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Wine science in the Wild West: Information-seeking behaviors and attitudes among Washington state winemakers and growers

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Abstract

This case study provides a foundation for improving the efficacy and efficiency of communicating wine science by investigating winemakers' and growers' behaviors and attitudes around accessing professional information resources. Interviews and surveys of Washington state winemakers and growers yield qualitative data concerning how they interact with the many different information sources available to them, what frustrates or enables their learning, and their attitudes toward employing scientific research findings in their winemaking. Findings show that, beyond a general preference for traditionally authoritative sources, Washington state winemakers and growers as a whole are remarkably diverse with resource preferences and attitudes relating to how they think about the role of science in winemaking and the nature of being a good winemaker. Winemakers' and growers' sense of professional identity, in other words, proved the strongest predictor of their resource use preferences, whereas demographic characteristics such as educational background or age failed to correlate with resource use preferences. Attending to this heterogeneity and the reasons behind it may help extension and

other science communicators craft messages framed to be more relevant and trustworthy to their industry audiences.

Keywords: information acquisition, resource use, science communication,
Washington state

Introduction

Knowing how winemakers and growers use professional information resources – whether they look for information, where they obtain it, and what they do with it – is vital to the work of agricultural extension and researchers in wine-related fields. Nevertheless, very little work has been done to understand resource use amongst this group of professionals. This study explores those behaviors from a user-centric perspective, querying winemakers’ and growers’ use of and attitudes toward resources, and developing a typology of resource use behaviors.

Winemaking is an information-intensive job: the challenges of each vintage may require a new conceptual toolbox, and what we know about winemaking shifts and flexes as viticulture and enology researchers (and those from adjoining fields including biochemistry, microbiology, geology, materials science, and others) publish new findings. Granting agencies both public and private now demand that researchers demonstrate how their work will be translated to the industry: how industry members will learn about the research and the financial gains to be had from findings being put into practice (see, for example, requirements for proposals to the American Vineyard Foundation; Deitrick, 2014). Agricultural extension services associated with the American land-grant university system have traditionally supported the information needs of regional agriculture but they are, in consequence and together with researchers themselves, increasingly charged with disseminating new research to the industry (Radhakrishna, Tobin, & Foley, 2014).

This scenario, when explored at all, is usually explored from the perspective of researchers and, by extension – appropriately enough – agricultural extension services as knowledge-holders asking questions about effective ways of disseminating research, of getting winemakers to listen, of getting research into practice (e.g., Gharis *et al*, 2014; Boshoff, 2014). These aims all begin with foundational assumptions that research is worth disseminating, that winemakers who don't employ research-supported practices aren't listening and need to be convinced, and that the goal of research communication is to bring as much of the industry as possible 'on board' with a new innovation (Knott & Wildavsky, 1980). While sensible from the perspective of competitive research funding, these assumptions are unwarranted in light of how winemakers and growers actually practice their craft. They are, moreover, counterproductive when the result is trying to push and pull along winemakers whom experts and communicators have imagined, and therefore constructed, as recalcitrant and ignorant (Wynne, 1992). In short, the researcher-focused approach works within the much-maligned deficit model of science communication which assumes that non-scientists' failure to take up scientifically supported information is the product of ignorance (Sturgis & Allum, 2004; Weigold 2001). The post-cognitivist tradition of Wynne (1992) and others which has so strongly colored contemporary studies in science communication gives us an alternative: to begin instead with the assumption that winemakers and growers have reasons – complex and comprehensible reasons grounded in their social contexts and personal expertise – for their various attitudes toward scientific information. This study proceeds in that tradition, asking not why winemakers and growers fail to take up scientific practices, but how they interact with available information resources.

Despite the resource-intensivity of communicating new research findings, little research has appeared concerning winemakers' and growers' information resource use or

continuing education behaviors; the peer-reviewed literature shows one similar recent study, about winemakers in South Africa, published earlier this year (Boshoff, 2014). The present study demonstrates that Washington state winemakers and growers are highly heterogeneous in their information-seeking preferences and behaviors and that education, experience, place of employment, and other demographic characteristics do not explain that heterogeneity. Their attitudes around the role of science in winemaking and being good winemakers, however, do. Because no difference was observed in any case in the responses of winemakers and growers, they are discussed here in aggregate.

Understanding information seeking behaviors and resource use as value-laden is key to extension and researchers communicating with an awareness of how their audience actually perceives and uses scientifically supported information. The concept of market segmentation, borrowed from business marketing research, provides a useful way to think about how scientifically supported messages could be tailored for a heterogeneous audience to be more relevant to audience needs and to better engender trust and participation amongst winemakers. This study thus provides data not only about which resources winemakers and growers are using but also a new framework for thinking about the factors involved in how they approach those resources.

Methods

Washington state was selected as the site of this case study on account of its known diversity. Washington state is second only to California in U.S. wine production with approximately 800 wineries, 350 wine grape growers, and 12.5 million cases produced annually (Washington Wine Commission 2014). No iconic grape or style dominates either regionally or state-wide and most wineries are small operations (with production generally below, and often far below 20,000 cases/year) producing wines sold for over \$20 to a largely regional market.

Interviewees were solicited by personal emails to all winemakers with available email addresses located in Walla Walla or the general Prosser/Yakima/Zillah area (see Figure 1). These regions represent relatively more and relatively less developed communities respectively and were selected to increase the likelihood of obtaining a broad range of diverse responses. Interviews were scheduled with all winemakers willing and able to be interviewed when the research was taking place: sixteen total, one involving two winemakers (neighbors who work together) and one involving a winemaker-grower pair. All took place in the interviewee's tasting room or adjoining office in semi-private settings. While interviewees were chosen by convenience sampling, their heterogeneity mimics that of the industry and suggests that a range of responses has been gathered. They range in age from early thirties to over sixty and in years of industry experience from less than five to well over twenty. One holds an associates degree, twelve bachelor's degrees, three masters degrees (including two MBAs), one PhD, and one a JD. Case production at the smallest of their wineries is less than 1,000 cases per year and, at the largest, approximately 22,000. Two are female. Eight are located in Walla Walla, the remainder in Prosser or the nearby communities of Zillah and Yakima.

Semi-structured interviews were conducted in-person by the author, audio recorded, and manually transcribed. A modified grounded theory approach was taken with codes emerging organically from the data and an iterative (or 'constant comparative') approach used to build theories (Evans, 2013; Hallberg, 2006). Inductive coding identified all positions and attitudes around information resources, winemaker education, science and technology, and the nature of winemaking; codes were then refined to reflect shared patterns and texts were re-coded. Conclusions were drawn by developing codes into themes tested against the texts and against survey data.

