WERA-39-WSASAS Sheep Symposium

Integrating Advanced Concepts into Traditional Practices

June 19, 2013

Museum of the Rockies

Montana State University

Bozeman, Montana

PROCEEDINGS

2013 WERA-39-WSASAS SHEEP SYMPOSIUM:

INTEGRATING ADVANCED CONCEPTS INTO TRATIONAL PRACTICES

JUNE 19TH, 2013

MUSEUM OF THE ROCKIES

MONTANA STATE UNIVERSITY, BOZEMAN, MT

PATRICK HATFIELD, SYMPOSIUM CHAIR

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WESTERN SECTION

AMERICAN SOCIETY OF ANIMAL SCIENCE

MORNING SESSION

AFTERNOON SESSION

John Walker

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Sheep, Black Swans and the Future of Agriculture

Dr. Walker has served as Professor and Research Director at the Texas A&M University Agricultural Research and Extension Center in San Angelo, Texas since 1997. His responsibilities include providing leadership to a multi-disciplinary team of scientists that develop new technologies for increasing the efficiency and sustainability of range livestock and wildlife production. His area of expertise involves foraging ecology, modification of livestock foraging behavior and targeted livestock grazing for landscape enhancement. Dr. Walker developed the first fecal near-infrared spectroscopy calibrations for predicting botanical composition of ruminant diets. He continues to develop near-infrared spectroscopy solutions in support of research in foraging ecology, and animal nutrition. Prior to his current position Dr. Walker was a rangeland scientist for the Agricultural Research Service at the U.S. Sheep Experiment Station in Dubois, Idaho. In this position he conducted research to improve sustainable utilization of rangelands. Studies included combination grazing of sheep and cattle; use of grazing livestock to control noxious weeds; genotypic and phenotypic factors affecting foraging behavior; weed ecology; low input sustainable sheep production systems; and carbon budgets on sagebrush steppe rangelands. Dr. Walker received his B.S. in wildlife science and Ph.D. in rangeland ecology both from Texas A&M and his M.S. in range science from Colorado State University. He has authored or co-authored 60 scientific journal articles and over 100 other professional publications. Dr. Walker serves on numerous professional and civic boards and committees including the Targeted Grazing Committee both for the Society for Range Management and the American Sheep Industry Association.

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Alternative Feeds: For a Temporary Crisis or Permanent Problem

Dr. Whitney is an Associate Professor, Ruminant Nutritionist, and project leader for the Texas A&M AgriLife Research Nutrition Program, San Angelo. He is also a faculty member in the Department of Animal Science (College Station). He received a B.S. in Animal Science from Southwest Texas State Univ., a master's in Agricultural Education from Texas A&M Univ., and a doctorate in Animal Science/Ruminant Nutrition from the Univ. of Arizona. After receiving his Master's degree, he taught Animal Science classes at Palo Alto College (San Antonio) and did postdoctoral research at Montana State Univ. prior to his appointment in San Angelo. His interdisciplinary research program is directed toward helping producers (especially in the Edward's Plateau Region of Texas) make informed management decisions related to feeding livestock. His primary objective is to reduce feed costs by (1) increasing livestock production efficiency; (2) increasing the value of underutilized feed sources such as dried distillers grains and ground juniper and mesquite trees; (3) using plant secondary compounds to enhance ruminal function, bypass protein, and animal health, and reduce internal parasite viability. Dr. Whitney is currently Chairman of the American Society of Animal Science Western Section committee and a member of the following: American Society of Animal Science, Society of Range Management, American Registry of Professional Animal Scientists, Texas Sheep and Goat Raisers, TX A&M Agriculture Animal Care and Use Committee, TX A&M Council of Principal Investigators, WERA039 research group, and Texas Forage and Beef Workers group.

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ALTERNATIVE FEEDS: A SOLUTION FOR A TEMPORARY CRISIS OR A PERMANENT PROBLEM?

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ABSTRACT: Feed costs represent a significant portion of the total cost of livestock production. Historically, when traditional feed costs are inflated, alternative feed ingredients are more thoroughly researched, discussed, and eventually used in livestock diets. As the price of feed ingredients return to normal, use of alternative feeds quickly subsides. However, recent factors including drought, rising fuel costs, and competition for biofuel feed resources have caused an unprecedented rise in feed costs. These factors, along with current issues such as economic stagnation, greater emphasis on enhancing natural resources, and increased environmental and livestock production regulations, suggest that a temporary crisis may be developing into a permanent problem. Numerous alternative human food and crop residues, (e.g. bread, candy, cotton gin trash) have been researched and used to help stabilize inflated feed costs, but they are not always available, have variable nutritional characteristics, and can be difficult to handle. In contrast, an alternative feed does exist, which is abundantly available throughout North America, requires no inputs such as fertilizer, irrigation, pesticides, or herbicides, and is highly resilient to drought and market volatility: woody plants. Therefore, the process of converting woody plants to feed should be revived by making it more efficient, enhancing the nutritional value of the final products, and documenting benefits to the animal, natural resources, and rural economies. Currently, no other program is available that can economically, or even theoretically, reduce brush encroachment while concurrently producing a livestock feed ingredient that is cost competitive to traditional roughages.
Keywords: alternative feeds, feed cost, livestock production, juniper, roughage

