

Final Report on:
MAKING THE MOST OF FINE FLEECE:
ENVIRONMENTAL, ECONOMIC, AND SOCIAL COSTS AND
BENEFITS OF ALTERNATIVE MARKETING STRATEGIES FOR
SHEEP WOOL

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PROJECT SUMMARY

The overarching goal of this project was to help small-scale sheep producers accurately evaluate if they might improve the sustainability and profitability of their sheep operations through sales of specialty fiber products. In addition to quantifying economic costs and returns, this project evaluated environmental and social aspects of various wool products and marketing approaches.

While wool is a wonderfully versatile and sustainable fiber, it rarely provides a large profit margin for producers, even when coming from sheep bred specifically to produce superb fiber. The economics of small-scale sheep operations can be marginal, especially for beginning shepherds. The difference between a thriving venture and bankruptcy might be the successful implementation of home-based enterprises that add significant value to standard sheep products.

Many shepherds already possess the core component of a value-added fiber business – they have fleece to sell – but few have sufficient expertise in fiber arts to develop such a business with a high probability of success. This project test-marketed a variety of products including fine- and medium-diameter raw wool from whiteface range sheep; show-quality raw wool; and wool that had been commercially processed into batts, roving, combed top (undyed and dyed), and three ply yarn.

Sustainability and profitability were highest for premium quality, natural-colored raw wool prepared for direct sale to handspinners. The manufacturing and sales of combed top and carded roving from natural-colored sheep also met criteria for sustainability and profit. Dyed wool products ranked low in environmental compatibility; even the most eco-friendly dyes produced exhaust water unsuited for graywater release. Coarse-grade white wool over 30 microns in diameter was the least profitable of the raw wool products. For shepherds producing less than 200 pounds annually of white coarse-wool, shearing costs may exceed revenue from wool sales.

I sold fiber directly to handcrafters through three venues. Fiber sales at sheep and fiber festivals were brisk but profitable only after recouping substantial upfront costs for outfitting a professional-looking booth. As a new fiber business operator, I was unable to successfully compete with well-established businesses to purchase booth space at the largest fiber festivals. New fiber producers may need to begin by setting up booths at new fiber festivals.

By exhibiting fleeces in state fair competitions, my wool had good visibility to many potential customers without requiring booth infrastructure or steep entry fees. I sold most of the fleeces

to fair goes at excellent prices but profits were reduced by travel costs and limits to the number of fleeces allowed per event. Participation in an area ag/craft show was cash negative, likely because most people attending the rural event were not willing or able to pay the price for handcrafted, sustainable fiber.

Internet marketing is widely used by small-scale shepherds. Business websites, Etsy stores, Facebook pages, and Ravelry groups provide platforms for selling raw and finished fiber goods. Sales from my website were modest, with website fees, shipping, packaging, and advertising costs creating a net financial loss. Informal surveys of shoppers at my fiber booths suggested that Internet sales would have been significantly higher – even profitable – had I used social media platforms rather than a business website.

In all sales venues, customers were more willing to pay premium prices for raw show fleeces than for any other products I offered. High quality combed top was the next most popular and profitable item. My custom sweater yarn in nine lovely natural colors was the most expensive product to produce and hardest to sell at any price.

Based on this study, I posit that small-scale shepherds might optimize wool income by either of two quite different strategies.

Shepherds wanting high income from wool might consider raising a hardy breed that appeals to handspinners; natural-colored Dohne Merinos and Corriedales work well for me. Shepherds would need to carefully tend the flock to enhance wool quality (including using sheep coats) then sell pristine raw fleeces to handspinners via in-state fiber events or through social media. Wool skirtings could be sold to craftspeople for wet-felting projects, or sent for professional processing into combed top. This marketing niche best fits meticulous shepherds with good sales skills and the patience to sell just a pound or two of wool at a time.

Alternatively, shepherds might raise a site-adapted breed of whiteface fine-wool sheep, employing practices that safeguard wool quality but also minimize input costs. The wool could be sold, after minimal skirting on the shearing floor and packing in bulk bags, to a reputable regional wool buyer or cooperative wool pool. This time-proven method of wool marketing is low risk, though only large flocks that rigorously control production costs consistently derive a big wool check this way.

No matter the wool marketing strategies used, to achieve long-term sustainability small-scale sheep operations need to carefully limit inputs and also harvest income from additional enterprises such as sales of breeding stock, meat, composted manure, or custom grazing services. Aggregating into cooperative groups of like-minded shepherds for purchase of inputs and sale of products might also improve profit margins, business success, and rural resilience. Only those practices which conserve or regenerate the health of the land, the sheep, and the human community will be sustainable for the long term.

BACKGROUND

Farmers have long kept small flocks of sheep to manage weeds and grass around their farmsteads. Requiring little infrastructure and being relatively easy to handle, sheep added minimal expense to family farms while they reduced land maintenance costs, helped fill farmers' freezers with high quality meat, and boosted farm income through lamb sales.

But sheep numbers in the US have declined a staggering 80% since 1960. Most landowners now mow or use herbicides to control vegetation around their facilities. Summer fallow, field edges, brushy patches, and crop residues that once were grazed by sheep are now tilled or sprayed to control vegetation.

Ironically, while sheep numbers were plummeting, conservation scientists were documenting the success of targeted sheep grazing in controlling weeds, reducing fire hazards, and managing plant succession in natural communities for the benefit of native wildlife and vegetation. Food scientists recently reported that grass-raised lamb is one of the most healthful of proteins, with a fatty acid profile approaching that of salmon. And now the burgeoning consumer trend toward local/sustainable/handcrafted/homegrown goods has created a fiber market niche uniquely fitted to small-scale shepherds.

Most small-scale shepherds sell wool at commodity prices via participation in cooperative wool pools, or through direct sales to regional wool brokers. These markets provide convenient, proven venues for wool sales that help sustain sheep operations. Cooperative wool pools also create a community of sheep producers, Extension specialists, and others who work to enhance success for the sheep industry.