An online survey (hosted on FluidSurveys™) was developed expanding on themes from interviews, additional informal interactions with state wine professionals, and a review of available information resources. The survey was distributed through multiple channels: a link in the Washington State Wine Commission's weekly email news blast, an email introducing the study and linking to the survey distributed to the Washington State University (WSU) viticulture and enology extension email list serve, and personalized emails to all wineries listed on the Washington State Wine Commission's website for which email addresses could be found (approximately 500 total). 84 responses were received.

Approximately half of respondents completed the survey after receiving a personalized email, but the remainder responded to a link sent via the WSU viticulture and enology extension email list (none responded to the link in the Wine Commission's news blast). Subscribers to WSU extension publications are, therefore, likely overrepresented in the survey sample. Winemakers who rarely or never employ email or the internet are also likely unrepresented. While the survey was not designed to be representative, the inclusion of respondents from across the state and a range of backgrounds suggest that the scope, though not the prevalence, of winemaker/grower characteristics has been captured (Horst, 2013).

Results

Extensive interviews – forty minutes to over two hours – provided the core data set for understanding winemakers'/growers' attitudes around using information resources with survey data providing supporting evidence from a larger population. In complementary fashion, an online survey yielded a broader picture of what resources winemakers/growers in the state employ with interview data providing explanatory detail. The study as a whole should be considered a qualitative analysis yielding data on

the range and scope of winemaker/grower behaviors rather than a quantitative analysis describing population prevalences (Horst, 2013).

Survey respondents were distributed across experience levels with almost equal numbers having less than five, five to 10, 10 to 15, and more than 15 years' experience in their roles. Industry role-specific education levels from no formal education to PhD degrees were all represented, as were general (non trade-specific) education levels from associate's degree to PhD. Respondents came from all Washington state growing and winemaking regions. Winemakers and growers' response patterns were identical in all cases; they are, therefore, discussed in aggregate. Again, it should be noted that while the survey was not strictly representative, it garnered responses that can be expected to represent the diversity of attitudes Washington state winemakers/growers are likely to hold.

Diversity amongst winemaker/grower responses

You know, there's as many ways to do things as there are wineries in this valley, and not everybody does what the textbooks say. You know, I think there's more to it than just what's in the textbooks.

Perhaps the most striking commonality across interviews and survey responses is the striking lack of commonalities. Washington winemakers/growers do share near-universal trust in traditionally authoritative sources – textbooks and university extension – and a near-universal disdain for seeking information via Twitter. Appreciation for research in general and local, WSU-driven research in particular is also held in common, as is a (wholly predictable) view that all wineries and vineyards are different and each will operate a bit differently. Themes expressed across most or all interviews and supported by survey comments are summarized in Table 1. In essentially all other

respects, winemakers/growers differ: in their use of specific information resources, their approach to continuing education and understanding of its role in their winemaking/growing, their attitudes toward science, and the frustrations they expressed with looking for information. No single demographic factor – education in general or education in winemaking/growing, age, career path or years of experience – correlates with information-seeking practices or attitudes (data not shown).

Segmenting winemakers/growers by attitude toward winemaking

While winemakers and growers hold little in common as a whole, they hold much in common with other *subsets* of winemakers. Interviewees expressed patterns of preferences and attitudes that aligned with ideas about the nature of winemaking and what being a good winemaker/grower means, reciprocally creating and reinforcing ideas about winemaking/growing identity. Out of the interviews emerged four patterns or sub-groups, reinforced by survey findings (Table 2).

In a study of Danish scientists' attitudes toward communicating with the public, Horst (2013) used 20 interviews as the basis for a similar typology of attitudes which she describes 'not as a typology of scientists but rather as modes' of their behavior (p. 764), each of which 'enacts a particular identity for scientists and a corresponding understanding of what science *is*' (p. 771) While Horst emphasizes that her typology is not summative of her interviews, winemakers/growers in this study did align with specific types. The typology is, nevertheless, most useful as a heuristic of “qualitative ideal types” (Horst, 2013, p. 775) for thinking about winemaker/grower attitudes across and beyond Washington state, particularly in crafting messages about scientific research attuned to the different drives of each group.

Science-driven

So if someone does something because of conjecture, or because of something that they think is going to make a difference, well, look at what the base information is. Look up where it's coming from. Is this factual? Is it substantiated by the data and the research and that kind of thing, or is it just kind of something that people spread around as common practice? (WA 9)

Science-driven winemakers state explicitly that right and wrong exist in winemaking and that the right way is to follow scientifically supported recommendations. Good winemakers, in their conception, make wine safely and avoid risks. They tend to imply or state outright that they are better than other winemakers/growers. Though acknowledging that practical constraints may impede following scientifically supported recommendations perfectly, they believe that winemakers/growers should get as close as they can, recognize that they are approximating an ideal, and spare no reasonable expense in doing things the right way.

He's a f***ing idiot. I'm sorry, he gets his advice on fertilizer and pesticides from somebody who sells 'em?...The guy down the road, in most cases, he's just a guy who's been doing it longer the same way. (WA 9)

Science-driven winemakers actively avoid other winemakers/growers as information sources because they see others often acting in specious, unscientific ways and because others learn from vendors, who they perceive as an obviously biased source. This group overwhelmingly prefers reading the *American Journal of Enology and Viticulture (AJEV)* and talking directly with researchers. All reported subscribing to the full complement of trade publications but placed little emphasis on reading them. They eschew both other winemakers/growers and vendors as sources of information – often actively looking down on both as misleading – but still appreciate seminars as opportunities to learn about new research or technology. They identify reading and

learning as important parts of their job, say that most winemakers/growers don't do enough of either, and say that while not all research will be relevant or change their practices, staying up to date is important. Their explanations for why other winemakers/growers don't follow correct practices include laziness, ignorance of where to find and how to use resources, and employing scientifically unjustified practices for marketing purposes. When asked about their problem-solving strategies, science-driven winemakers describe rarely encountering problems because they know how to avoid them.

A sub-group of survey respondents (about one-sixth, the same proportion as of interviewees) showed science-driven characteristics: avoidance of peers and vendors as information resources, preference for *AJEV*, and lack of frustration over conflicting information.