Temporary Crisis or Permanent Problem?

The change in feed costs over the past decade is alarming and has proven to be unsustainable for many livestock production sectors. Rising feed costs (Figure 1) can be attributed to many factors, such as rising fuel costs and federal mandates of feed resources being diverted to biofuels production (EIA, 2012; Wise, 2012). These costs are exacerbated by matters such as inflation and drought-induced feed shortages. One notable example is the current price of cottonseed hulls (CSH), which provide little nutritive value and function mainly as a roughage ingredient to maintain rumen function (Table 1). As of February 15, 2013, Texas markets priced CSH at $145/dry ton, not including average freight of $3/loaded mile (Hansen-Mueller Inc., McKinney, TX). During the 2011 drought, CSH sold for approximately $350/ton in some markets until they were no longer available in Lubbock (Feedstuffs Magazine, October 5, 2011).

Currently, roughage ingredients of similar nutritional quality to CSH (Table 1) are difficult to economically justify in livestock diets when priced above $130/ton. The question is, how many times within the next 5 yr will CSH be priced below $130? Between June, 2010 and February, 2013, CSH were priced less than $130/dry ton only 85 out of 177 reports; only 3 times between January, 2012 and February 2013 (Texas markets; Hansen-Mueller Inc., McKinney). Higher quality roughage ingredients such as alfalfa hay have an even more discouraging price history for the livestock feeder.

During times of feed shortages and elevated feed costs, livestock producers are more predisposed to utilize alternative feeds, even if those feeds have not been thoroughly researched or analyzed for nutrients. As the cost of traditional feed ingredients returns to normal, use of alternative feeds subsides. For instance, high feed prices during 1918 to 1919 and during the 1930's, resulted in greater research and use of sawdust and ground aspen trees in livestock diets (Davey, 1977; NRC, 1983); however, use during both periods halted as the price of traditional ingredients returned to normal. Even though woody residues have not been generally recognized as competitive feed alternatives under normal economic conditions (Scott et al., 1969), it is notable that *Populus* trees were approved as an Association of American Feed Control Officials feed ingredient in 1980 (AAFCO, 2011).

We predict that livestock producers will need to increase use of precision diet formulation to maximize gain-to-feed efficiency and increase feed storage capacity to help stabilize feed price fluctuations. In addition, greater transportation and feed costs will encourage onsite confined feeding operations and grazing systems that utilize local feed resources to reduce time spent in the feedyard. These predictions are partially based on the fact that the regulatory burden on large concentrated animal feeding operations is rapidly increasing. In some areas, this will lead to a greater demand for brush control to enhance forage production. We also predict that membership in livestock cooperatives will become more important, to share financial burdens, equipment, labor, and expertise. These predictions justify the establishment of a national *Wood-to-Feed Program* that will remain economically and environmentally sustainable even if traditional feed ingredients become "reasonable" once again.

Alternative Feed Examples and Considerations

The number of alternative feed ingredients that have been used in livestock diets is extensive and cannot be thoroughly discussed in this paper; however, the following references provide abbreviated summaries: (NRC, 1983; Lardy and Anderson, 2003; Blache et al., 2008). Before potential feed ingredients can be commercially fed to livestock, feeds must first be approved through FDA or AAFCO procedures to ensure the feeds are safe for the animal and do not result in residual compounds in milk or meat that affect human health. Furthermore, certain issues need to be considered before using any feed, especially alternative feeds that have not been extensively researched. For example, depending on concentration certain secondary plant compounds, i.e. condensed tannins (CT) and terpenoids, can either reduce animal performance (Barry and Forss, 1983; Pritz et al., 1997; Blache et al., 2008) or increase animal performance (Waghorn et al., 1987; Min et al., 2001; Ramirez-Restrepo and Barry, 2005).

