University of California
Agriculture and Natural Resources
Making a Difference for California

The Grazer's Gazette

A Newsletter about Livestock, Pastures and Rangeland *Volume 5: Number 3* *July, 2010*
Edited by John M. Harper, Livestock & Natural Resources Advisor, Mendocino & Lake Counties

In this Issue ***Page***

John Harper's Livestock & Natural Resources Blog Updates March 3, 2010—March 16, 2010

*From time to time **The Grazer's Gazette** will reprint articles from John Harper's on-line blogs and postings to Facebook and Twitter. If you are not already on John's email distribution list and would like to get this information when it is posted, please contact the UC Cooperative Extension at 707-463-4495 or email **cemendocino@ucdavis.edu** with your current email address. Also, be sure to notify us of email or address changes so that you continue to receive timely information.*

Current Reading: Carbon Dioxide & Grazing

March 3, 2010

Part of a Livestock and Natural Resources Advisor's job is keeping up with the scientific literature. Recently, I've been reading the Environmental Impact Assessment (Volume III) of Livestock Production in Grassland and Mixed Rainfed Systems in Temperate Zones and Grassland and Mixed-Rainfed Systems in Humid and Subhumid Tropic and Subtropic Zones (Except Africa) and while fairly technical there are some great summaries. To give you an idea, I'm posting the summary of CO^2, one of the "greenhouse" gases, and the impact of grazing on it below. I hope you find it interesting too.

Carbon Dioxide Balance in the Atmosphere

The fraction of incoming solar energy which is radiated back out to space from the earth as long-wave radiation is determined by the concentration of several atmospheric gases. The principal long-wave, energy-absorbing trace gases are carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide, all of which are increasing in the troposhpere. CO_2 is the most abundant and is being added in the greatest quantity; it is expected to cause about 50 percent of global warming occurring in the next half century (Johnson et al. 1994).

(Continued next page)

(Continued from page 1)

There are two questions associated with CO_2 and the impacts of livestock grazing on the environment: a) the impact, direct or indirect, of livestock grazing on atmospheric CO_2 and b) the impact of atmospheric CO_2 on livestock grazing and, subsequently, on the environment. Neither of these questions has definitive answers in the literature. However, the postulation that rangeland-grazing animals could increase in numbers from current levels so that their contribution to atmospheric CO_2 would be significant compared to CO_2 generated by industrialized humans and their activities is untenable. The second question, the impact of atmospheric CO_2 on livestock grazing, is dealt with at length in recent literature and is more easily addressed.

Despite media obsessions with tropical moist forests, savannas actually dominate the southern continents, covering 65 percent of Africa, 60 percent of Australia, and 45 percent of South America (Stott 1994). In savanna ecosystems, the majority of the grass species involved belong to the C_4 group of photosynthetic plants. In such plants, the rate of photosynthesis continues to increase with the intensity of photosynthetically active radiation (PAR), instead of the carbon dioxide curve flattening off to a plateau, as is more normal in C_3 species. In C_3 plants the carbon dioxide is fixed initially as a three-carbon compound, phosphoglyceric acid; by contrast, in C_4 plants, the carbon dioxide is fixed as a four-carbon compound, oxaloacetic acid. C_4 plants are the most efficient photosynthetically where light conditions are maximized, so that their optimum temperature for CO_2 fixation lies between 30 and 45^{o} C, their photosynthetic rate under optimal conditions is between 40 and 80 mg CO_2 dm^{-2} h^{-1} (3 to 4 times that of C_3 species), and the light saturation is 100 percent. This means that they are ideally adapted to bright, fairly dry environments, precisely the conditions associated with open savanna grasslands of the seasonal tropics. However, there is some evidence that this competitive advantage in hot, dry regions may be significantly diminished as a consequence of predicted greenhouse effects, such as increased atmospheric CO_2, because C_4 species appear to show little photosynthetic response to elevated CO_2 (Woolhouse 1990). Nevertheless, dry-matter production may still be enhanced by an improvement of the plant-water status, through the reduction of stomatal aperture which usually accompanies the effects of high CO_2 concentrations (Squire 1990).