Vision-driven

I don't have to go with what they say. I just go with what works for me and that's how I make my style. (WA 12)

Vision-driven winemakers say explicitly that right and wrong do not exist in winemaking. While they believe that scientific research is important and sometimes useful, they emphasize that staying true to one's own ideas of what a wine takes precedence. Because ideas about wine quality are subjective, they observe, following someone else's prescriptions is likely to result in losing one's own personal style. Thus, while they consider themselves well-educated on scientifically-supported practices, they do not always choose to employ them. Vision-driven winemakers think that it is important to take risks and that risk-taking winemakers make more interesting wine than those who follow recommendations and make wine safely.

Vision-driven winemakers discuss wanting to learn and appreciating opportunities to do so but say that time constraints prevent them from reading as much as they might. They make use of varied sources including peers, textbooks, seminars, and trade magazines and are willing to use vendors as information resources. They describe valuing highly their personal relationships with peers with whom they share information.

As a winemaker I don't follow a recipe. I always want to get better and to improve it, and maybe by kind of a little research I might take it or take a little part of it that's going to make me think something, you know, and so I'm not going to take their experiment or their new techniques or whatnot and totally make my wine from them, you know. It's just like, once again, you have to stay true to yourself. (WA 15)

While all interviewees mentioned in-house trials, vision-driven winemakers in particular were enthusiastic about trying new strategies for the sake of small improvements in wine quality, citing informal conversations with peers as the main source of inspiration for these experiments. They see conflicting information as an inevitable consequence of everyone having different opinions and different preferences and remain fairly untroubled because they will decide what works for them via in-house experiments or their guiding principles.

The vision-driven profile was not easily distinguishable by any pattern of survey responses, perhaps because they are open to learning from all types of sources and because, while they are not frustrated by conflicting information, neither are formalists (but for completely different reasons).

Utility-driven

You tend to go through this thought process of, you know, am I going to be able to pull that off with what I've got, and is it worth my time to do it, and then work forward from there. (WA 10)

Utility-driven winemakers express right and wrong in winemaking/growing as being fundamentally about figuring out what works for your situation. While they see value in scientific research, they emphasize that the test of science's value is in whether it works in a practical setting; experience earns more ready trust than science. They note researchers and winemakers/growers as having different goals – researchers 'want to make breakthroughs' (WA2), while winemakers/growers simply want to make better wine – and are consequently likely to dismiss 'cutting edge' research as not relevant or practical in real-world production situations. Congruently, they express less concern with trying to 'keep up' with new research.

This group is most likely to seek information when they have a specific problem to solve and place the least emphasis on continuing education. Utility-driven winemakers describe being open to finding ideas anywhere so long as the result is making better wine – 'We'll take information from anywhere' (WA6A) – but rely particularly on other winemakers, vendor representatives, and seminars. Vendor representatives are seen as helpful, able to offer solutions references to other winemakers/growers who have previously encountered a similar problem, tried the vendor's solution, and can provide a first-hand peer account of how it worked.

With my mind I'm not even trying to understand, I'm just doing bench trials and seeing what works instead of trying to understand the science of it. I don't think I'll ever wrap my mind completely around. Just bench trial it. If it works, it works; if it doesn't, move on to the next bench trial. (WA 7)

Like vision-driven winemakers, pragmatists emphasize that winemaking 'is not following a recipe;' while they might collect numerical data, how the wine tastes is always most important. Several noted that scientists can seem out of touch with reality and that scientific recommendations change over time, using these as reasons to trust experience and to be more or less explicitly mistrustful of scientists and scientifically supported recommendations.

I guess because wine is so complex that it's very hard for me to believe in numbers. (WA 10)

I was told I wasn't supposed to do it, but I knew a lot of people who did it and it worked just fine and then the research came out and said, well, it works. (WA 3)

Amongst survey respondents, utility-driven winemakers appear to form an identifiable cluster: very frustrated by conflicting information, more likely to doubt the trustworthiness of textbooks and WSU extension (still a small percentage), more likely to place high trust in their peers as resources, and more likely to use Facebook to gather information. They are also more likely to express other frustrations around using information resources, including information taking too long to find, being hard to use, and not being region-specific.

Pensive

I used to be really in-tune with what was going on in science and stuff like that, and now, well I still do. I don't know how to say this. I'm a little bit, kind of jaded, I guess, in that I mean I'm grateful for the education I have...I don't know how to say this. What we're trying to do, a lot of it is business, you know, it's marketing, it's selling wine, and so that's partially consumer-driven and partially

just taste. Hedonic things, and so sometimes it's like I don't really care what the pathway is for some compound. I just don't. (WA 11)

Two interviewees fell outside all three above profiles resemble each other, appearing to form a fourth profile. Both have strong technical backgrounds and prestigious educational pedigrees, but express doubts about the role of science in good winemaking. They maintain that scientific research is important, are thankful for and say that they actively use their educations. While they see right and wrong sometimes existing in winemaking, they also see many acceptable solutions for any given problem. Though both mention thinking about underlying scientific principles, they explicitly employ many other considerations in their winemaking beyond the scientific.

I don't see its applicability or how applicable it is toward what I'm doing any more. Like, the information I learn is still, the knowledge that I have is still very applicable, but the new tidbits that I'm seeing offered, it's not drastically altering what I'm doing in the vineyard and/or the winery. (WA 14)

I've actually been thinking a lot about the role of science in wine and especially in viticulture, but that's a whole 'nother topic. But anyway, yeah, no, I find experience is typically all I need to look for. (WA 14)

These winemakers find new research interesting, but largely irrelevant to their daily practice and have a growing disinclination toward bothering to keep up with it in general despite a general inclination toward and enjoyment of reading and education. They rely upon *AJEV* as their primary information resource and secondarily upon talking to other winemakers, and are willing to talk to vendors but have reservations about doing so. Both evinced some apprehension or embarrassment about their concerns around the role of science in winemaking.

Use of and preference for specific resources

Survey respondents were asked both about their actual information seeking practices and how they would ideally prefer to learn about new winemaking/growing information, but their stated preferences were in both cases the same. The following list draws from survey and interview data to describe sources in rough order of preference.

1. Other winemakers/growers

Together, survey and interview data suggest that peers are the most popular and oft-used information resource for WA winemakers/growers in general: over half consider peers among their primary two or three resources (Figure 2). Interview data support the survey findings, but suggest that winemakers with different attitudes consult with other winemakers/growers in different ways. Science-driven winemakers, who trust almost exclusively in scientific winemaking knowledge, report either consulting with a highly selective group of winemakers they consider their 'peers' (WA 13) or discounting 'hearsay' from other winemakers altogether because neighbors may be acting with 'absolutely no scientific basis' (WA 4). With that notable exception, all other interviewees reported that calling a knowledgeable friend is one of if not their first response to encountering a winemaking problem for which they need to learn new information.