Diets containing greater than 5% mesquite leaves can reduce intake and BW gain in sheep (Baptista and Launchbaugh, 2001), due to compounds such as flavonoids, phenolics, and alkaloids (Cates and Rhoades, 1977; Solbrig et al., 1977; Lyon et al., 1988). Other compounds to consider are phytoestrogens and certain minerals such as Se, as previously reviewed (NRC, 1983; Blache et al., 2008). Thus, analyzing each ingredient for chemical composition and purity is especially important in alternative feeds. Two other important considerations include the need for specialized facilities and equipment to store, move, and process low-density feeds and the use of pre-treatment technologies (e.g. air- and oven-drying, ensiling, and pelleting) that can reduce concentrations and bioactivity of secondary plant compounds. Each individual buyer will need to use research, experience, or both, to determine if the ingredient is worth purchasing.

Development of the Texas AgriLife *Wood-to-Feed Program*

Goats will consume juniper leaves while grazing (Malachek and Leinweber, 1972); thus, our first experiment centered on feeding lambs mixed diets that contained redberry juniper leaves. Because blueberry juniper was more readily browsed than redberry juniper (Riddle et al., 1996) and goats consumed more juniper than sheep (Straka, 1993), we hypothesized that our results would be even more relevant to goats and blueberry juniper. In this experiment, replacing 50% of the CSH with redberry juniper leaves increased animal performance in lambs, compared to diets containing CSH or juniper leaves as the sole roughage source (Whitney and Muir, 2010). These results led to a study in which mixed diets containing ground juniper leaves and small stems were fed to lambs. The juniper successfully replaced all of the oat hay in diets containing 40% DDGS (T. R. Whitney, unpublished data). Additional studies showed that redberry juniper-based diets can reduce *Haemonchus contortus* infection (Whitney et al., 2011; T. R. Whitney, unpublished data) and that other *Juniperus* spp. have similar nutritional characteristics as compared to redberry juniper (Table 1).

A further review of the literature revealed a wealth of information related to successfully incorporating woody material into livestock diets (e.g. Sherrard and Blanco, 1921; Archibald, 1926; Hvidsten, 1940; Nehring and Schutte, 1950; Marion et al., 1957; Parker, 1982; NRC, 1983). These reports, along with numerous others, demonstrate a potential to reduce woody plant encroachment, while synergistically developing a low-cost livestock feed ingredient. For example, Marion (1957) reported that steers fed mixed diets containing 50% ground mesquite wood performed similar to steers fed 50% CSH and that the mesquite meal cost 44% less than CSH. So, why did this process not develop into a permanent production practice? Many suggest that the low cost of traditional roughage sources did not justify the additional labor and equipment costs needed to convert standing trees into feed. However, machinery and techniques available today are much more capable and efficient in converting large quantities of standing trees into quality hammermilled feed products. Also, brush encroachment has become the center of attention for natural resource, livestock, and wildlife management and soil and water conservation, and the current price of roughage feed ingredients justifies an integrated program that converts woody plants into feed.

The Texas AgriLife *Wood-to-Feed Program* has been developed from almost a century of documented research efforts, advanced technology, entrepreneurship, and foresight of our predecessors. The primary goal is to increase the value of encroaching woody plant species to reduce harvesting costs, while synergistically increasing grass production and ecosystem health, and reducing livestock feed costs. Multiple scientists and industry partners with complementary backgrounds and specialties are collaborating to rapidly increase adoption rate of this proven practice.

Implications

Rising livestock feed costs will necessitate changes within all livestock industries. Production practices will shift as producers address feed ingredient shortages. Energy, economic, and regulatory challenges will accelerate adoption of feeding alternative ingredients in livestock diets. The feasibility of any alternative feed depends on cost and availability. While the cattle industry is an excellent outlet for woody feed ingredients, small ruminants stand to benefit from utilizing ground woody plants perhaps even more than cattle, in part due to their suitability to landscapes where woody plants dominate. In certain circumstances, woody plants are an on-site feed resource on many sheep ranches throughout the U.S. Numerous benefits to rangelands, the livestock industry, and local economies will be recognized when large amounts of brush are harvested for livestock feed. Producers should be ready if the current price of feed transitions into a permanent problem.

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Table 1. Chemical composition (%, DM basis) and 48-h IVDMD of traditional and alternative feed ingredients[1]

	Nutrient[2]					
Item	CP	NDF	ADF	Ash	CT	IVDMD
Alfalfa, mid-bloom hay	17	47	36	9	-	71
Coastal bermudagrass hay	10	73	36	6	-	56
Sorghum-sudangrass hay	8	67	43	10	0.9	50
Cottonseed hulls	6.6	79	69	2.7	5.6	21
Redberry juniper, leaves	7.1	37.7	31.2	5.3	5.5	67
Redberry juniper, whole tree	3.6	66	56	4.2	4.7	29
One-seed juniper, whole tree	3.6	64	53	4.4	2.7	32
Eastern red cedar, whole tree	3.7	68	58	3.5	5.6	29

[1]NRC, 1983; NRC, 2007;Whitney, T. R., and J. P. Muir. 2010; W. C. Stewart and T. R. Whitney, unpublished data.

