLOGICAL DIVERSITY IN THE ROOT ZONE:** Organic matter is a food source for macro- and micro-organisms. Many of these organisms assist in recycling cover crops into the soil, while improving soil physical qualities in the process. Particularly noteworthy are increases in earthworm populations; they are a good indicator of soil health and improved physical conditions.

Increased biological activity occurs in the soil after the incorporation of organic matter from cover crops. Researchers have clearly shown that these organisms can reduce damage from root pathogens by inhibiting their growth and development.

- **PROVIDE HABITAT FOR BENEFICIAL GENERALIST PREDATOR AND PARASITOID INSECTS AND ARACHNIDS (SPIDERS AND MITES):** Since pest management strategies in organic winegrowing emphasize reliance on nature and the use of "soft" chemicals, it is important that beneficial arthropods are abundant and in close proximity to the vineyard to control harmful insects and mites.

Cover crops can provide habitat and food for beneficial insects at different stages of their life cycle. They also provide habitat for prey, such as aphids, mites, caterpillars, and other creatures. Research entomologists have a difficult time understanding the dynamics of pest and prey relationships in the cover crop, and their effects on grapevine canopies. Regardless, growers report experiences of reduced

leafhopper and mite problems when cover crops are planted in lieu of conventional insecticide applications.

- **PROVIDE FIRM FOOTING FOR HARVEST AND CULTURAL OPERATIONS:** When no-till, sod-forming cover crops are planted, the resulting firmer footing makes vineyard operations during wet weather more feasible. This can enable harvest, pruning, and spraying during inclement weather.

- **IMPROVE AIR AND WATER QUALITY:** Water quality laws are being increasingly enforced, and vineyard water runoff needs to be free of silt and excess nutrients. Cover crops help to prevent erosion. Nitrogen formed by legumes is less mobile than soluble nitrogen fertilizers. Cover crops assimilate free nutrients in the soil, and stabilize them during periods of high rainfall. During the dry periods of the year, cover crops help reduce dust, improving air quality. This also helps to reduce the problem of mite infestations, which intensify under dusty conditions.

Cover cropping farming systems

Choosing a cover cropping farming system will depend on the relative vigor of the site; water availability in the soil; viticultural objectives (increasing or decreasing vegetative growth); and pest management objectives for insect, mite, and weed control. Following are discussions of several different approaches.

Annually tilled and seeded: The majority of growers using this system choose it to conserve moisture in their vineyards. Cover crops are planted in the fall, allowed to grow until some point in the spring when the ground can be easily cultivated, and then mowed and tilled into the soil. This operation is often timed when the cover crop is flowering, as it will decompose easily at this stage. This system is best suited for relatively flat vineyards in which soil erosion is not a serious hazard.

Cover crop species typically used in this system include annual small grains (barley, oats, triticale), winter peas, common vetch, bell beans, daikon radish, Persian clover, and

Glenn McGourty's top ten cover crop picks for organic vineyard cover crops in the North Coast

ANNUAL LEGUMES

'Magnus' Winter Peas (*Pisum sativum*): This low growing, floppy cover crop germinates well in cool, moist weather, and produces moderate amounts of biomass and nitrogen. It has attractive pink and white flowers, and has light winter dormancy, so it grows well in the early spring. While it will twine its way up when mixed with other cover crops such as small grains, it isn't aggressive, and won't end up in the vineyard trellis. Used in annually tilled systems. Seeds are medium in price (about \$50 per acre).

Subterranean Clover (*Trifolium subterraneum*): the queen of leguminous cover crops for no till vineyard cover cropping systems! Does well in acid soils. Low growing and self reseeding, this cover crop produces moderate amounts of nitrogen and biomass. Grows mostly when grapevines are dormant, so it is not a big competitor for soil moisture. Cultivars 'Anthis,' 'Koala,' and 'Mt. Barker' are more winter-dormant and produce the most biomass. Seeds are medium in price (about \$50 per acre).

Bur Medic (*Medicago polymorpha*): germinates and grows well in areas with limited rainfall, but doesn't like acid soils. Excellent reseeding capability for no-till vineyards. Responds very well to liming. Low growing moderate producer of biomass and nitrogen. Don't like burs in your socks? Try bur-less selection 'Santiago' bur clover. Seeds are medium in price (about \$50 per acre).