In the savannas, both natural fire, from lightning strike, and human-induced fire are often entirely integral to the maintenance of the ecosystem. In many savannas, it would be impossible to maintain the economic productivity of the grass stratum without the use of fire as a prescribed tool (Stott 1994). It is now recognized that the savanna form is generally governed by the intricate interplay of five key ecological factors, namely plant available moisture, plant available nutrients, fire, herbivory, and major anthropogenic events. Savanna ecosystems have themselves long been a significant contributor to the never-ending story of global environmental change. Even before the impact of humans, fire, through lightning strike, friction, and refraction, was a natural stress in savanna lands. Today, savanna fires contribute the largest percentage of all the CO_2 emitted to the atmosphere through biomass burning in the tropics. In the Brazilian cerrado, for example, the entire humid savanna is fired once every two years, while 75 percent of the humid savannas of Africa burn annually. Thus, 85 percent of the CO_2 emitted from tropical Africa is derived from its savannas. Many ecologists and conservationists thus regard biomass burning in the savannas as a major contributor to global warming. But in reality the issue is much more complex, because the savannas have always burned regardless of human activity. What we need to know is the exact nature of the recent increase in burning over the long-term historical levels. Would this recent increase really be significant at all if it were not being added to the historical contributions over the past 150 years or so by the industrialized countries of the North (Stott 1994)? In many ways our future management of the savanna landscapes of Australia, South East Asia, India, Africa, and Latin America will indicate all too starkly whether we are succeeding in our human response to global environmental change (Stott 1994).

Deforestation and grazing influence species composition, primary productivity, and organic matter decomposition, thereby altering the liberation and sequestering of CO_2 (Archer 1994). Changes in land cover and ecosystem processes may further influence climate by altering surface energy flux and biophysical properties (albedo, temperature, evapotranspiration, air circulation, etc.) and by changing levels of particulate input (e.g., dust) in the atmosphere (Graetz 1991).

Continued next page

(Continued from page 2)

With an eightfold increase in population since the eighteenth century to the currently more than 5 billion people, development and industrialization have increased atmospheric level of greenhouse gases. The population now appropriates 40 percent of all organic matter fixed by photosynthesis per year and consumes the equivalent of 2 tons of coal per year. It is no great surprise that CO_2 levels have increased dramatically in the last century and particularly in the last three decades (Byers 1994a). The CO_2 concentration of the atmosphere has increased from as low as 265 ppm only 125 years ago to about 350 ppm at present (Mayeux et al. 1991), an increase of almost 30 percent. However, atmospheric levels of CO_2 are not expected to double before the year 2025 and may not occur within the next century (Trabalka et al. 1985). The biggest contributors to elevated CO_2 are emissions from factories, vehicles, and power plants, primarily within the industrialized countries. CO_2 release from deforestation has contributed as much as half of the atmospheric increase since 1800 and is responsible for at least 20 percent of current emissions (Byers 1994a). The slash-and-burn conversion technique immediately releases both tree and litter CO_2 to the atmosphere. Dead organic matter in the soil holds two times as much total CO_2 as there is in the atmosphere and when released during deforestation is a major source for increasing atmospheric levels of carbon. Deforestation without slash and burn, for example, in the U.S. where the forest heritage was converted into the Midwest breadbasket and logs converted to lumber for construction, does not contribute as much CO_2 to the atmosphere. Using this latter technique leaves the majority of the CO_2 in the lumber. However, past deforestation, especially in Central and South America, has been done to accommodate crops and pastures for livestock grazing (Cross 1994). Thus, there is a relationship, albeit indirect, between livestock grazing and elevated atmospheric CO_2.

Possible effects of the predicted increase can be characterized as a) the direct effects on rangeland vegetation caused by a carbon enriched atmosphere, or b) indirect effects on vegetation caused by global warming as a consequence of increased CO_2 and other greenhouse gases. There is substantial evidence to support the hypothesis of some researchers that there have already been dramatic changes in rangeland vegetation over parts of the world that can be related, at least in part, to elevated atmospheric CO_2 (Byers 1994a).