[2]CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; CT = condensed tannins; IVDMD = invitro dry matter digestibility.

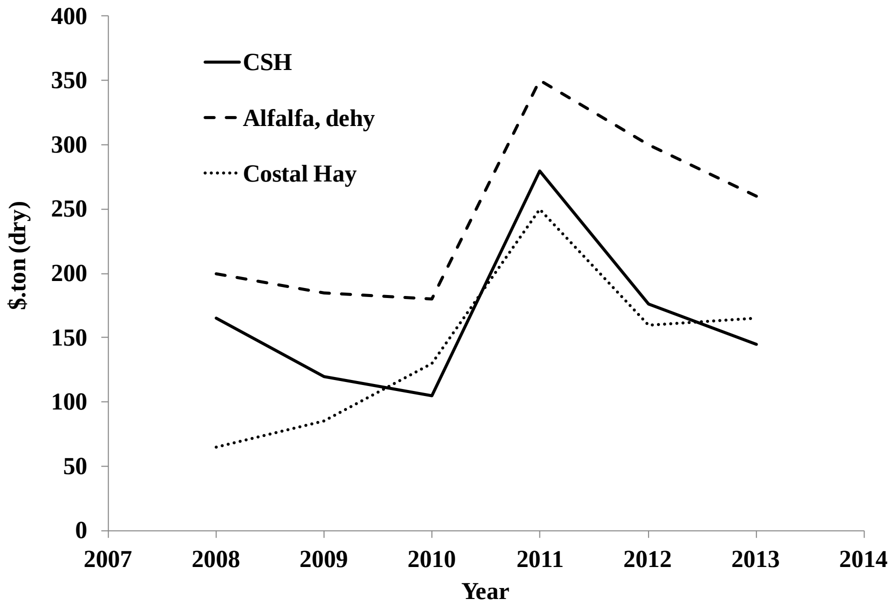

Figure 1. Market prices (at source and not delivered) for traditional roughage ingredients: cottonseed hulls (CSH; Hansen-Mueller Trading, McKinney, TX); dehydrated alfalfa (Alfalfa, dehy), and round bales of coastal bermudagrass hay (Costal Hay; USDA-AMS, 2008-2013).

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SHEEP, BLACK SWANS, AND THE FUTURE OF AGRICULTURE

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ABSTRACT: The U.S. sheep inventory continues to decline, regardless of recent stimulus programs and campaigning strategies. Only creative, out-of-the-box efforts that effectively educate, facilitate, and recruit prospect sheep producers can reverse this devastating decline. The purpose of this presentation is to examine the longstanding dogma of what has contributed to the decline of the industry, and present a unique case of how labor force enlightenment could possibly have a positive effect on sheep production in the U.S. Compared with other food animal production species, sheep generally require more labor; the dogma is that available labor is lacking. However, there is a segment of society that potentially has unused labor and that appears to be in need of unique opportunities that may align with their ideals; this segment should be targeted for expanding sheep numbers in the U.S. The potential labor force is retiring baby boomers, which is a rapidly expanding demographic. Industry promotion efforts should be focused on educating baby boomers on the economic, ecological and lifestyle values of sheep production.
Keywords: agriculture, baby boomers, food, sheep industry, sustainability

Introduction

The sheep industry is in a crisis and has been for a long time. As I reviewed previous reports on problems and solutions for the sheep industry, it was obvious that no new long-term solutions have been proposed in the last 30 yr; what has been attempted in the last 50 yr, has not worked (Gee et al., 1977; CAST, 1982; Parker and Pope, 1983; Purcell, 1998; Jones, 2004; Williams, 2008). In recent times, more often than not, it is agricultural economists that are describing problems and suggesting the solutions. However, it appears that the sheep industry violates the basic premises of economics; i.e., neither producers nor consumers appear to be rational agents. My premise in this paper is to develop a convincing rationale for a new solution to recommend to the industry, while it still has some infrastructure left. Please be aware that this paper is written with a great deal of trepidation, because I do not want to offend people that I respect or an industry that afforded me a wonderful career. Furthermore, while the following maybe wrong, I hope that my arguments, at the least, stimulate discussion that results in a reversal of a long-term decline and ultimate collapse of the U.S. sheep industry. With this said, I go forward with confidence in knowing that while I may not do any better than those that preceded me, I cannot do much worse.