'Flame' crimson clover (*Trifolium incarnatum*): one of the prettiest legumes, grows to low height (about 14 inches) and is covered with profuse red blooms in late spring. Produces copious biomass that can be hard to incorporate sometimes. Very competitive with weeds. For tilled vineyards. Seeds are medium in price (about \$50 per acre).

ANNUAL FORBS

Daikon radish (*Raphanus* sp.): This tall growing radish forms large taproots that help to open up clay soils. Blooms profusely, and provides habitat for beneficial insects and their prey. Germinates well under cool and moist conditions. Attractive and interesting cover. Cheap to plant (around \$30 per acre).

ANNUAL GRASSES AND SMALL GRAINS

'Zorro' fescue (*Vulpia myuros* var. *hirsuta*): A low growing and early maturing grass suited for non-tillage vineyards. Germinates early, and grows well under low rainfall. Prolific seed producer. Can be mixed with annual self reseeding legumes. Seeds are expensive (about \$80 per acre).

'Blando' brome (*Bromus hordeaceus* ssp. *molliformis*): Produces more biomass than 'Zorro' fescue, but still is low-growing and matures early. Good choice for non-tillage vineyard floor management. Germinates well under low rainfall conditions. Can be mixed with self-reseeding annual legumes. Seeds are medium in price (around \$50 per acre).

'Juan' triticale (*x Tritosecale*): This plant is ideal for stabilizing soil during vineyard installation. It forms a big, fibrous root system, germinates well under cool and moist conditions, and has a long winter dormancy, so it doesn't bolt early, allowing time to till it into the soil while it is relatively small in stature and biomass. If left to mature, it can produce five tons to the acre of straw, so it is very productive. Useful for mixes with annual legumes for annual tillage cover cropping systems. Seed is inexpensive (about \$30 per acre).

PERENNIAL GRASSES

Fine fescues, including hard fescue, sheep fescue, and red fescue (*Festuca ovina*, *Festuca ovina* var. *duriuscula*, *Festuca rubra*): These grasses are good choices for vineyards with moderate vigor that are managed by mowing only. They can all be mixed, although hard fescue and sheep fescue are the lowest growing. They will go very dormant in the summer, but green up again with winter rains. Expensive to plant, around \$120 per acre.

Turf-type perennial rye grass (*Lolium perenne*): The cultivars 'Elka' and 'Manhattan II' form tough, weed-free turf and will also devigorate vines. Perfect for non-till, mow only vineyard floor management in vineyards with good soils. May need to be fertilized, or plant with perennial clovers for nitrogen. Expensive to plant, around \$100 per acre.

other annuals that grow well during the cool months.

In upland areas prone to soil erosion, where water is not available for irrigation of either the vines or the cover crop, it is highly recommended to use straw mulching or compost "overs" (coarse particles between one and two inches in size) to minimize the loss of soil from the vineyard while waiting for the cover crop to start growing in the fall.

This farming system is tillage-intensive, and soil is exposed to sunlight during the summer. Loss of soil structure and organic matter occurs if tillage is excessive. Regardless, many growers using this system believe it allows them to grow very high quality fruit without irrigation or concentrated fertilizer applications.

Many people like the looks of cultivated vineyards, and this often is the

method of choice near expensive and attractive winery facilities (particularly in Napa Valley).

Non-tillage vineyard floor management with annual cover crop species

In a no-till system with annual cover crops, the vineyards are tilled initially and seeded with species that will reseed themselves on an annual basis. Thereafter, the vineyards are mowed in



Winter annual cover crop mix of winter peas, bell beans, and oats.

spring and early summer. Tillage is restricted to only beneath the vines. Subterranean clovers, rose clovers, crimson clover, red clover, berseem clover, bur medic, bolansa clover, and Persian clover are all suited for this farming system. Grasses that can be used include Blando brome and Zorro fescue.

Another no-till approach is planting annual cover crops that are not self-reseeding, such as oats, barley, peas and vetch, with a no-till drill. This approach is useful when tillage could cause erosion, and it is desirable to keep tillage to a minimum. Usually, seeding is done just before fall rains. The cover crop is simply mowed and left to lie on the soil surface.

Non-tillage vineyard floor management with perennial species

Perennial species are most commonly used in vineyards planted on fertile sites. Many of the perennial grasses are very competitive with grape vine roots, and will have a devigorating effect on the vineyard. This may be desirable if the vineyard is seriously out of vegetative balance.