I'm not so arrogant to think that, someone's probably had the same problem, someone smarter than me's probably figured, at least tried something. It get's passed around. (WA 6a; utility-driven)

Beyond asking for help with a specific problem, winemakers/growers cite casual, informal, often brief interactions with their peers as among the most frequent sources of inspiration for new ideas to trial in their own winemaking/growing. While

some describe conversing with winemakers outside their immediate neighborhood, few say that their network extends beyond Washington state.

2. Trade magazines

70% of survey respondents read trade magazines often or consider them a main source. Wine Business Monthly, Wines and Vines, Practical Winery and Vineyard, Vineyard and Winery Management, and Good Fruit Grower are all popular with over two-thirds of those who occasionally or often read trade magazines reporting at least sometimes reading each. Wine Business Monthly is the most widely read, followed closely by Practical Winery and Vineyard and more distantly by the other three magazines. Approximately 80% of readers rely on print copies; 20% to 30% read online versions of the magazine (some do both).

Interviews suggest that, while trade magazines are widely read and appreciated, at least some winemakers feel as though they lack sufficient detail to be useful – 'they dumb it up, and in that dumbing up you really can't make any conclusions' (WA 2, utility-driven); 'even in those articles that are published that I'm interested in, I just find that I want more' (WA 14, pensive).

3. Seminars and workshops

In seminars you can ask questions, so there, you can find out the details you need to find out. (WA 10, utility-driven)

In interviews, seminars are almost universally highlighted by winemakers/growers of all attitude types and across all demographics as a preferred way to learn; a third of survey respondents attend them often or consider them a main source. Universal consensus was that seminars were understandable, either aimed at about the right level of technical complexity or, in some cases, 'too basic' (WA9,

science-driven) – a comment made most often by experienced winemakers about seminars sponsored by community colleges for which they felt the intended audience was most likely early-career winemakers. The quality of individual seminars was reported as highly variable and related to the skill and rhetorical expertise (audience awareness, in particular) of the speaker, not to the sponsoring organization. Excepting the occasional skepticism about vendors as information sources (see 8. *Vendors as information sources*, below), winemakers/growers discussed seminars presented by WSU extension, community colleges, vendors, the Washington Wine Technical Group without drawing clear distinctions between these sponsors.

4. *Textbooks*

It's kind of tough finding good information. Generally you have to pay for it. So usually it's an archaic textbook that's sitting somewhere. (WA 16, vision-driven)

Two-thirds of survey respondents report using textbooks occasionally, often, or as a main source; only 10% never consult them. Several interviewees commented that textbooks – including older, classic textbooks – often contained key information that could be found nowhere else.

5. *Academic journals (AJEV)*

The only academic journal that winemakers/growers report reading with any frequency is the *American Journal of Enology and Viticulture*. Unsurprisingly, it is read by those with a self-perceived strong science background, though that may mean a BS, MS, or PhD in enology and viticulture, chemistry, or biology. In total, 20% read *AJEV* often or consider it one of their primary sources. Among interviewees both science-driven and pensive winemakers mentioned *AJEV* as among their main sources of information.

6. *Extension faculty and newsletters*

You can go right to the source, and I can call Jim Harbertson at WSU Prosser and ask him any winemaking question and get a somewhat more substantial or, well, valid reply. (WA 13, science-driven)

About a quarter of survey respondents reported contacting extension faculty often or as a main resource. Among interviewees who do, WSU extension faculty are perceived as helpful, friendly, and accessible. The ability to develop personal relationships with specific faculty and their willingness to be called about problems were frequently noted.

Extension newsletters and other publications are read often or as a main source by a third of survey respondents, but never read by 20%. Interview data corroborated this split, with some interviewees saying that they make frequent use of these resources – 'I get the [WSU extension] email blasts, and they give a short summary...and so I took the recommendation on the one and it helped out pretty good' (WA 12, vision-driven) – and others not mentioning them at all with no evident pattern. Without exception, when winemakers/growers are asked about WSU extension in interviews, seminars and direct contact with faculty are mentioned before extension publications.

8. *Vendors as information resources*

We have a lot of pretty reliable sources. ETS, Scott Labs are both pretty close and pretty accessible for us, and they have a lot of good information. (WA 3, utility-driven)

While approximately 12% of survey respondents never contact vendor representatives for information, 15% do so often or as a main source and 40% do so occasionally. Interviews suggested that, while education level *per se* was unrelated to

using vendors as an information resource, winemakers who perceive themselves as having strong science or viticulture/enology backgrounds are less likely to consult vendors and, on the contrary, more likely to have reservations about or outright deny their usefulness as a resource. On the contrary, those who consult with vendor representatives cite them as extremely useful, developing personal relationships with representatives as they might with extension agents.

9. Internet

Nearly half of survey respondents say that they rarely or never consult university or private company websites and over half rarely or never consult other websites. Approximately half of interviewees recounted rarely going to the internet for general education, but did so universally to find additional resources on a specific topic of interest that they had already identified by talking to a peer, attending a seminar, or reading a book or magazine. Google searches, winebusiness.com and the *Wine Business Monthly* online archives, and the *AJEV* online archives were mentioned most often. The web in general was widely regarded as a 'limited' (WA 16) winemaking/growing resource because the overall quality of web-based information is poor, a great deal of filtering is required to identify usable results, and reputable sites are few and far between. As a medium rather than an information source itself, internet-based information-seeking amongst winemakers/growers warrants more detailed attention (Bailey, Hill, & Arnold, 2014).

10. Social media

Facebook and Twitter are not widely used by winemakers and growers as information resources. Less than 10% of survey respondents use Facebook often or as a main source of information and two thirds never use it as a resource. Approximately

90% never use Twitter to learn about new winegrowing/winemaking information, and none cite Twitter as a frequent or main source. Social networking platforms were never mentioned in interviews. When interviewees mention consulting with peers, extension faculty, or vendor representatives, they reference making phone calls or, less often, sending emails.

Overall, survey respondents showed a strong preference for face-to-face or reading-based modes of learning over web-based sources in general (including websites, webinars, and videos), which most found tolerable, and social media, which a majority said they would not use (Figure 3).

Frustrations with information resources

While very few survey respondents said that resource-related problems actively prevented them from learning, frustrations were common and mostly related to time constraints: information taking too long to find or to read (Figure 4). Only 5% of respondents thought that having too many resources was a significant frustration, but 20% thought that having too few sources was a significant problem and 36% felt that being unable to find the information they needed was. Nevertheless, many didn't see these as concerns at all, reinforcing the idea that winemakers/growers are highly heterogeneous in their use of and attitudes toward learning about new trade information. Other significant frustrations concerned the process of finding information taking too long, sources being difficult to read, desired information being buried in information that isn't useful, and information not being specific to their region.