State of the Sheep Industry

Having faced and endured many problems sheep producers appear to be in a state of learned helplessness. This is a condition defined as the general expectation that one cannot control important events, leading to lowered persistence, motivation, and initiative. Seligman and Maier (1967), while studying the relationship between fear and learning, discovered an unexpected phenomenon, while doing experiments on dogs using Pavlovian (i.e., classical) conditioning. In Seligman's experiment, he paired a tone with an electric shock, restraining the dog in a hammock during the learning phase. The idea was that after the dog learned to associate the tone with the shock, the dog would feel fear on the presentation of a tone, and would then try to escape. The conditioned dog was placed into a shuttlebox, which consists of a low fence dividing the box into 2 compartments. The tone was sounded, but surprisingly, nothing happened. The dog was expected to jump over the fence. Next the conditioned dog was shocked, and again nothing happened. The dog just laid there. When an unconditioned (i.e., normal) dog was put in the shuttlebox the dog, as expected, immediately jumped over the fence to the other side upon receiving a shock. Apparently, what the conditioned dog learned in the hammock was that trying to escape from the shock is futile; this dog learned to be helpless. The theory of learned helplessness was then extended to human behavior, providing a model for explaining depression. Depressed people learned that all action is futile.

Declining sheep numbers are a sign of learned helplessness in the sheep industry. Consider several studies have shown that sheep numbers are not responsive to positive returns on investments. For instance, between 1972 and 1987 sheep had positive receipts less cash expenses for 15 of the 16 yr (Figure 1) and these positive receipts increased 460% over that period (Stillman et al., 1990). However, during that same period, stock sheep inventories fell 1.5 percentage units per year for a loss of 24 million head. Similarly, a study of 5-yr breeding ewe elasticity to revenue exhibited a 1% increase in lamb prices would result in only a 0.7% increase in breeding ewe numbers (Jones and Schroeder, 1998).

Elasticity is used to assess the change in one variable (e.g. ewe numbers) as a result of a change in another variable (e.g. lamb prices). When the value is greater than 1, this suggests that the demand for the good/service is affected by the price, whereas a value that is less than 1 suggests that the demand is insensitive to price. The elasticity found by Jones and Schroeder (1998) was significantly lower than a similar study using economic data from 1924 to 1983, which had a 5-yr elasticity of 1.4 and included a period of increasing sheep inventories and peak sheep numbers in the mid 1940's (Whipple and Menkhaus, 1989). Williams et al. (2008) reported returns to labor, investment, and risk on sheep operations of 17% in 2006, but the U.S. breeding sheep inventory for January 1, 2013 reported a 13% decline since 2006.

Jones and Schroeder (1998) also found a very low elasticity associated with wool revenue and predicted that elimination of the wool subsidy program would likely have only a small impact on the size of the industry. However, that was not the case. The loss of the wool price supports between 1992 and 1994 led to a major sell-off of breeding stock (Williams et al., 2008). It appears that from an economic perspective the sheep industry overreacts to negative consequences and under reacts to positive consequences, which could be interpret as a sign of learned helplessness in the industry.

Like sheep producers, lamb consumers are relatively insensitive to prices as indicated by several studies that have estimated low elasticities between lamb price and per capita lamb consumption (Williams et al., 2008). In the U.S., lamb has always been a specialty meat consumed primarily by ethnic groups and discerning consumers rather than a staple food item (Figure 2). Over the past 100 yr, annual per capita lamb consumption on a carcass basis has not exceeded 3 kg (6.6 lbs.) per person and has always vied with veal for the last place meat item of the American diet. Per capita consumption of lamb was about 0.6 kg (1.3 lbs) between 1975 and 1995 whether the price was \$2.60 per kg (\$1.18/lb) or twice that at \$5.20 per kg (\$2.35/lb), respectively.

Problems in the Sheep Industry

Producers, economists, and animal scientists each have theories to reverse the decline in sheep numbers, which are:

- Sheep producers believe predator control is the solution.
- Economists believe that increasing demand and thus price is the solution.
- Animal scientists believe that increasing production efficiency, i.e, lowering production cost, is the solution.