There is a range of cover crops that vary from being slight to very competitive. The fine fescues (hard fescue, creeping red fescue, and sheep fescue) are the least competitive, grow very short, and survive well.

Turf selections of perennial rye grass and tall fescue are intermediate in their competitiveness. They have fairly low stature, and require mowing only once or twice per year.

Pasture selections of perennial rye grass, tall fescue, and orchard grass are the most competitive, and can have a tremendous impact on vineyard vigor. They should be planted on only the most vigorous sites with deep soils.

These grasses may also be used in parts of the vineyard that are prone to erosion, or places where it is desirable to reduce dust. Seasonal waterways, vineyard roads that aren't heavily trafficked, turn-around areas, staging areas, or other places where the soil needs to be protected are potential sites for these grasses.

There is a good case for including perennial legumes in a sward of grasses, as they will supply nitrogen for the grasses. Unfortunately, they may also attract rodents such as voles and gophers, which can damage grapevines. Despite this potential problem, many growers also include white clover, strawberry clover, alsike clover, and birdsfoot trefoil in a perennial mix. These species provide not only nitrogen for the grasses, but also habitat for generalist predator and parasitoid insects.

Some growers have had success planting perennial grasses alone, and then, after two or three seasons, planting annual legumes into the sward. If the annual legumes and perennial grasses are initially planted together, the legumes will shade the grasses out, and a poor stand of perennial grasses is likely to occur in the sward.

California native grasses can also be used as cover crops. Favorites include pine blue grass, mokulemne, and molate red fescue as less competitive species; and California brome, meadow barley, and blue wild rye as more competitive choices. Seed is expensive for these grasses, and they are not as competitive with weeds in some cases as other pasture grass species used as cover crops.

It is important to let these grasses flower late in the spring, in order for them to accumulate carbohydrates in their root systems, which improves their persistence and competitiveness with weeds.

Tilled and no-till farming systems

Some growers use different farming systems in alternate tractor rows to moderate vigor, incorporate compost, pro-



Summer cover crop of sunflowers planted for beneficial insect habitat, diversity and beauty. Bonterra Vineyards.



Crimson clover, an attractive annual clover.

vide diverse habitat, or for aesthetic reasons. One system commonly employed uses a no-till approach of self-reseeding annuals for three years in alternate tractor rows, with annually planted and plowed down cover crops in other tractor rows.

After three years, the planting systems are switched to alternate tractor rows. Perennial species are also used in this way. In most cases, this approach is used on more vigorous sites not prone to soil erosion.

Cover crop rotation

Over time, cover crops can develop pests and pathogens that make it difficult to reseed the same species year after year. That is one reason why mixes are planted, as the effect of planting the same species annually seems less pronounced when a mixture of diverse species are used.

Sometimes, growers will use completely different species from year to year, such as mustards or radishes, followed by legumes, which are then followed by annual grains. Other growers take the approach of mixing all three together simultaneously, believing that there is an adjustment in species composition in the sward to the particular season's growing conditions.

Cultural practices for cover crops

SEED SOURCE

Cover crop seed should be purchased from dealers who sell quality seed that has been tested for viability and is free

from weed species. Under organic certification laws, growers are obliged to attempt to source organically grown seed. Unfortunately, this is nearly impossible for many of the small seeded cover crops, which are not even grown in the U.S. You are required to document in writing for your certification records that you attempted to purchase organic seed, even though conventionally grown cover crop seed can be used in organically-certified vineyards.

SEEDING

Being agronomic crops, most cover crop species grow best when planted in a well-prepared seed bed with adequate fertility. Usually, this requires two diskings, harrowing, and firming the soil with a ring roller or cultipacker prior to seeding. If the ground is somewhat compacted, it may be necessary to shallowly rip the area to be planted to a depth of about 12 inches with a tool bar and shanks, especially where wheel traffic occurs in tractor rows.

Seeding can be done with several different implements. For small areas, hand broadcast spreaders ("belly grinders") can be used. Tractor-mounted broadcast spreaders are also used for larger areas, but are not very precise. Seed drills are the best choice when expensive seed is being planted and accurate placement is required.

Most seed drills use two soil-cutting blades called coulter, which are set at

acute angles to each other. These cut a slit in the soil, with seed metered from a box above them, falling through tubes that open between the coulters. Small wheels are located behind the coulters to pack the soil firmly after the seed is deposited. Another alternative is a ring roller attached to the seed drill that firms the soil after seeding.