The value of wool pools and commodity wool buyers is not to be disputed, and this project does not in any way seek to undercut commodity wool sales. But not all sheep produce fleeces within the “only white and fine” wool parameters preferred by mainstream wool buyers. Natural-colored (i.e., gray, black, brown, or spotted) or otherwise “off” wool is discounted or discarded. At \$5 or more per head to shear wool sheep at least once a year, it’s a blow to the economics of shepherding to throw away wool. Crossbred sheep, which are often preferred by small shepherds due to the positive effects of heterosis on vigor, reproduction, and growth, can produce individuals with colored spots or completely colored fleeces. Wool with even a speck of color contaminates white wool and slashes prices paid for it. For fear of colored fiber contamination, productive crossbred sheep are widely avoided in favor of breeds with lower vigor, growth, or reproductive rates but better wool.

It would be a boon for shepherds to profitably market “off” lines of wool. As one small step in that direction, this project was designed to provide information useful to shepherds contemplating whether a home-based fiber venture might shore up their profitability. Business risk for shepherds can be reduced by better understanding of the economic, environmental, and social implications of a specialty fiber enterprise.

More profit will help farm families welcome the next generation into the business and back to the land. Additional income from enterprise diversification helps farmers weather economic downturns such as the plummeting lamb prices of 2012. More, and more dependable, income helps keep land in ag production. In Montana, long-established farms are now often sold solely for their amenity values such as recreation. The land is then all too frequently taken out of production and the skillful hands of experienced land managers. A cascade of calamities can follow: biodiversity decreases, weeds and erosion increase, land stewards are lost as mentors and neighbors, and the socioeconomics of rural communities are impoverished.

Urban consumers are emerging as important allies in rural rejuvenation. “Slow Fiber” craftspeople pay handsomely for fleece with a “good story” behind it. Fiber connoisseurs want to use their purchases to connect with family farmers, and through them experience deep ties to

land, livestock, nature, and traditions. Handspinners seek tactile connection with the circle of life through their purchase of fine fiber from friendly family farmers.

Shepherds need this connection as well. Many small-scale shepherds operate at a loss or a thin margin of profit. In Alberta in 2010, low-performing flockmasters spent \$298 to raise a lamb selling for \$179; average performing flockmasters spent \$227 to raise a lamb selling for \$184; and high performing flocks spent \$160 to raise a lamb selling for \$185 ([http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/sg14663](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sg14663)). Prices can fluctuate wildly in commodity sheep markets, and sketchy economics aren't conducive to good husbandry, let alone allowing shepherds to pass their business on to the next generation. One way to bring young people back into sheep-based agriculture is to exploit niches of value-added fiber products, particularly those products that reward good stewardship, integrity, and sustainability.

The US market for handspinning fiber has 35,000 fiberists spending \$41,000,000 annually (The National NeedleArts Association, 2013). Certainly there are some shepherds with healthy businesses marketing specialty wool, such as Joanna Gleason (www.gfwsheep.com) and Dee Heinrich (www.peeperhollow.com). But nationally-acclaimed fiber arts teacher Judith MacKenzie told me that perhaps 5% of the specialty fiber businesses launched each year become profitable and persist more than a few years. While many shepherds are eager to supply this market, it is a difficult enterprise in which to succeed.

Beginning shepherds need more information to inform their decisions about whether to launch a specialty fiber enterprise. Despite several years of diligent research I know of no systematic study to help shepherds evaluate the likely economic, environmental, and social costs and benefits of a fine fiber enterprise. I've researched this because as a farm-flock shepherd, I've found that selling small quantities of non-standard wool through commodity channels is sometimes not possible (they won't take natural-colored wool) and usually not very profitable.

For five years I sold most of my wool clip through commodity channels, receiving less than \$1.50/pound on average. All natural-colored fleeces were unsaleable through this venue. But in 2013 one of my colored Corriedale fleeces was chosen Handspinning Sweepstakes Champion of the Montana State Fair. I sold this and another similar fleece for \$20/pound to handspinners at the fair. I also prepared two Targhee fleeces, one of which won Best Fleece of Show. The Targhee fleeces sold for \$12/pound after the competition. Fair premiums and sales income from these four fleeces totaled \$556, while through the commodity market I would have received \$45 for the same fiber.

As a handspinner myself, I've purchased fiber from across North America through online sources. I've sold fleece to people as far away as Florida, New Jersey, Oregon, and Texas. There is an elusive but lucrative market for the wool I raise, if I can learn to strategically process and market it. There are several other beginning, small-scale shepherds nearby also eager to sell specialty fiber, but they can't risk time and money in testing the market. We all struggle with the (poor) economics of (small) scale, and that's kept family sheep farms down for too long.

METHODS

My flock of 100 adult fine- and medium-wool sheep were professionally sheared in 2015, 2016, and 2017. All fleeces were lightly skirted on the shearing floor to remove belly wool, which was

bagged separately. Tags (manure and urine stained bits) and wool from the top knots and lower legs were sorted off for onsite composting. These lightly skirted fleeces ranged from 7.8 to 13 pounds, with lamb fleeces being the lightest and mature ram fleeces the heaviest. Each skirted fleece was bagged separately and labeled with the individual sheep ID. Bagged fleeces were stored inside, in the dark, with bag tops open for ventilation, until they could be further sorted.

Within a week of shearing, I sorted each individual fleece into one or more wool lines (or categories) based on suitability for eventual marketing as:

1. Premium, show-quality fleeces. These were primarily from sheep which had been coated with the goal of producing exceptional fleeces for wool competitions and eventual sales to handspinners. These fleeces were carefully groomed and rolled for display, then stored individually in bags in a cool, dark room.
2. Carded roving or combed top. This wool and that reserved for yarn was the cleanest, strongest, longest fiber I high-graded out of the uncoated fleeces. On average, about 25% of each fleece, often from the shoulders and side, was sorted into this high-value line. The wool was sorted by color as well: white, gray, black, and moorit (red-brown). White roving was processed at Thirteen Mile Wool Mill in Belgrade, Montana. Combed top and colored roving was processed at Mountain Meadow Wool Mill in Buffalo, Wyoming.
3. Batts. This wool line was mainly shorter-stapled Targhee fleeces with some vegetable matter contamination. Batts were processed at Thirteen Mile Wool Mill.
4. Yarn. Sorted as described above in 2. Yarn was processed by Mountain Meadow Wool Mill.
5. Commercial bulk fiber. Fiber remaining after initial skirting was sorted into five lines: fine (less than 23 micron) white wool; coarser white wool (23-25 micron); crossbred white wool (above 25 micron); white wool with burrs or hay contamination (the “burry” line); and colored wool with significant vegetable matter (see 6 below). White wool was rebagged into fabric wool sacks then sold to a commercial wool buyer, Center of the Nation Wool.
6. Seconds for felting projects. Colored wool with significant vegetable matter was set aside for home processing into felted pet beds, boot rugs, and tractor seat covers.