Predator Control

Predation is unique to the U.S. as compared with causes for sheep number declines in other countries (Woodford, 2010). A recent survey of sheep producers reported that "better predator control" was the fourth ranked reason that would help producers to expand their sheep numbers. However, the ranking varied by region and flock size and was less important in small flocks and regions were sheep numbers are currently expanding (ASI, 2010). However, I would argue that predation is not the problem, labor is. Some producers are able to successfully produce lamb in the face of high predator densities. To accomplish this, they committed to using available technologies (e.g., trapping and snaring, livestock protection dogs, night penning, etc.) to ensure the safety of their livestock. Producers have shown that this is possible to suppress predators below an economic threshold. But, the commitment required more and persistent labor than most producers were willing to invest. Finally, I would leave the reader with a quote from Shimon Peres, current president of Israel, to ponder relative to the predation problem: "If a problem has no solution, it may not be a problem, but a fact – not to be solved, but to be coped with over time." .

Increasing Demand and Price

"If demand was increased and thus, the price of lamb and wool, it would solve the industries problems" is a common statement by members of the sheep industry. Clearly, at some price level, sheep inventories would increase for a sufficient duration to make a real difference in the industry. But, as demonstrated by the low elasticities between revenue and ewe inventories, the price at which that would occur would be greater than could realistically be expected, which would not be sustainable. Domestic production cannot meet the current demand for lamb. In spite of econometric studies to the contrary (Williams et al. 2010), there is little evidence that promotion has helped reverse the downward trend in sheep numbers. Thus, increased demand would marginally benefit U.S. producers, but rather, would be of greater benefit to Australian and New Zealand producers. Finally, when slaughter lamb prices are high, “over feeding” of lambs in the feedlot is incentivized, resulting in a rapid devaluation of fat lambs. This happened in 1988, 2001 (McKinnon, 2002) and 2012, and it resulted in a negative perception by the producers, which, as stated above, caused an overreaction.

Increasing Production Efficiency and Reducing Labor

Efficiency of sheep production has increased, albeit more slowly than other livestock species (Parker and Pope, 1983). Sheep producers have been rather slow adopters of new technologies, and if sheep numbers continue to decline, availability of new technologies to further improve efficiency of sheep production will be reduced. Purcell (1998) concluded that it will be very difficult to solve the viability problems of the sheep industry based solely on increases in production efficiency. This is particularly true now that half of the lamb consumed in the U.S. is imported and domestic producers would most certainly loose a price war.

Sheep have many biological advantages compared with beef cattle relative to converting forages to high quality protein because of the greater relative growth rate of lambs and greater prolificacy of ewes (Walker, 1994). Sheep can better utilize steep rangelands with low forage production than cattle. But, sheep have a major cultural disadvantage. Sheep production requires more labor per animal unit than cattle enterprises (Stillman et al., 1990; Woodford, 2010). The additional labor required for sheep production is often cited as an obstacle to expansion of the industry in terms of hired labor and shearers. The reality is that this additional labor requirement has an equal or greater toll on sheep enterprise operators and their families. For example, as older operators seek to reduce their work load or the business passes to the next generation, whose cultural expectations include greater leisure time, sheep are often the first enterprise to be abandoned. This problem is exacerbated because of the highly concentrated nature of the sheep industry, where 1.5% of the operations account for 48% of the national flock (Williams et al. 2008). It is these large operations where labor from both the operator and hired labor is most crucial for a successful business. This is why I argue that labor is the resource most limiting to resurgence in the sheep industry. However, I contend that the amount of work required to successfully operate a large range sheep operation is no longer normative in this country. Further, only the families with a strong sheep culture and great equity will be able to maintain these operations in succeeding generations.

Agriculture, as it is practiced in developed countries, relies on large inputs of fossil fuels. A comparison of corn inputs and yields between mechanized and labor-intensive production systems demonstrates this point (Pimentel, 2009). Mechanized corn production requires 11 h of labor and 8,228 Mcal of fossil energy inputs to yield 9,400 kg/ha (150 bu/acre) of corn. Labor intensive corn production requires 634 h of labor and 4,082 Mcal of fossil energy inputs to yield 1,721 kg/ha (27 bu/acre) of corn. The fossil energy in the mechanized system is more efficiently used in producing 4 Mcal in crop output for each 1 Mcal of fossil fuel input compared with a ratio of 1:1.5, respectively, for the labor intensive system. This comparison illustrates 2 important points relative to modern agriculture and societal norms. Agriculture has progressed through intensification and the substitution of fossil energy for human labor, and both trends appear to be universal for all types of production. Because sheep production, and particularly range sheep production, has fewer opportunities to intensify or substitute fossil energy for labor, it will be at a competitive disadvantage to food production systems that can intensify, at least as long as fossil energy is relatively abundant. However, should fossil fuels and/or feed grains become limiting, sheep production could become very competitive as a source of high-quality animal protein. In that situation, lamb would have a clear advantage over beef because acceptable lamb can be produced on forages and requires only about 25% as much fossil energy to produce as feedlot finished beef (Cook, 1976).