Mayeux et al. (1991) and Scifres and Hamilton (1993) describe changes in the vegetation of the southern Great Plains and Southwest of the U.S. as essentially an increase in the distribution and density of naturally occurring shrubs from widely separated sites into open grassland stands. Many woody species were a part of the migration from limited sites to become established across the broad range of soils and topography. Archer et al. (1988) describes the mechanisms of establishment of pioneer woody plants in a grassland environment and subsequent changes through juvenile to mature plants and associated components of mottes in south Texas. Major woody species that have increased and/or thickened as a part of this phenomenon include mesquites (Prosopis spp.), creosote bush (Larrea divaricata), and junipers (Juniperus spp.), many shrubby composites including sagebrushes (Artemisia), rabbitbrushes (Chrysothamnus), snakeweeds (Gutierrezia), and a host of less geographically important plants.

The commonly accepted combination of causes for the increase of woody plants on open grasslands (overgrazing, fire suppression, propagule dissemination, climate change) are acknowledged by Mayeux et al. (1991). However, these researchers also believe that the change cannot be explained by these factors only and contend that no compelling evidence exists which substantiates that any single one or combination of them is responsible. Woody plant increases have been observed across extreme heterogeneity of the entire American West as well as in other parts of the world, including Argentina, Mexico, South America, Australia, Africa, and India. Interestingly, in the low veld of Rhodesia, shrubs increased at the expense of perennial grasses more in the absence of domestic livestock than when grazed lightly or moderately (Kelly and Walker 1976). Areas from which grazing has been excluded since before significant woody plant invasion, including an exclosure since 1915 on the Jornada Experimental Range in southern New Mexico, have been encroached by woody vegetation similar to adjacent unprotected sites.

Future changes in plant community structure have been predicted as consequences of continued increases in atmospheric CO_2 in the next century (Bazzaz and Garbut 1988, Overdieck 1986). Mayeux et al. (1991) considered whether the effects of global increases in atmospheric CO_2 levels are already evident as shifts from open grassland to shrubs. There is

(Continued next page)

(Continued from Page 3)

evidence that higher levels of CO_2 may have already influenced productivity of forests based on studies of annual growth rings of pine species (LaMarche et al. 1984) where tree growth rates were found to exceed those expected from climatic trends, but to be consistent with global trend in CO_2. Historic increases in the yields of other plants, including several crops such as wheat (Gifford 1979, Byers 1994a) and soybeans (Allen et al. 1987), may be at least partly due to increased availability of CO_2.

CO_2 enhancement of the atmosphere will have its greatest effect under hot, dry climates, where leaf temperatures and stomatal closure lead to elevated O_2/CO_2 ratios at the site of CO_2 fixation. In C_4 plants, however, there already exists a CO_2-concentration mechanism, the C_4 cycle, which is not susceptible to O_2 competition, and in which the carboxylating enzyme is protected by a locally elevated concentration of CO_2. It is not surprising, therefore, that C_4 plants show little response to elevated CO_2. This means that their competitive advantage may be reduced under increased atmospheric CO_2, having significant effects on both the composition and the productivity of the grass stratum in the tropical savannas. But, again, there is much uncertainty about this simple prediction because the single variable advantage may be offset or transcended by significant changes in the other environmental factors concerned with dry-matter production, particularly temperature and precipitation (Squire 1990).

Increasing the CO_2 concentration of the atmosphere in which plants grow increases carbon assimilation rates and has favorable effects on other physiological processes of all functional groups of plants (Pearcy and Bjorkman 1983). Idso et al. (1987) found that the literature indicated plant growth would be increased by approximately 30 percent by a 300 ppm increase in atmospheric CO_2. When combined with the 3^o C predicted increase in temperature from the greenhouse effect, the plant growth enhancement factor rises from 1.30 to 1.56. These same researchers found that even higher growth enhancement could be achieved if the non-CO_2 trace gas effect is equally as strong. However, they also found that atmospheric enrichment tends to reduce plant growth at relatively cold temperatures and that predicting the ultimate biospheric consequences of the earth's atmospheric CO_2 concentration may be more complex than originally anticipated.

A study reported by Riechers and Strain (1988) using blue grama (Bouteloua gracilis) bears out that much more specific information will be required to predict changes. Blue grama, a C_4 grass species, may benefit more from CO_2 enrichment than would be predicted based on the response of other C_4 species studied in other experiments, even though the relatively large enhancement in growth is far less than the increases seen for many C_3 species. Therefore, even though some C_4 species, such as blue grama, may be differently enhanced by elevated CO_2, they will still be at a comparative competitive disadvantage compared to C_3 species.