I dyed some of the white roving and top using two different methods to compare water quality impacts and buyer preferences. The first dye method used Greener Shades brand acid dyes and food-grade citric acid. I set the acid dyes using solar heat. The second method used Earthues plant-derived dyes and alum (aluminum potassium sulfate) mordant, set with heat from microwaving the fiber afloat in the dye bath. During dyeing, I took water quality samples from 1) hot tap water; 2) water remaining after wool was washed with commercial, “eco-friendly” wool wash detergent; 3) exhaust water from alum mordant pre-treatment of wool; 4) exhaust water from dyeing wool with Saxon blue natural dye with alum mordant; and 5) exhaust water from dyeing wool with Greener Shades aqua blue dye and citric acid. Within 24 hours of collecting them, I mailed the water samples to the Soil, Water, and Plant Testing Laboratory at Colorado State University, where they were tested for basic chemistry, heavy metals, and suitability for stockwater and crop irrigation.

In preparation for selling products, I researched and developed labeling, packaging, shipping plans, and sales agreements. I hired a graphic designer and though we worked 80 hours to draft and refine logo alternatives, I was dissatisfied with the final result and chose not to use it in marketing.

Using the Squarespace web platform for online stores, I built a website at www.PrairieShepherd.com to market my products. To heighten awareness of the website I

purchased one 1/6th page ad, plus two classified ads in editions of the Natural Fiber Guide of *SpinOff*, the most popular US-based magazine for handspinners.

I participated in one major multi-state fiber festival, three in-state fiber festivals, four state fairs, and one local craft/ag show. I gave one keynote presentation on *Science and Serendipity in Search of Sustainable Prairie Sheep* at a fiber guild retreat (slide presentation attached as a media file). I offered two classes on wet felting techniques at a yarn store, and taught over 300 grade school students the rudiments of handspinning and sustainable shepherding in a one day event. I gave private lessons to five grade schoolers, three teenagers, and four adults wanting to learn wet felting and spinning. I provided sheep husbandry information to people from six ranches from three states, and provided input to four shepherds pondering sale plans for their wool clips.

To assess sustainability of the various products I tracked all costs, inputs, and income throughout the project. I summarized this in a simplified version of the MultiCapital Scorecard for company sustainability (www.multicapitalscorecard.com and www.sustainableorganizations.org). This context-based method measures performance relative to organization-specific standards for sustainability. Ratings I assigned were qualitative and had no absolute value outside this comparison.

RESULTS AND DISCUSSION

Economics of Wool Marketing

Worst-case scenario for shepherds of wool sheep is paying to have sheep sheared then having to pay again to dispose of the wool because there is no market for it. It can happen. With shearing and wool handling costs for small flocks now hovering around \$7.50 a head, a shepherd with a hundred sheep could lose more than \$1,000 annually on wool alone. The only way to secure value from the fiber in this sad circumstance would be to sell sheep with the weight of the wool still on them. Analogous to selling the goose that lays golden eggs, selling your flock to get some cash for their wool definitely fails any measure of sustainability.

Small-scale shepherds who sell their wool at commodity prices better have other ways to help pay their bills. During this study my white fine-wool clip made a slender profit of about \$10 per sheep, but for coarser (30 micron) wools, shearing costs exceeded sales revenues.

There is a modest but expanding market for domestic production of luxury-grade wool products for sale to handspinners and other fiber artists. Success in this niche market hinges on the “story” behind the products offered. Fiber artists often pay ten to twenty times the commodity price for high quality fiber produced by family farms with reputations for excellent stewardship and unswerving commitment to customer satisfaction. Capturing large prices is contingent upon more than sustainable agriculture; big payoffs also hinge upon savvy business practices that position products favorably in easy view of likely buyers.

Of the seven main products tested in this study, I found the highest financial rewards per pound of product in selling premium quality fleeces to handspinners (Table 1). The lowest returns, more accurately described as the biggest losses, came from yarn production. Unless sales of the yarn greatly improve in the future, I would have been money ahead to compost the wool I had made into yarn.

In short I learned what successful shepherds have known for centuries: sheep are low cost, low return beasts, and shepherding pays best when shepherds don't spend. The closer I can sell fleece to the back of the sheep, the better chance I have to be profitable.

Incidental to the planned products tested in this study, I prototyped several more sheep-related products. Tanned sheepskins, and wet felted utility items like pet beds and tractor seat covers, have good potential for profit. Kits for crafters to make their own felted soaps and luxury scarves sold at narrower profit margins, but tweaking their manufacture could improve sales and prices. Wool-stuffed pillows are pure luxury with a hefty profit potential (Table 1).

Comparison of Sales Venues

I sold fiber directly to handcrafters through three venues. Fiber sales at sheep and fiber festivals were usually brisk but profitable only after recouping substantial costs for outfitting a professional-looking booth. As a new fiber business operator, I was unable to successfully compete with well-established businesses for booth space at the largest fiber festivals. New fiber producers may need to begin by setting up booths at new fiber festivals.

By exhibiting fleeces in state fair competitions, my wool had good visibility to many potential customers without requiring booth infrastructure or steep entry fees. I sold most of the fleeces to fair goers at excellent prices but profits were halved by travel costs and limits to the number of fleeces allowed per event. Display of fleeces at an area ag/craft show was cash negative, likely because most people attending the local event were not willing or able to pay the price for handcrafted, sustainable fiber.

Internet marketing is widely used by small-scale shepherds. Business websites, Etsy stores, Facebook pages, and Ravelry groups provide platforms for selling raw and finished fiber goods. Sales from my website were modest, with website maintenance, shipping, packaging, and advertising costs eating up most of the income. An informal survey of shoppers at my fiber booths suggest that Internet sales would have been significantly higher had I used Facebook or Etsy rather than a business website. I had thought that a blog might boost sales at my website, but only 7 (27%) of 26 fiber booth visitors said that farm blogs induce them to purchase fiber. This despite 100% of 22 people saying that they want to support family farms and small-scale shepherds. Customers were more willing to pay higher and more variable prices for raw show fleeces than they were for roving, top, or yarn. Customers at fiber festivals often shop with their smartphone in one hand, a skein of yarn in the other, checking festival prices against the Internet.