The current situation of high grain and fuel prices is not new. In the mid 1970’s, following the 1973 oil embargo and concomitant high grain prices, there was much interest and research on forage finishing beef. The concern was that food production would not match population growth and that feeding grain to livestock would have to end. Of course those concerns passed, at least until recently, and world population has increased from 4 billion in the mid 1970’s to its current 7 billion. However, the norm, until the Green Revolution in the 1950’s, was that feed grains were too scarce to support livestock feeding on today’s scale. It is impossible to say if the current situation will last, because as Nobel physicists Niels Bohr famously said: “Prediction is very difficult, especially if it's about the future.”

Future of the Sheep Industry

One trend that does not require prediction, because the demographics are already in place and are projected to have a large impact, is the collapsing birthrate in the developed world (Drucker, 1999). In all developed countries, the strategy of all agricultural institutions will have to be based on a different assumption of a shrinking population, and especially of a shrinking young population. This development could turn the U.S. industry around, particularly if a concomitant decline in availability of feed grains occurs. One of the implications of an aging population is that people will have to continue to work to older ages. Most of them will not have worked in physically demanding occupations and will be able and perhaps prefer occupations that require a moderate level of physical activity. Also, because wealth tends to be concentrated in the older generation it is likely that many of the baby boomers will have equity in small rural properties. Is anyone starting to see a match here?

The Black Swan

Nassim Taleb (2010) defines black swan events as an event that is a surprise (to the observer), has a major effect, and after the fact is often inappropriately rationalized with the benefit of hindsight. Examples of black swan events include the rise of the Internet, the personal computer, and the September-11 attacks. The black swan that could have a major impact on sheep numbers would be an agricultural policy that emphasizes agricultural and environmental sustainability over production and the regulation of externalities (i.e., a consequence of an economic activity that is experienced by unrelated third parties). For example, consider air pollution and regulation of waste discharge from manufactures. Unless regulated manufacturers can discharge waste into the atmosphere with no cost to either the manufacturer or the direct consumer of the goods produced, all users of the air must ultimately pay the cost (e.g., such as increased health care cost). Externalities can be regulated by either fiat or by trade (e.g., carbon credits). Sustainability and negative externalities are 2 sides of the same coin. Sustainable agriculture systems do not produce negative externalities and, in fact, often produce positive externalities (i.e., ecosystem services).

The first notable effort by the American Sheep Industry Association to promote environmental benefits of sheep grazing occurred in 1994 with the publication of a special issue of the Sheep Research Journal: "The Role of Sheep Grazing in Natural Resource Management". This was followed by publication of: "Targeted Grazing - a natural approach to vegetation management and landscape enhancement" (Launchbaugh and Walker, 2006). Unfortunately, this effort has not been widely embraced as a method to increase sheep inventories, perhaps because it is more labor intensive than raising sheep strictly for commodity purposes. Currently, only about 6 percent of sheep producers are paid to provide the environmental benefit of weed control (ASI, 2010). If the ecological benefit of sheep grazing was appreciated and the economic benefit compensated, it could be the black swan that enables the phoenix to rise again.

Implications

The biggest problem of the sheep industry is declining inventory. This is not just a U.S. problem, but it is happening in all developed countries (Williams, 2008; Woodford, 2010). If this continues to happen, infrastructure required to support the industry will shrink and the problem of concentration of packers and buyers will intensify. Large operations must be sustained; this is where the sheep are currently concentrated. However, growth will be in smaller operations. A trend has already begun. The growth will be with unique breeds rather than traditional dual purpose breeds. The industry should make a concerted effort to recruit retiring small-acreage-owning baby boomers to the sheep industry. Sheep production could be a reasonable fit for that segment of the population. Furthermore, sheep production matches the concept of niche markets as a growth area for the industry; this is especially true in using sheep for ecosystem restoration and improvement. Additionally, sheep production provides locally grown food, which coincides with the ideals of many baby boomers. I suggest that promotion dollars could be better spent on advertising the virtues of sheep production in forums such as the AARP magazine rather than the culinary delights of lamb in food magazines. Make no mistake, the only metric that matters relative to the sheep industry is the effect of new programs and technologies on the size of the U.S. sheep flock. As Rodney and Sharon Kott head off to retirement, maybe they should be the "poster people" for this new segment for expansion in the sheep industry.

This solution may seem rather weak in comparison to the problems faced by the industry, but I believe that it is at least in the right direction. "The mere formulation of a problem is far more essential than its solution, which may be merely a matter of mathematical or experimental skills. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advances in science."--Albert Einstein. I hope that I have accomplished this.