In interviews, winemakers/growers generally expressed positive feelings about information resources and scientific research – 'It's always great to have more resources' (WA 7, utility-driven) – true even for those who doubt the relevance of either to their

day-to-day work. Some did voice issues related to being unable to find sufficient information or needing to spend too much time doing so as frustrations – two in particular observed that information is sometimes, frustratingly, held privately by large companies – but most described these instead as time constraints.

I don't have a lot of free time, so that's why I do that [skim], otherwise I would love to read everything. Sometimes I start reading and I stop, but it's not because of them, it's more because of me. (WA 15, vision-driven)

While some winemakers/growers say that keeping up with new information isn't a priority for reasons enumerated above, many indicated that they would read more than they currently do if they had the time, with some expressing feelings of guilt or self-judgment around not spending more time on self-education. While interviewees' attitudes were generally positive, then, they might have expressed 'takes too long to find what I need' or 'what I need is buried in not-useful info' as 'frustrations' in a survey context.

In both interviews and surveys, winemakers/growers say that most new information they encounter is not 'relevant' or 'applicable' to them. Most interviewees acknowledge this as a consequence of winemaking/growing being highly contextual and do not articulate this as a frustration *per se*. Some, however, think that too much research involves expensive equipment they don't need and can't afford or impractical solutions. Those who complain about the inapplicability of research are, however, in the minority compared with those who are pleased that researchers are investigating their problems 'in their own backyard' (WA 12, vision-driven).

Discussion

Boshoff's study of winemakers' information-seeking behavior found that the 'enlightenment model' of research use (per the typology developed by Weiss, 1979) predominated amongst South African winemakers: they value and pay attention to research, but often cannot cite how they have put what they learn into practice (Boshoff, 2014). The same held true for the Washington winemakers and growers studied here: interviewees unanimously praised the value of research and yet most struggled to articulate how research impacts their winemaking/growing. Moreover, while all reported routinely engaging in continuing education behaviors, they often did not connect those behaviors with how they practice their craft. Interviewee's subjective impression of how much time they spend on continuing education ranged from "a very small percentage of what we do" (WA 7, utility-driven) to a major part of their job ('There's a lot of stuff out there and reading's what it's all about...You have to spend time doing it.' WA 9, science-driven). Ideas about how much time they *should* spend on self-education and what they expect to get out of it, however, were unrelated.

Assuming that winemakers must have some kind of motivation for continuing to spend time reading, attending seminars, and doing research, that these habits have benefits beyond direct applicability to winemaking/growing seems obvious. Per Carey's (2009) two-model framework of communication, winemakers/growers appear to seek information not just for "transmission" but as a "ritual" directed at supporting and maintaining communities: establishing their sense of self personally and within the community and via the social aspects of networking and participating in events (Burton, 2008). Their efforts may not earn economic capital in terms of higher sales revenues but social and cultural capital instead, as Bourdieu (1990) would suggest.

This study finds evidence for four winemaker/grower types describing four different sets of attitudes and practices around the role of science in winemaking,

individually held concepts of what it means to be a *good* winemaker or grower and thus, indirectly, concepts of wine quality. To science-driven winemakers, good winemakers employ evidence-based practices and make wine safely and correctly; good wine is consistent and technically correct. Vision-driven winemakers describe good winemaking as staying true to personal visions of what a wine should be, even if that means doing things a bit differently; risk-taking wine is better than safe wine. They do not doubt the veracity of scientific research, but they do sometimes insist that its goals are not their goals. To utility-driven winemakers, good winemakers trust in real-world experience, not necessarily (though sometimes) disdaining scientific research but ultimately doing whatever they find works for them; wine quality relates solely to the end product. And pensive winemakers actively question what good winemaking means, valuing scientific research and formal training but questioning their role in making good wine or being a good winemaker.

These types are, necessarily, oversimplifications, flattening complex identities and emphasizing the commonalities within subgroups while de-emphasizing individuals' differences (Guest, 2013). These risks may nevertheless be worthwhile when the typology is understood as a tool – limited, but useful in a particular context – relating to what different winemakers/growers find most valuable and therefore to ways in which science communication can be most relevant. Science-driven winemakers will likely find research information most valuable when it focuses on the details and integrity of the science. Vision-driven winemakers may in contrast be best served by research presented as *options* for achieving specific style objectives. Utility-driven winemakers, most likely to be skeptical toward the accuracy or usefulness of scientific research, may see greatest value when connections are highlighted between scientific research and practical experience. And, if scientific research findings might oppose

common experience, utility-driven winemakers' skepticism may be assuaged by explicitly addressing that conflict and offering an explanation; in other words, by expressly treating experiential knowledge as real and making the science more real by reenacting it in a familiar space (Woolgar & Lezaun, 2013). The preferences and motivations of pensive winemakers are less clear. In all cases, detailing the parameters of approaches designed for winemakers/growers holding various attitudes will require additional study specifically along those lines.

Market segmentation, borrowed from business theory, may be a useful framework for approaching this additional research. Market segmentation is a means toward tailoring a message to different sub-groups of a heterogeneous target audience based on the values they hold. Per Beane and Ennis (1987), segmentation is conducted for two reasons: '(1) to look for new product opportunities or areas which may be receptive to current product repositioning; (2) to create improved advertising messages by gaining a better understanding of one's customers' (p. 20). In the present context, the first reason becomes seeking to understand what winemakers/growers want from scientific research and extension; the second describes designing research/extension messages to be more attractive to particular types of winemakers. Bruwer and Li (2007) define as 'the nexus of market segmentation' 'that it allows a business to deal with diverse customer needs in a resource-efficient manner,' a statement which seems to perfectly describe the needs of extension and other science communicators trying both to persuade winemakers/growers to employ scientifically supported practices and to support their specific information needs while managing limited resources (King & Boehlje, 2000). Bruwer and Li review literature showing that demographic information is not an accurate predictor of 'diverse customer needs,' which are better described by 'lifestyle patterns' related to the 'needs and values [products] reflect,' conclusions

congruent with the present study in which scientific information represents both needs and values to winemakers/growers.