Environmental Footprint of Wool Products

Results of the CSU water quality tests were definitive that the wastewater from any phase of wool processing should not be used at my place for long-term irrigation or stockwater (see supplemental files titled Wool Dye Water Test Summary 2016). Even the straight tap water from my kitchen has excessive sodium and salinity for sustained use as irrigation water, so it's not surprising that exhaust water from dyeing would not be safe for discharge on my soils. My original plan was to also test for effects of the discharged water on soil health, but the unequivocal results of the water testing ruled out all options for graywater use of exhausted dye

liquids. Soils at my ranch are naturally tight, with high pH, which would only magnify negative impacts of using dye exhaust water for irrigation.

I concluded that my breeding strategy to include natural-colored sheep in the flock is the best and probably the only environmentally sound way to produce quantities of colored wool on my property.

Beyond water impacts, I also gauged environmental impact by the mileage embodied in each product I prototyped. Distance traveled in manufacture of products is a commonly used metric of environmental impact. There is a recent fashion trend to purchase goods within local “fibersheds” which sustainably grow fiber and manufacture garments within a compact geography (www.fibersheds.com). Operating a secluded ranch in northern Montana doesn’t position me into an established fibershed, but I chose to limit the carbon footprint of my products by restricting embodied mileage to less than 1,000 miles during manufacture. Note that this does not include mileage that the products might travel after they are purchased.

While a thousand miles seems quite a distance, it ruled out products that use chemical dyes, cotton ticking, and distant processors (Table 1). It precluded sales through booths at the most successful regional fiber festivals. It prompted me to search hard for packaging materials and labels produced – or at least sold – within Montana. It left me with only a few wool mills to consider. While profits were good for colored sheepskins and will also be strong for wool pillows, I’m going to need to find closer manufacturers to reduce their carbon footprints.

Triple Bottomline Sustainability Rankings

A short-term, shoestring project such as this doesn’t warrant robust, quantitative triple-bottomline sustainability assessments. This I discovered only after I went to calculate carbon footprints or embodied energy of the various products tested in this study. Turns out this is a complex, controversial field in which I have no background. So I scouted online for a qualitative sustainability assessment to meet my need to understand the social, environmental, and economic impacts of fiber products I prototyped.

Martin Thomas and Mark McElroy of the Center for Sustainable Organizations (www.sustainableorganizations.org) created an open-source, context-based tool to assess a product’s triple bottomline. Their trademarked MultiCapital Scorecard analyzes sustainability throughout the manufacturing process, but not to the entire product lifecycle as that lies outside direct control of the manufacturer.

“In corporate sustainability management, *context* refers to the combination of circumstances that determine what the norms, standards or thresholds for sustainability performance should be when attempting to judge whether or not an organization’s activities are sustainable (<http://www.sustainableorganizations.org/>; follow link near bottom of page for “Sustainability Context: A Quick Definition).” Users of the MultiCapital Scorecard define business-specific targets or thresholds for economic, environmental, and social sustainability.

Despite greatly simplifying the application of this powerful tool, I found it useful in aggregating and comparing sustainability metrics. For this analysis I defined three sustainability thresholds (essentially what I reckoned to be tipping points for sustainability) within each of the three parameters comprising the triple bottomline of sustainability (economy, environment, and society):

- Economic:
 - Upfront investment that risks more than \$1000 is unacceptable.
 - High likelihood that the project will not be cash-positive is unacceptable.
 - Only those efforts that provide me a living wage, i.e., at least \$12/hr, are acceptable.
- Environmental:
 - Projects are unacceptable if they make water unsuitable for irrigation or consume large amounts of water.
 - Projects are unacceptable if they require or produce toxic materials.
 - Materials and manufacturing of products should occur within 1,000 miles of my ranch, and the closer the better.
- Social:
 - Projects that require me to leave the ranch more than 10 days a year are unacceptable.
 - Projects are unacceptable if they create unsafe, unfair, or stultifying conditions for workers.
 - Projects are most desirable if they foster the success of beginning shepherds.

For each product and activity I tested in this study, I determined whether these thresholds were met. Failure to meet a threshold gave a score of zero, while meeting the threshold resulted in a score of one. With three criteria within each of the major categories (economic, environmental, and social), the maximum score within each category was three. The overall sustainability score was the sum of scores of the three categories. I color-coded the sustainability section of Table 1 as an aid to understanding. Green shaded boxes indicate products that met all three sustainability thresholds within the area of impact. Red shaded boxes indicate products that failed to meet all the sustainability thresholds within the area of impact. Yellow boxes met some but not all the thresholds.

Products with the top sustainability scores were commercial sales of white fine (22 micron or less) raw wool; sale of show quality raw wool to handspinners; and sale of white or natural-colored top, or natural-colored roving, to crafters. Dyeing wool, creating wet felting kits, and producing chrome tanned sheepskins all had unacceptable environmental consequences.

None of the marketing venues I tested were fully sustainable. The ones which can probably be tweaked into sustainability are sales at in-state fiber festivals and state fairs; and online marketing using a platform such as Etsy, Facebook, or Ravelry rather than through a private business website.

Production of High Quality Fiber

Every aspect of sheep management is recorded to some degree in the quality of the wool clip. Experienced wool classers can feel, see, smell, and even hear (quickly snapping a staple length of raw wool near her ear, the tester listens for distinctive sounds from strong versus weak fibers) important qualities of the wool such as fiber diameter, staple length and strength, luster, crimp, silkiness, resilience versus drapiness, yield, cleanliness, and handle (an elusive quality that combines all other metrics listed to describe the holistic nature of the fiber). While laboratory testing is indisputably valuable, the most skilled wool classers can differentiate by one touch the probable suitability of raw wool for various end-products.

Whether assessed by talented wool classers or by laboratory testing, wool quality directly corresponds to the quality of the shepherd's total sheep husbandry program. High quality wool cannot be produced by sheep suffering from poor health, excessive stress from rough handling practices, lack of shade or shelter during extreme conditions, or suboptimal nutrition such as too much, too little, unbalanced, inconsistent, or contaminated feed. Shearing day is a moment of reckoning, like an annual report card on total shepherding skills and practices.