Slit seeders can also be used for no-till seeding. These utilize a device similar to a rototiller, except that the cutting blades are flat, and not bent at right angles like the bolo tines typically used on a rototiller. The seed box is mounted above the tiller, and seed is directed into the slits, packed by a ring roller mounted on the seeder. This seeder works best with cover crop species that have considerable seedling vigor.

SEEDING AND IRRIGATION SEASONS

Cover crops are usually planted in the fall, and rely on fall rains to begin germination. In cooler, shorter growing season areas, many vineyards are equipped with overhead sprinkler systems for frost protection. It is very helpful to seed early, and then irrigate the vineyard with an inch of water from late September to mid-October to start the germination process. Small seeded cover crops and perennial species definitely benefit from early seeding and irrigation to start germination. If rains don't come immediately, additional water may be required.



California poppies and annual lupine useful for "beauty" cover crop mixes.

Three interesting new cover crops for vineyards

Balansa Clover (*Trifolium michelianum* Savi) is native to southern Europe and the Mediterranean region. It is a winter annual clover that grows well in Mediterranean climates with cool, moist winters. It was introduced into Australia in the 1950s, and has naturalized in many pastures throughout southern Australia.

Balansa clover can grow up to three feet tall, but when mowed or grazed, it forms a low growing and dense canopy. It is an attractive plant, as the leaves often have purple and pink markings. Flowers are white and pink, and it blooms abundantly in mid-April to early May.

It grows moderate amounts of biomass, similar to a vigorous cultivar of bur clover or subterranean clover. It produces abundant seed, and regenerates well in dry land conditions.

All cultivars produce high levels of hard seed, which can germinate for several seasons (some agronomists are concerned that it might be a bit weedy). Compared to subterranean clover, it appears to germinate later in cool soil temperatures. It normally is seeded at the rate of 10 lbs per acre.

Balansa clover tolerates water logging for extended periods of time, once germinated. It has grown extremely well in two cover crop trials in Lake County, which is high elevation (more than 1,400 feet) and very cool in the winter.

There are three cultivars of Balansa clover in the trade. 'Frontier' is the earliest flowering selection, and will flower and set seed the best in short growing areas, such as places with shallow, dry soils. 'Paradana' is a mid-

season cultivar, and matures two weeks after Frontier. 'Bolta' is 10 days later than Paradana, and is well-adapted to cooler and wetter sites than others.

Persian clover (*Trifolium resupinatum*) is an annual clover for Mediterranean climates native to Turkey, Afghanistan, Portugal, Greece, Iran, and Iraq. It was introduced into Australia in the 1950s, and has been grown commercially since the 1970s.

There are two groups of Persian clovers: hard-seeded types (*Trifolium resupinatum* var. *resupinatum*) which are self-seeding clovers for use in pastures and cover crops; and soft-seeded types (*Trifolium resupinatum* var. *majus*) used more for annual cover crop mixes that are plowed into the soil or short-term rotations that require annual reseeding.

This excellent cover crop has excellent seedling vigor, grows and blooms over a long period of time, and tolerates water-logged soils once it has germinated. It is an attractive plant, with lavender to pink colored flowers, and deep green foliage.

In California, two cultivars are available for planting. 'Nitro' belongs to the hard-seeded Persian clover group, and is suited for self-reseeding annual cover crop swards. It grows taller than subterranean clover, and later into the growing season. 'Lightning' is a soft-seeded Persian clover, and must be seeded annually. It is taller in stature than Nitro and is well-suited as a nitrogen builder for vineyard soils. It can be planted with small grains such as triticale, and is

competitive in mixed annual cover crop swards.

Persian clover seeds are quite small, and should be seeded at the rate of 10 lbs per acre. It is aromatic, and attracts many beneficial insects.

Fenugreek (*Trigonella foenum-graecum*) is a winter-growing annual native to southern Europe and Asia. It has been used for centuries as a condiment, medicinal plant, forage, food, spice, and dye. Fenugreek is very aromatic, and has been used to make artificial maple syrup flavor for baked goods, chutneys, and confections. Seeds are ground and used in curries.

Young seedlings and other portions of fresh plant material are eaten as vegetables. The plant is high in saponin from which steroid drugs are refined. Pharmaceutical uses include antibiotic properties, soothing sore throats, expectorant, laxative, and aphrodisiac.