Market segmentation techniques have been employed in science and medical communications to design messages concerning climate change awareness for different sub-groups of Americans holding different sets of values (Nisbet, 2010), alcohol abuse prevention (Moss, Kirby, & Donodeo, 2009), and teenage substance abuse prevention (Suragh, Berg, & Nehl, 2013). Similarly, thinking about science communication with winemakers/growers through the lens of market segmentation seems likely to yield new ways of connecting with a diverse audience more effectively. Nevertheless, a marketing approach toward market segmentation may be inappropriate in this setting.

Representing attitudes in terms of benefits – that is, assuming that product benefits represent the fundamental rationale for consumer behavior (Honkanen, Olsen, & Myrland, 2004) – could be productively informed by contemporary sociology of science research which observes that individuals' behavior is not always rational, not always internally coherent, and intricately social and political (Law, 2004; Wynne, 1992).

The richest body of literature on information-seeking preferences and resource use patterns exists in medicine around the behaviors of physicians and nurses (challenged only, perhaps, by that surrounding engineers; Leckie, Pettigrew, & Sylvain, 1996). Both groups are expected to engage in evidence-based practice (Kim, Bartlett, & Lehmann, 2005; Kritz *et al.*, 2013; Winters *et al.*, 2007). Evidence-based medicine is, per an article considering surgeons' research use, 'a process of lifelong self-directed learning in which caring for patients creates a need for information about diagnosis, prognosis, treatment, and other health care issues' (Bhandari *et al.*, 2003, p. 1183).

Making appropriate topical substitutions, we might equally well discuss evidence-based winemaking. A 2003 meta-analysis of physicians' information-seeking behavior (Dawes

& Sampson) and several more recent studies (e.g., Kim, Bartlett, & Lehmann, 2005; Kritz *et al.*, 2013) have demonstrated that textbooks and talking to colleagues are physicians' preferred resources – nurses also make frequent use of practically-focused professional journals (Winters *et al.*, 2007) – but that high variation exists among individuals (none examined physician identity as a potential descriptor of that variation). The winemakers and growers in this study appear, at least in these ways, similar to these other professional groups.

Despite obvious differences in what we expect of health care professionals versus winemakers/growers, the two groups are not wholly dissimilar. Both medicine and winemaking are simultaneously informed by scientific research and everyday practice, involve adjusting scientific recommendations to highly varied circumstances involving financial and other physical constraints, and juxtapose scientists who conduct research but rarely if ever practice the related craft with practitioners who conduct research only informally. And yet, societal expectations of medical professionals are much different than of winemakers. Food producers might be seen as indirect protectors of human health with responsibilities similar in gravity if different in kind to those of physicians, but wine producers are historically not held to the same standards as food producers. As was observed when the United States Food and Drug Administration (FDA) began in 2013 to enforce the Food Safety Modernization Act (FSMA) enacted in 2011, wineries rightly have important differences compared with other food processing facilities. (Wineries and related businesses have been required to register with the FDA since the Bioterrorism Act of 2003, but were only rarely inspected until the FSMA mandated regular inspection of *all* registered food processing facilities; Howe, 2012) Federal inspectors accustomed to touring milk processing plants and the like, now responsible for wineries, were appalled to see winemakers and cellar workers wearing

neither gloves nor hairnets, grapes being crushed outside unprotected from birds and insects, and dogs running free through the cellar. (Smith, 2013) Winemakers were equally appalled to be told that these traditional, standard, accepted practices were not only illegal but disgusting. In asking authorities to apply a different set of standards to wineries, wine industry representatives pointed out that no known case of food poisoning has ever been attributed to wine. Because alcohol at wine concentrations acts as a preservative, helped by the low pH wine generally enjoys, wine poses an exceptionally low food safety risk (Howe, 2012). Biogenic amines, heavy metals, (Pozo-Bayón, Monagas, Bartolomé, & Moreno-Arribas, 2012), and ochratoxin A (Mateo *et al.*, 2007) are all real health risks, but avoiding them is a very small part of a winemakers' job.

Evidence-based practice in winemaking is, then, largely about wine quality rather than wine safety. What 'quality wine' means for any given winemaker or grower dovetails with the story they want their wine to tell, the role they see for science in winemaking, and the information-seeking behaviors they practice. Unlike physicians or nurses, winemakers and growers are not constrained by a social mandate to practice their craft in accord with scientifically-supported recommendations. Quite the contrary, social portraits of wine as art and winemaking as romantic and expressive allow for and even encourage deviations from scientifically-supported practices in the interest of telling the story of a particular place, winemaker, or worldview. The concept of evidence-based practice, as it has developed in medicine, exists in winemaking and wine growing; it is strong, for instance, in New Zealand, where corporate definitions of high quality and regionally appropriate style have developed in tandem with industry-oriented research (Brodie, Hollebeek, & Benson-Rea, 2006). Marked by high diversity and perhaps, as some interviewees suggested, a 'wild West' or 'cowboy' mentality of

strong individualism (WA 11, pensive), Washington state is much different. Judging that as a problem necessitates taking a judge's stance on whether Washington state wine quality is acceptable as it is or needs to change, which may, in fact, be what extension or the Washington State Wine Commission wishes to do.

Aside from the potential proscriptive desires of industry organizers, the present research suggests new approaches toward framing winemaker/grower-oriented communication for researchers, extension personnel, and others charged with research dissemination. Rather than targeting winemakers or winegrowers, greater success may be had by targeting communications to science-driven, vision-driven, or utility-driven industry members – that is, to industry members holding specific attitudes towards research and the role of research in winemaking/growing. Acknowledging these attitudes, implicitly or explicitly (if judgmental attitudes can be withheld) does two things. First, doing so frames messages in ways coherent with winemakers' and growers' worldviews. In the face of potential contradictions between new and previous knowledge, like the physicians of whom Law speaks,

their major preoccupation is in working out *what to do*. In an ideal world all the indications line up and fit together... But since the world is not perfect often those involved need to work out how to act in the face of conflicting indications.

(2004, p. 52)

Communications enact science, and 'enactments...don't just present something that has already been made, but also have powerful productive consequences' (p. 56) for the ways in which winemakers and growers construct their ideas about how wine works. Reducing conflicts between indications by making connections with the realities to which winemakers and growers already subscribe makes it easier for them to incorporate rather than discard a research-based message and asks them to do less work.