The quality of any wool clip will be improved by:

- High quality, consistent, balanced nutrition. Consider working with a professional animal nutritionist to develop balanced rations and mineral supplements specific to the class of sheep and composition of their foodstuffs and stockwater.
- Implementing a comprehensive health program, including vaccinations, deworming, quarantine of new or sick sheep, and genetic selection for health and productivity. I enlisted a local veterinarian to help develop and oversee a comprehensive health protocol for my flock.
- Selecting for site-adapted sheep. I found that some breeds thrived in my environment while others did not (see attached "Prairie Shepherd GFSWG talk"). In general, I found that crossbred sheep were more efficient and productive than purebreds. Through crossbreeding I developed a site-adapted, efficient, dual-purpose flock that reliably produces both premium fiber and market lambs.
- Low-stress stockmanship. As an offshoot of this project, my neighbors and I worked with well-known stockman Whit Hibbard to produce a YouTube video on proper handling of sheep (https://www.youtube.com/watch?v=MgYp8_Eo4L8). For beginning shepherds, one of the best investments for future success is to learn safe, gentle, effective handling techniques for livestock. I also found that using a trained stockdog reduced stress to both sheep and shepherd, and thus indirectly improved wool quality.
- Good pasture management. Sheep are widely considered the livestock species best suited to fulltime foraging in rangeland situations. Profits accrue when grazing and other land management practices maintain diverse, robust, and productive grass-, shrub-, and woodlands. Sheep are well-suited to both intensive and extensive grazing enterprises; so long as nutritious swards of grasses and forbs are maintained, wool quality is fostered.
- Minimizing contaminants such as paint brands, vegetable matter and burrs, and non-wool fibers. Keep hair sheep, goats, chickens, guard dogs, barn cats and hairy children from snuggling with wool sheep. A fleece of mine was once bumped from a championship because the judge found one long blonde shepherd hair in among five pounds of lovely brown sheep wool. Remove all twine, plastics, feed sacks, etc. from areas used by wool sheep. Sheep coats are nearly required under most management conditions to produce award-winning fleeces.
- Hiring the best shearing team available. It's worth paying extra to hire a shearer who minimizes second cuts at the same time he/she avoids nicking the sheep. Well-trained wool handlers are essential as well to optimize the harvest and initial sorting of wool. In fleece competitions, it is the combined effort of the sheep, shepherd, and shearer that is being appraised.
- Skirting and sorting all wool into appropriate, consistent classes/lines. It's said that all wool has some value or use for which it is best suited. I found that strategic sorting of wool into specific lines captured the highest overall income from my wool clip. Scott Lammers of Center of the Nation Wool in Billings, Montana, and Wool Classer Cheryl Schuldt of Miles City, Montana, kindly took the time to advise me on the categories of wool to separate and how to best prepare the clip for marketing.

- Storing raw wool correctly in appropriate pest-resistant containers and in dry, cool conditions out of sunlight.

CONCLUSIONS

No wonder most farm-based fiber businesses fail within a few years of starting! While wool is arguably the most versatile and sustainable fiber on the planet, it rarely generates strong profits for shepherds. The increasing popularity of hair sheep (which either don't grow wool or shed it annually) is at least partly due to the precarious economics of wool.

Products tested in this study were commercial-quality raw wool sold to industrial wool buyers; show-quality raw wool sold to handspinners; and wool commercially processed into batts, roving, top (undyed and dyed), and yarn for sale to craftspeople.

All measures of sustainability were highest for natural-colored raw wool prepared for direct sale to handspinners. Dyed wool products ranked lowest in environmental compatibility; even the most eco-friendly dyes produced exhaust water unsuited for graywater uses. Coarse-wool (30 micron) from white sheep managed under typical husbandry practices was the least profitable of the raw wool products. Shepherds producing less than 200 pounds of white coarse-wool per year should anticipate a net loss on the wool enterprise.

Between 2015 and 2017, my fine-wool (fiber diameter under 22 microns) ewes produced fleece that grossed \$22.79 per head (9 pounds of fine wool at \$2.44/lb plus 1 pound of belly wool at \$0.83/lb) while coarse-wool (30 microns and above) ewes grossed only \$6.10 per head (10 pounds of coarse wool at \$0.61/lb). With 100 sheep being sheared, an all fine-wool flock would bring home \$1,669 more fiber income annually than would an all coarse-wool flock.

Beyond the fineness of the wool, color ***REALLY*** matters. Just a few colored fibers in a white fleece will make a wool handler screech and bury the vile fleece in with the tags to avoid contamination of the entire wool clip. But having an entire flock of high-quality natural-colored sheep can be an economic powerhouse.

In my flock, each white medium-wool (24 micron) ewe grossed \$15.32 (9 pounds of medium wool at \$1.61/lb plus 1 pound of belly wool at \$0.83/lb) of fiber income annually. But black, moorit, badger gray, or speckled medium-wool ewes grossed \$100 per head (\$16/lb for 5 pounds of show fleece plus \$5/lb for 4 pounds on chaffy wool for rugged felting projects, with 1 pound of waste wool consigned to the compost heap) in fiber income. With a hundred head of white medium-wool sheep my yearly fiber income would be \$1,532 but with the same number of colored medium-wool sheep, the check would be \$10,000. That's a whopping 650% increase in fiber revenue.

To be realistic though, not all colored sheep produce premium show fleeces. In my flock about 65% of colored sheep produce premium fleeces. Wool from the other 35% goes to Wyoming for processing into combed top, or into grab bags for wet-felting into pet beds, tractor seat covers, or floor mats. With 65 sheep producing \$100 fleeces and 35 sheep producing \$40 fleeces (8 pounds at \$5/lb with 2 pounds going to compost), the profit moderates to \$7,900, which is still 500% better than the all-white medium-wool flock.

How the wool is marketed is no less important to profitability than the type of fiber you choose to raise. As a wool marketing neophyte I managed to lose money lots of different ways (Table 1).