The fenugreek plant is erect, growing to nearly three feet. It has trifoliolate foliage, white flowers, and abundant yellow-brown seed pods that produce brown seeds. It grows considerable biomass and fixes nitrogen. It can be used as an annual cover crop in much the same way as winter peas, crimson clover, or other nitrogen-fixing cover crops.

The seeds are much larger than clovers, and should be seeded at the rate of 40 to 60 lbs per acre in well tilled and prepared seed beds. In our trials, fenugreek is sensitive to cold, and doesn't germinate well unless planted while the soil is warm, and irrigated.

Perennial species can also be seeded in the spring, at the same time that warm season summer cover crops are seeded. Late April and early May are when these covers can be planted. In many respects, it isn't the best time to seed perennials, as they need moist soil conditions to develop an extensive root system, which is more likely to occur with fall seeding. For perennial species,

mowing will be needed to reduce competition from annual summer weeds. Irrigation will benefit both types of cover crops.

FERTILIZER

Cover crops need specific nutrients to grow well. Many organic growers use compost, which in most cases will adequately provide what the cover

crops need. Compost made from a mixture of animal manure and grape pomace (50:50 mix) normally has enough NPK to get the cover crops off to a good start. Rates vary, but most growers will start with one or two tons per acre applied annually. In subsequent seasons, less material will be used.

In the North Coast, legumes respond well to applications of rock phosphorus

one season, physically incorporated into the soil, followed by liming the next season. Applications should be made based on soil tests to ensure that the proper quantity of materials are applied. Popcorn sulfur is needed in some high rainfall areas, specifically for the legumes.

SPRING TIME MOWING

Most cover crop species benefit from spring time mowing, as it can eliminate shading from faster growing weed species, and promote tillering, or expansion of the plants' crowns. For low-stature cover crops, this should be done just before they transition from the winter dormant/basal rosette stage into mature growth and flowering. On the North Coast, this usually occurs in early March, about the same time that prunings are being shredded. It is usually done in the same equipment pass.

Large stature annual cover crops are often clipped at bud break (removing anything growing above 18 inches) to reduce frost hazard for emerging vine growth. Tall cover crop swards are not desirable at this time, as they can impede air movement and increase the tendency of young shoots to freeze or develop *Botrytis* shoot tip rot.

SPRING TILLAGE

If the vineyard is going to be disked, the maximum addition of nitrogen from legumes occurs when the legumes are incorporated into the soil as they are blooming. Many growers will first shred the cover crop with a mower, and then disk it in. This will also improve decomposition rates, as smaller crop residues decompose faster than large ones. Timing is very important, as the soil must still be moist enough to easily till-in the crop. Maximum nitrogen release occurs about three weeks after incorporation, assuming that the soil remains moist.

Additional tillage may be required to fully incorporate all residues, usually in tillage operations spaced about 10 days apart. A final pass is often made with a ring roller to pack the soil firmly so that it is easy to walk on, and looks attractive.

LATE SPRING AND SUMMER MOWING

Self-reseeding annual cover crops are mowed in late spring and early summer after seed-set in order to minimize dry residual growth that might be flammable, and also to mow down summer weeds. For perennial cover crops, several mowings might be required to keep the foliage from growing excessively tall.

If California native grasses are used, there are some advantages to letting the plants flower in June and then mowing them. Even though there can be large amounts of foliage present, this approach allows the grasses to accumulate more carbohydrates in their root systems, so they survive summer dormancy better than if they are continuously mowed.

Conclusion

Cover cropping is an important component in organic winegrowing systems. Growers enjoy numerous choices in species and farming systems. Organic winegrowing does not limit any cover crop choices, since the same crops are available as in conventional winegrowing systems.

Choosing a cover cropping system should be very site-specific. Growers must consider their style of farming, yield and quality objectives, and any other criteria that they consider important. ■

More reading

Ingels, C., R. Bugg, G. McGourty, P. Christensen, 1998. *Cover Cropping In Vineyards — A Growers' Handbook* UC ANR Publications #3338, Oakland, California. 162 pages.

McGourty, G. 1994 "Cover crops for North Coast vineyards." *Practical Winery & Vineyard* 15 (2): 8-15.

Miller, P.R., W.L. Graves, W.A. Williams, B.A. Madson, 1989. *Cover Crops for California Agriculture*. UC ANR Publications #21471.

Reprinted from:



Visit our website:
www.practicalwinery.com
 to learn more about **PWV**.

58 Paul Drive, Ste. D, San Rafael, CA 94903 • 415-479-5819