Rochefort and Woodward (1992) modeled the response of global family diversity to global environmental change, including climate and a doubling of atmospheric CO_2. The model assumes that three primary mechanisms define diversity: the capacity to survive the absolute minimum temperature of a site, the ability to complete the life cycle in a given time length and warmth of the growing season, and the capacity to expand leaves in a defined regime of precipitation and vegetation transpiration. Global temperatures are assumed to rise 3^o C and global precipitation increase 10 percent. The direct effects of CO_2 on vegetation transpiration are also included. The addition of CO_2 in the atmosphere along with a 10 percent increase in precipitation appears to counteract the negative effect of increasing temperature on vegetation diversity (global warming was found to be deleterious for global diversity because the increased rate of vegetation transpiration, at the higher temperatures, was not offset by increased rates of precipitation). As a consequence, one-third of the world's floristic regions might increase their diversity or at least maintain a similar value of diversity to the present. The model demonstrated that CO_2 taken as a factor by itself can have a significant effect on global family diversity, and the authors recommend strongly that CO_2 effects should be included when modeling global climate change.

While increasing CO_2 appears to improve water use efficiency of all plants, experimental evidence suggests that effects on other physiological processes are more strongly expressed in plants that possess the C_3 photosynthetic pathway than in those with C_4 photosynthesis (Bhattacharya 1993). Carbon assimil ation rates vary widely with species and environmental conditions but are thought to be higher in C_4 than C_3 species at current levels. Mayeux et al. (1991)

(Continued next page)

(**Continued from page 4)**

compared net carbon assimilation rates of little bluestem (Schizachyrium scoparium), a C_4 native perennial bunchgrass widely distributed across the Great Plains of the U.S., and the C_3 woody invader honey mesquite (Prosopis glandulosa) at increasing CO_2 levels. Their studies indicate that photosynthetic rates of the grass are about 20 percent higher at CO_2 levels characteristic of 150 years ago. However, net photosynthetic rate of the shrub equals that of the grass at today's atmospheric CO_2 level, 350 ppm, and will exceed that of the grass as ambient CO_2 level continues to increase. Thus, the C_3 mesquite has realized a greater relative advantage than the C_4 grass as CO_2 increased over the last 150 years, if increasing photosynthetic capacity improves performance at the whole-plant or higher levels.

The work by Mayeux et al. (1991) has profound implications for predicting relative composition changes of rangeland vegetation between C_3 plants (woody and cool-season species) versus C_4 plants (warm-season perennial grasses). However, there may be offsetting conditions not addressed in their experiments. CO_2 can interact in complex ways to alter plant growth, making it difficult to predict the future productivity and composition of plant communities from the results of studies solely examining the effect of CO_2 on plant performance (Coleman and Bazzaz 1992).

Even with the lack of definitive information on interactions between elevated atmospheric CO_2 and other environmental factors, such as temperature and precipitation, the evidence is strong that rangeland vegetation will be affected in both composition and productivity potential by the greenhouse effect, including CO_2. The result could be a decrease in the relative proportions of C_4 to C_3 plants based on the increased competitive advantage to C_3 plants from increasing CO_2. In the studies by Mayeux et al. (1991), there was also a dramatic increase in the response of C_3 herbs to increasing CO_2 at subambient levels representative of the past 150 years. Oats (Avena sativa) and wild mustard (Brassica kaber) were grown in a continuous CO_2 gradient from 150 ppm to current ambient, about 350 ppm. Over the range of increasing CO_2 from 250 to 350 ppm, representative of the change in the last 150 years, net carbon assimilation increased by over 50 percent. Leaf area and oven-dry weight of top growth increased by the same extent or more, indicating that historical changes in CO_2 may have profound effects on the growth of C_3 herbs. C_3 woody plants respond to elevated CO_2 to the same or greater extent as C_3 herbs (Tolley and Strain 1987). Conifers exhibit a pronounced growth increase, suggesting that CO_2 may have already played a role in recent increases in the extent of the piñon pine-Juniper type and the abundance of a number of Juniperus species throughout North America.