I sold fiber directly to handcrafters through three venues. Sales at in-state fiber festivals and state fairs were profitable, but I lost money at local craft and ag shows. Internet sales were sporadic, with shipping, packaging, and advertising costs eating up all the profit and more. Informal surveys of shoppers at my fiber booths suggest that Internet sales would have been significantly higher had I used Facebook or Etsy rather than a business website. Only 7 of 26 people interviewed said that farm blogs influence their fiber buying decisions, yet 100% of them said that they want to support family farms and small-scale shepherds.

I learned that in Internet marketing, the beauty of your online pictures and prose are far less important than getting your products in direct view on jumpin' social media networks of craftspeople. Shepherds might not realize that there is a huge Internet community of fiber enthusiasts swooning over pictures of creamy white wool cascading off a Merino ram's shoulder during shearing. Just about every day someone on an Internet fiber forum confesses to yearning for just one more sniff of the irresistible aroma of raw wool. Blogs trace the creative path from sheep to shawl, telling stories of fiber journeys like how a novice spinner bought a two pound fleece from a bum lamb named Sarah, spent months twirling a hand spindle to make thread-fine yarn, then knit it painstakingly into an heirloom shawl worth hundreds of dollars, as if such a treasure would ever be sold.

Really, I am absolutely not exaggerating about how much some people love wool. I too am a fleece sniffing, fiber swooning, spinning-addicted wool lover. Love of wool is a big part of why I raise sheep. But alas, love alone won't pay the bills. Sustainable profits are what fuel my sheep operation.

I derive tremendous satisfaction as well as much-needed income from my home-based fiber business. I get energized hearing customers gush about their joy in handling superb fiber, and how they want to help family farms like mine that are dedicated to wildlife conservation and regenerative agriculture. I love helping sheep transform sunshine, rain, and prairie plants into such a beautiful, versatile, and earth-friendly product as wool. Through my fiber business, my land and livestock are connected to and strengthened by a bevy of urban customers far from northern Montana. Society benefits as a whole when shepherds employ sustainable production practices, and urban-rural connections are essential to building a better world for generations yet to come.

When other shepherds ask me about marketing wool, I tell them "I don't have pat answers for you. Your results will vary from mine. Mine improve over time. Growing and marketing wool has a learning curve that will probably cost you money at first, even if you end up developing a thriving business with time."

Based on my limited experience in this study, I posit that small-scale shepherds might optimize wool income by two quite different methods. Shepherds wanting high income from wool might consider raising a hardy dual purpose breed (or breeds) attractive to handspinners; natural-colored Dohne Merinos and Corriedales work well for me. Carefully tend the sheep for wool quality, including keeping them coated properly, and then sell pristine raw fleeces to handspinners via an Etsy shop or Facebook group. Sell the chaffy wool to niche wool mills for making into top, or sell direct to crafters for use in felting projects. Sell grassfed lambs directly to customers, then harvest, tan, and sell the tanned sheepskins.

Alternatively, shepherds might raise a site-adapted breed of white, dual purpose fine-wool sheep such as Targhee, Rambouillet, or Dohne Merino. This strategy requires little more than standard good husbandry practices that minimize input costs. The wool could be sold, bellies out and with very minimal skirting on the shearing floor, through a regional wool pool or to a reputable regional wool buyer.

Profitability is apt to be better and surer in marketing raw rather than processed fiber. Shepherds wanting to market processed fiber might consider developing local marketing groups or cooperatives, with all the members raising similar sheep using similar management practices. Professional processing fees drop by 15-35% or more when the wool clip climbs from 100 pounds up to 1,000 pounds annually. Mountain Meadow Wool in Wyoming offers a yarn development program (see attached media file) which would be most profitable for small-scale sheep producers banding together as a cooperative.

The vast majority of shepherds will not be able to sustain their businesses solely or even primarily on income from wool. To be profitable and thus sustainable, most small-scale sheep operations will need to carefully limit inputs as well as harvest income from additional enterprises. I sell breeding stock, butcher lambs, compost, and handcrafted felt and knit items. I day work for other sheep outfits, do environmental consulting, and teach fiber-related classes.

There are lots of other options to consider. A skilled shepherd could start a targeted grazing program to control weeds or fire danger on public or private lands (http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwj-x6b7ruLYAhUF-mMKHcPHA4oQFggUAAA&url=http%3A%2F%2Fanimalrangeextension.montana.edu%2Fbeef%2Fdocuments%2FNutrConf2012-6-LisaSurberSlides.pdf&usg=AOvVaw3t-JqbTieMtMjr_jRhOyAz). Maybe a shepherd lives in a lovely place with facilities that could bring in revenue through farm stay programs (<http://www.farmstayus.com/>). Perhaps a fiber-based CSA would suit you (<https://www.crochetconcupiscence.com/2012/10/5-fiber-csas-where-you-might-want-to-get-your-yarn/>). Maybe you're a natural teacher and communicator like shepherd Kate Larson, Roving Reporter for Interweave's *SpinOff* magazine (<https://www.interweave.com/article/spinning/top-5-roving-reporter-posts-2017/>). Maybe there's a part-time career for you as a wool classer, wool handler, or festival organizer.

Agricultural expertise and sometimes financial help are available to shepherds through university Extension programs, state and national sheep producer groups, and USDA programs such as SARE, Rural Business Development Grants (if organized as nonprofit co-ops), the Rural MicroEntrepreneur Assistance Program, and Value-Added Producer Grants.

To some extent, every successful shepherd wears a lot of different hats: business person, strategic planner, salesperson, risk manager, accountant, ovine emergency medic, geneticist, grazing systems specialist, animal nutritionist, sheep whisperer – the list goes on and on. No one person can do all these things skillfully. Small-scale shepherds might gain a lot by forming cooperative groups that share expertise, equipment, labor, and other resources.

No matter the business model a shepherd chooses, only those practices which conserve or regenerate the health of the land, the sheep, and the human community will be sustainable for the long term. As Dr. Fred Provenza once told me, "All life is about relationships. All joy is about good relationships." Successful shepherding is about creating good relationships between the land, some sheep, and a community of shepherds, customers, and support people. And getting those relationships right leads to lasting joy as well as sustainability.