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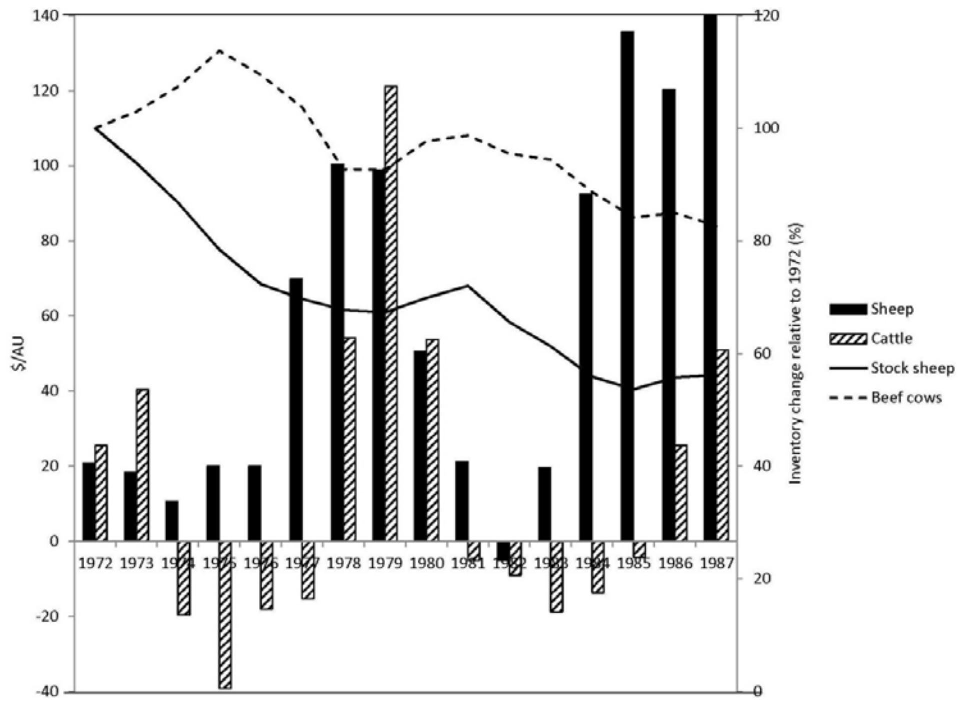

Figure 1. Comparative returns (bars) and inventory changes (lines) for sheep and beef cow enterprises. Returns are cash receipts less cash expenses (Stillman et al. 1990). Inventory changes for stock sheep and beef cows are shown relative to 1972 inventory where 1972 inventory = 100.

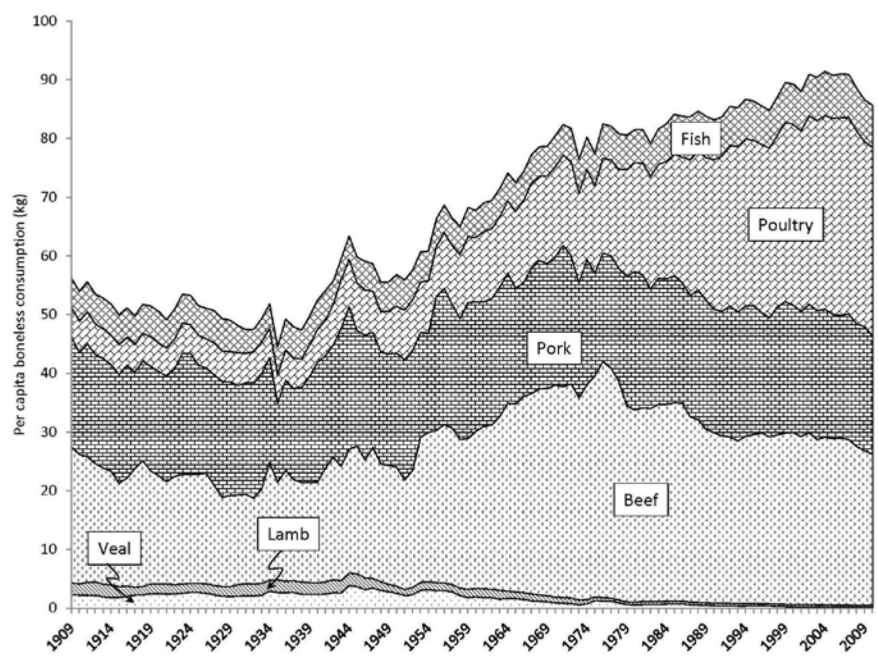

Figure 2. Boneless per capita consumption of different animal protein sources.

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