Second, doing so recognizes and validates winemakers' and growers' experiential knowledge. Irrespective of whether communicators actually believe in this validity, respecting relevant expertise outside of their own sphere and moving toward the "democratization" of science for which so many have called (see, for example, Carolan, 2008 and Collins & Evans, 2002) improves their message's credibility in the eyes of their audience. As Carrier observes, scientific experts' 'ability to take up social hopes and fears, or aspirations and concerns, is an essential element of good expert advice' (2010, p. 206). Interviewees' comments indicate that peers, seminar presenters and, for many, local extension personnel are strong in this ability while written communications often fall short. This discrepancy will unavoidably have much to do with the value of personal relationships and face-to-face interactions. Nevertheless, those communicating via less personal media can understand the attitudes held by the type of winemaker and grower who comprise the audience for a particular communication tool and employ audience-appropriate, audience-sensitive framing. Doing so not only improves the palatability of the message, but invites co-participation on all sides – from scientists and winemakers and growers – in a knowledge-creating system able to see scientific and experiential knowledge as working not against each other, but in collaboration.

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Table 1. Major themes common across all or nearly all interviews

Winemaking is highly contextual	Research is most valuable when it's local
Money drives winemaking/growing decisions	More information is a good thing
Good winemakers keep learning	WSU research should be supported
'The proof is in the pudding'	Problems have many acceptable solutions
Washington winemakers don't like to be told what to do	Experimenting in the winery is important

Table 2. Winemaker/grower identity profiles

<p>Science-driven</p> <p>Right and wrong do exist in winemaking</p> <p>Follow scientific recommendations first</p>	<p>Vision-driven</p> <p>Right and wrong do not exist in winemaking</p> <p>Follow your own winemaking vision first</p>
<p>Utility-driven</p> <p>Winemaking is figuring out what works for you</p> <p>Trust experience first</p>	<p>Pensive</p> <p>Right and wrong sometimes exist in winemaking</p> <p>Science's role in good winemaking is uncertain</p>

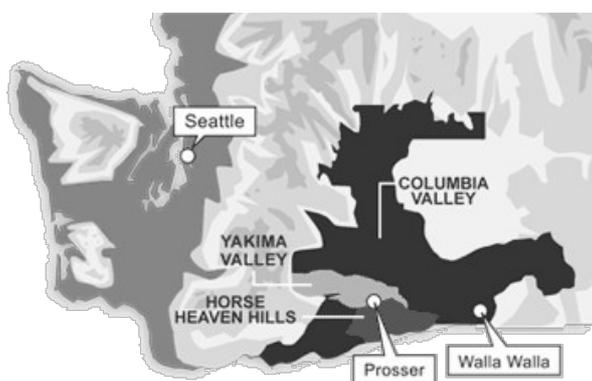


Figure 1. Map of Washington state highlighting Walla Walla and Prosser, the communities around which interviews were centered. Reproduced with permission from the Washington Wine Commission.

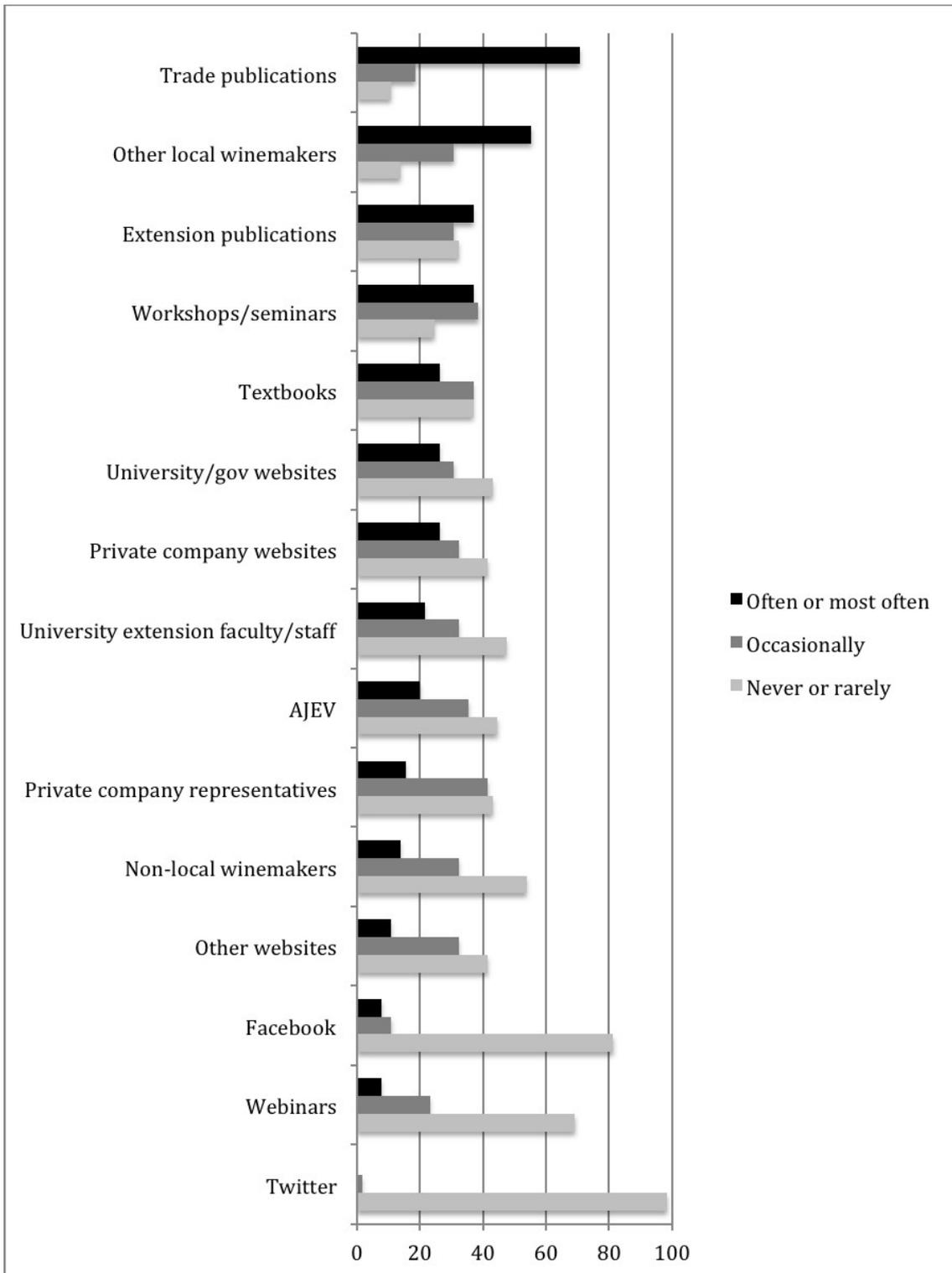


Figure 2. Total respondents' information resource usage ("How often do you use the following types of resources to learn about new winemaking/growing information?")