IMPACTS, CONTRIBUTIONS, AND OUTCOMES

The major impacts of this project to date have been to increase my knowledge base and improve my business practices. My original plan was to test various wool marketing strategies in Year One; report out through publications and presentations in Year Two; and by Year Three, my outcomes were to have influenced more sustainable shepherding practices on an impressive, or at least significant, scale. Ha! I should have known better. I do now. This being my tenth year of shepherding and selling wool, I'm finally consistently getting black ink on profit and loss reports. At last, maybe I have worthwhile information to report.

I expended considerably more resources toward the goals of this project than anticipated, and in doing so found that some of my original objectives were not feasible or cost-effective. Based on this, and with permission from WSARE, I shifted focus to continued investigation of potential avenues to enhance sustainability for small-scale shepherds.

Thus the major contributions of this project ended up being in lessons learned, including documenting failed or abandoned activities along the way. Thankfully, there were some unexpected successes to balance the shortfalls. Sharing both the failures and successes equally serve the overall goal of the proposal, which was to help small-scale shepherds increase profit, or at least reduce risk, in managing and marketing their wool clip. Indeed if I had access to such a revealing report – warts and all, as my grandmother would have said – before I wrote the grant proposal, I could have been much more efficient in developing a sustainable shepherding enterprise.

So three years after starting this WSARE project, I'm now ready to disseminate lessons learned. Based on information summarized in this report, I am currently drafting two articles for submittal to magazines:

- Fiber Follies: How NOT to Start a Sustainable Sheep Business. The intended audience for this article will be shepherds, or potential shepherds, contemplating starting a value-added fiber enterprise. Potential publishers for the article are *sheep!*, *Mother Earth News*, and *Sustainable Farming*. The article will present key data from this investigation to help shepherds better predict outcomes to their triple bottomline (environment, economy, and social aspects such as quality of life) if they were to launch a specialty fiber business. They will have objective data on a variety of popular products, fiber processing methods, and sales venues. From this, shepherds may choose the best strategy for their own production goals and constraints. This information can help shepherds reduce the risk of launching a fiber enterprise, while making the most efficient use of resources they manage. Tucked in among other information in the report will be what a friend of mine calls “sneaky prophylactic education” about best management practices that benefit both nature and people.
- Wool that Looks, Feels, and Does Good: Supporting Stewardship, Sheep, and Shepherds. The audience for this article will be fiber artists, and the magazines that might publish it include *SpinOff* and *Ply*. The article will help fiberists understand the importance of sustainable agriculture in today's society, and encourage them to “vote with their money” to help shift agriculture toward more sustainable practices.

The third audience I wanted to reach with this project was young people, with the goal of providing them with encouragement and accurate information that might help them launch a successful career in agriculture. In this course of this project I learned that rather than writing

articles, the best way to reach young people is to talk with, work alongside, and mentor them. Tech savvy and Internet connected, young people already have access to a mountain of written information on shepherding. What they rarely have is one-on-one time with established shepherds who might mentor them.

During this project I mentored young people in several ways:

- I helped three teenage and pre-teen shepherds build their first flocks of sheep. We discussed their shepherding goals, available resources, facilities, and support systems. Together we evaluated the potential for them to meet their goals by obtaining stock from my flock or employing my management practices. We selected specific sheep best suited for their circumstances and then I sold some, and donated some more, sheep to help them each start flocks. I continue to work with these bright young shepherds as they grow their flocks and businesses. This has been the most gratifying part of the entire project for me.
- I hosted six small groups of young people to meet my flock, discuss sustainable shepherding, and experiment with fiber through simple spinning, dyeing, and felting projects. While insurance and biosecurity concerns precluded my hosting a large open-farm field day, these modest exchanges produced lots of learning, smiles, and pride-in-projects from the young participants. (I talked to my insurance agent about hosting a public event at my ranch. The agent said this type of event poses significant liability risk, and would require a \$1,000+ per day supplemental short-term liability policy. Additionally, in researching sheep health protocols I discovered that some sheep diseases pose significant health risks to children and pregnant women. Biosecurity of the flock can also be compromised by contaminants coming into lambing areas on the clothing of visitors. While any one of these hurdles could be surmounted, considering the combination of risks, I decided against having public events at my ranch.)
- My neighbor Eric Barthelme, noted stockman Whit Hibbard, and I produced a basic stockmanship video for sheep (https://www.youtube.com/watch?v=MgYp8_Eo4L8). Our intent in this work was to increase safety for beginning shepherds and their sheep.
- I organized bulk purchases of lamb milk replacer and vaccines for six local ranches as a way to reduce costs for beginning and small-scale shepherds.

This project certainly informed and changed my business and marketing practices, as demonstrated by the shift between my proposal and the project outcomes:

- I planned to create a photo- and information-rich website (with blog and survey capabilities) using the Squarespace platform. I created and maintained www.PrairieShepherd.com for this purpose. Then I researched blogging and found that it requires inordinate amounts of time, skill, and web exposure to be effective in marketing products. When informally quizzed, visitors to my craft booths said that their preferred online shopping venues are Etsy, Facebook, and Ravelry rather than single business websites. Thus I have terminated my website and will launch either an Etsy or Facebook account for future marketing.
- I planned to purchase booth space at well-established regional wool markets such as Estes Park, Colorado, but discovered that booths are allocated and sold through highly competitive jury selection. As at juried art shows, there are many more businesses seeking to sell products than there is booth space available, so the sales opportunities go to long-established and successful fiber businesses rather than to new businesses. Despite not obtaining a booth at the major regional wool market in Estes Park, I did exhibit raw fleeces there in 2015. The judge praised the quality of the fleeces, two of which won their categories, and half of which I sold at the competition.

- I learned that while I enjoy shepherding and producing excellent fiber, I want to market my wool from home as much as possible. Fiber festivals and state fairs aggregated crowds of potential purchasers of my fiber, and I really enjoyed interacting with so many fiber enthusiasts. But travel costs plus paying a person to sheep-sit while I traveled gobbled up a lot of the profits. Developing a fully functional booth turned out to be more expensive, risky, and time-consuming than I anticipated. I concluded that working with a small group of shepherds to develop a shared booth would be more feasible and profitable for future events. A friend dropped into my booth for a visit and promptly my sales went way up as Katy is a naturally outgoing salesperson who absolutely loves to make deals. I, on the other hand, do well in helping people learn to use tools and plan creative fiber projects. The most successful booths have people doing both, and sharing a booth with other shepherds ups the chances for that.
- Though I love a huge palette of brightly colored wools, dyeing has unacceptable environmental impacts in my circumstances. Based on this project, I decided to produce multi-colored fiber through genetics, maintaining a flock of white and natural-colored sheep. When I just have to have bright colors, I'll revert to simply using Kool-Aid, food grade citric acid, and solar-heated rainwater.
- I hadn't realized how useful and fun it could be to participate in regional fiber guilds. By joining guilds in both Great Falls and Billings, I made friends, sold used equipment and new fiber at good prices, learned new skills, and was paid to speak at a fiber retreat (<http://www.greatfallstribune.com/story/life/2016/10/20/warm-fiber-arts-weekend-great-falls/92471742/>).
- I'll do more research into the value of eco-certifications in the marketing of wool. My operation met qualifications for being predator friendly, wildlife friendly, and sustainable through various programs. It takes significant time and money to obtain and maintain certifications, however, so more investigation is necessary before moving forward on this.
- I tested three niche market opportunities for wool that I hadn't anticipated when developing this proposal.
 - Using natural-colored wool with some vegetable matter contamination, I made pet beds, tractor seat cushions, and throw rugs. I gave these to friends who immediately asked me to make more. I sold several pounds of this grade of wool at \$5/lb. Low-value fiber and simple manufacturing might position these products to be at least moderately profitable.
 - Sheepskins: I recovered pelts from sheep harvested for meat. I worked with the butcher to carefully remove the hides, then took them home where I fleshed, salted, and air-dried them. I sent them to Stern Tanning Company in Wisconsin for chrome tanning. Professionally tanned, natural-colored sheepskins were one of the two most profitable products I tested, the other being premium show fleeces from natural-colored sheep (Table 1). Demand exceeded my supply for these sheepskins even when I charged \$200 each.
 - Wool too coarse for garments, such as the 30 micron wool from Clun Forest and Ile de France crossbreeds, was transformed into very marketable pillows by St. Peter Woolen Mills in Minnesota. I haven't offered the pillows for sale yet, but based on prices of similar products offered online I anticipate a net profit of 30% or more.
- The success I had in developing site-adapted, dual purpose sheep was noted by other shepherds who then purchased breeding stock from my flock. After extensively researching 20 breeds, I trialed eight breeds and then developed specific crossbred sheep to meet my production goals (see attached media file Prairie Shepherd GFSWG talk 2016). This type of breeding effort has been reported to be expensive and difficult

for small-scale shepherds (ASI Sheep Production Handbook, 2012), yet my results were positive. Other producers now seek out my lambs for replacement broodstock, and even handspinners have contacted me about genetics as a route toward obtaining “designer fleeces.” I’ve now sold breeding stock into three states, and last year sold all surplus breeding-quality sheep to shepherds building their flocks. In the past, many of my good ewe lambs and older rams were sold as meat animals rather than as breeding stock.

- Based on the advice of the owner of the most successful yarn shop in southeast Montana, I developed two kits for wet-felted items. The kits featured dyed roving from my flock for DIY-types wanting to make felted handsoaps and luxury silk/wool scarves. In addition to selling these kits on consignment through the yarn store, I taught a nuno felting class there to help market the kits. These products sold at a moderate pace and profit, but when the yarn store changed ownership the relationship became difficult and I terminated the arrangement.
- As part of an “ag day” event in my county, I shared wool-related learning with more than 300 grade school students. The hands-on sessions had children spinning and felting wool, as well as learning about sheep breeds and products. Many children (and more than one adult!) were surprised to learn that wool is the most sustainable of fibers; it comes from sheep rather than a store; and that well-managed sheep provide such a diversity of useful products and ecosystem services.

INFORMATION PRODUCTS

The talk I gave at the 2016 autumn retreat of the Great Falls Spinners and Weavers Guild (GFSWG) addressed sustainable wool production. Slides from that talk are attached to this report as a media file.

A story in the Great Falls Tribune about that fiber retreat can be viewed at <http://www.greatfallstribune.com/story/life/2016/10/20/warm-fiber-arts-weekend-great-falls/92471742/>.

Photos illustrating this WSARE project are attached to this report as a media file.

As described in the Impacts, Contribution and Outcomes section of this report, I am currently drafting two articles for popular magazines. One article will reach out to shepherds, while the second will provide fiber artists with findings gleaned from this project. With these articles I aim to expand public understanding of sustainable shepherding practices, as a pathway to improving both the environmental compatibility and economic returns of specialty wool production.

BUDGET REPORTING

In the proposal, I requested \$10,646 for this project. All told, I spent \$18,782 and contributed a further \$16,200 to complete the work:

Personnel (\$1,200 requested, \$1,700 spent plus \$14,400 contributed)

- Hire ranch sitter at flat rate of \$75/day to care for sheep while I traveled for this project: \$900

- Logo designer: \$500
- Veterinary consultation and on-site review of shepherding practices: \$300
- My time to complete work associated with this study which I otherwise would not have done in the usual course of my work, estimated at \$15/hour = \$14,400

Travel (\$4,471 requested, \$5,573 spent)

- Mileage for Technical Advisor for one site visit: \$40
- Travel to fiber festivals, state fairs, yarn shops, as per original proposal: \$4,749
- Other travel to meet project objectives: \$784

Materials and Supplies (\$1,250 requested, \$533 spent plus \$1,800 contributed)

- Labels and packaging for fiber products: \$199
- Materials for scouring and dyeing of fiber: low-impact washing agents, acid dyes, citric acid, alum mordant and natural dye materials: \$334
- ~2,400 pounds of fleece from my sheep, estimated commercial wool pool value of \$1,800

Printing (\$375 requested, \$257 spent)

- Supplies for printing labels, informational brochures, and posters for use at public events: \$257

Other Direct Costs (\$3,350 requested, \$10,719 spent)

- Registration and fees for fiber, ag, and craft shows: \$265
- Furnishings, banners, sales agreements, receipts, business cards, complementary fiber samples, posters and a looping PowerPoint display highlighting this project, and other items to stock informational booths: \$533
- Water tests and testing equipment for nutrients, contaminants, pH, and salts: \$575
- Website domain purchase, development, and maintenance costs: \$1,140
- Lab testing of raw fleece to quantify fiber diameter, length, and comfort factor: \$194
- Commercial wool processing: \$8,012