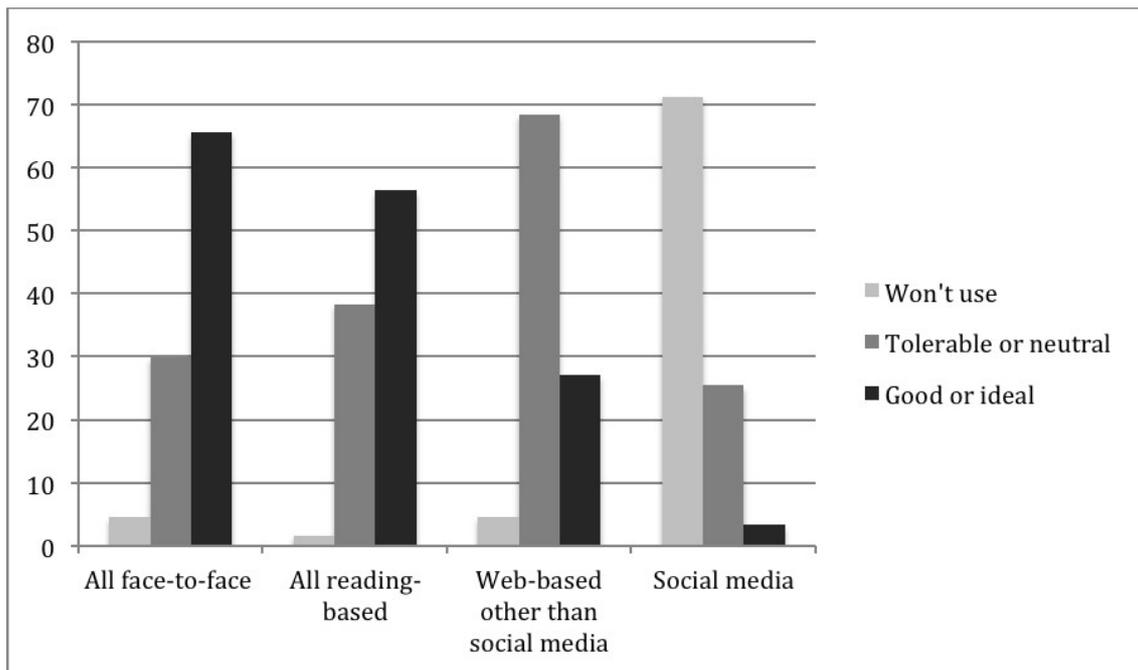


Figure 3. Responses to “How attractive do you find the following ways of learning?” aggregated by resource type

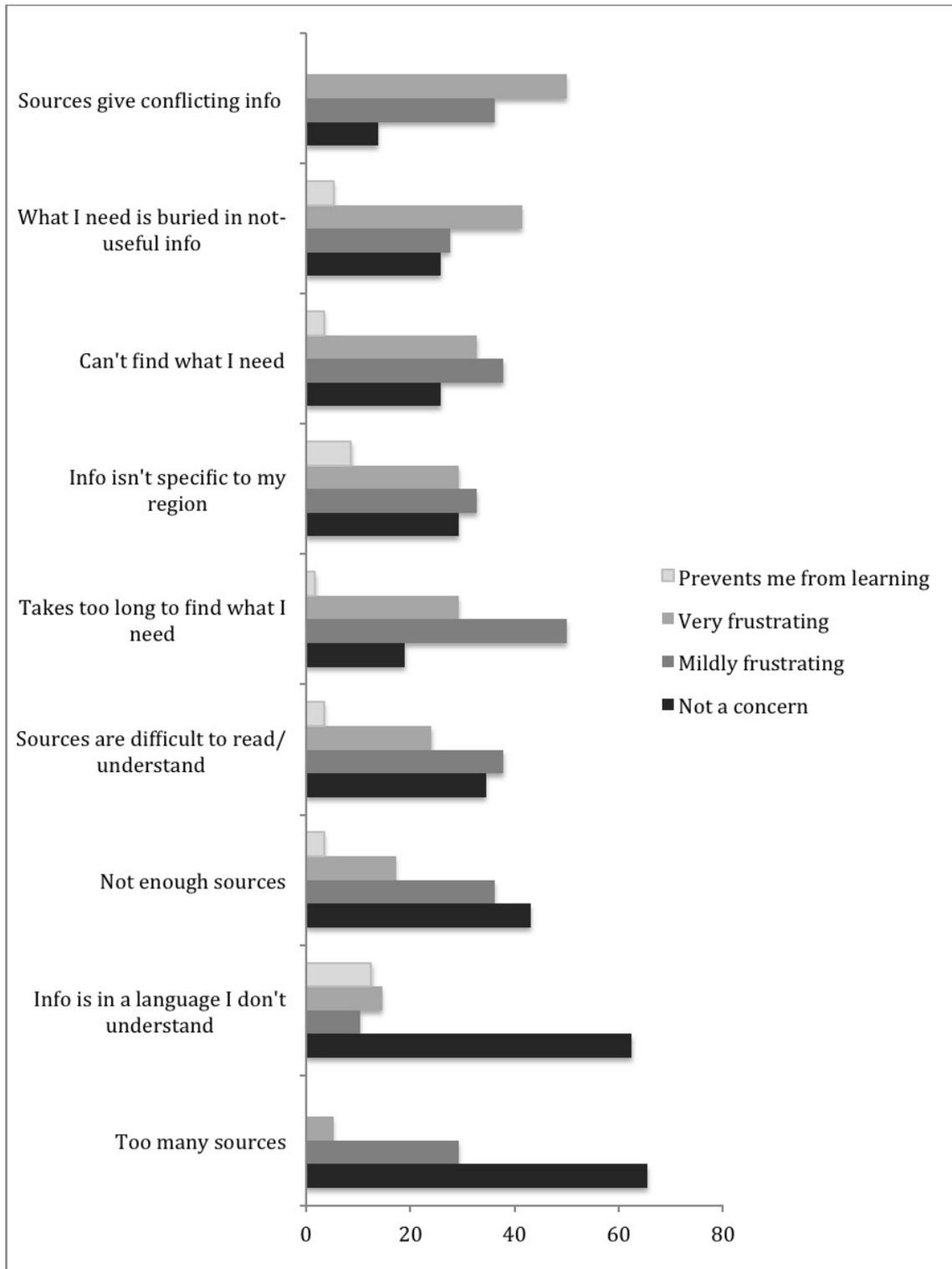


Figure 4. Responses to “What are your frustrations in learning about winegrowing/winemaking information?”