Mayeux et al. (1991) hypothesize that favorable effects of increasing CO_2 that apply to all functional groups of plants, especially improved water-use efficiency and amelioration of stress, suggest that overall productivity of rangelands will increase. However, increased productivity will probably continue to be reflected in increased biomass of less desirable C_3 weeds and woody vegetation, as opposed to C_4 warm-season perennial grasses, where the two functional groups occur together. This has very profound ramifications for rangeland management and for the use of grazing animals. The hypothesis that historical increases in atmospheric CO_2 conferred competitive superiority upon C_3 weeds and shrubs and rendered them inherently better adapted to today's rangeland than C_4 grasses implies that, by definition, current climax is characterized by shrub dominance. This seems true not only for the present but increasingly so in the future as CO_2 levels continue to climb. Efforts to define range condition and trend relative to a historical species composition in which shrubs were poorly represented seem unrealistic in light of both the hypothesized CO_2 effect and the well-documented success of woody plants over recent decades.

(a copy of this report can be found on the web at: http://www.fao.org/WAIRDOCS/LEAD/X6119E/x6119e03.htm#2.%20LGT%20Environmental%20Impacts)

(Continued next page)

(**Continued from page 5**)

Ethical Foods: New Marketing Study Clues for Niche Meat Products

March 4, 2010

There is a new marketing report recently released that has useful information for those livestock producers involved in targeting the niche meat market. Many producers have looked into organic, natural, grass-fed, and the concept of local. This report focuses on a new consumer preference, ***"ethical foods"***, and came about through a survey that was designed by Context Marketing[1] (www.contextmarketing.com) and conducted by Deciper, Inc., a marketing research services provider specializing in online survey programming and data collection.

So what does ***"ethical foods"*** mean?

According to the report the research found that ***"ethical"*** is a broad, flexible and often highly personal term when consumers apply it to food purchased in supermarkets or specialty stores.

Ethical food is defined by a number of attributes and perceived benefits regarding how a food is produced or processed, its impact on the environment, adherence to quality and safety standards, and even where food is sold and how it is priced.

Findings of the survey include:

- **Ethical claims help consumers identify high quality, safer foods.** While many consumers want their food purchases to help make the world a better place, such as by protecting the environment and improving the treatment of farm animals, they also find that credible ethical food claims assure them about food quality and safety. When asked to define the qualities of an "ethical food," most consumers readily emphasize health and safety benefits along with more altruistic concerns.
- **Ethical foods build brand engagement.** When consumers find ethical claims credible and relevant, they often develop a deeper emotional connection with the brand. Many consumers report that they are more willing to learn about ethically produced foods and recommend them to others, and are more likely to believe other quality claims made by the brand. Most important, 69% of consumers report they will pay more for food brands they see as **"**ethical."
- **Women and younger adults are more responsive to ethical claims.** While there is broad agreement on the importance of ethical foods among men and women in all age groups, women are generally more responsive to ethical claims for altruistic as well as health and safety reasons, and are willing to pay a little more for ethically produced food. Younger adults also are more attentive to many ethical claims than their older counterparts and are more likely to act on those beliefs when it comes to food purchases.

Given our proximity to both the San Francisco and Sacramento areas, producers targeting these markets should download and read the full report as it will help them with their product branding and advertising.

One of the most interesting findings was that the ***Eat Local Movement*** was gaining momentum. Sixty-six percent of survey respondents agree that locally produced food is always preferable and nearly half (49%) believe that for a food to be considered ethical it should be produced locally. More findings and intriguing statistics are in the full report. You can download it as a pdf file at:

http://contextmarketing.com/sources/feb28-2010/ethicalfoodreport.pdf

[1]Context Marketing is a San Francisco Bay Area consulting firm that helps companies develop communications strategy and initiatives addressing the societal issues that influence brand preference and corporate reputation. The firm has worked extensively with companies and organizations in the food and beverage area.

(Continued next page)

(Continued from page 6)

New USDA Agency—Office of Environmental Markets

March 16, 2010

In past posts I've shared information concerning carbon credits and the potential for rangeland and forestland owners to benefit from this relatively new market.

The 2008 Farm Bill's conservation title directs the Secretary of Agriculture to facilitate the development of environmental markets and ensure the participation of America's farmers, ranchers and forest landowners. As set forth by Congress in the Farm Bill, the Office of Environmental Markets (OEM) will work across government and in consultation with experts and stakeholders to build a market-based system for quantifying, registering and verifying environmental benefits produced by land management activities.

More information can be downloaded at:

http://www.ocio.usda.gov/directives/doc/SM1065-001.pdf

2007 Farm Bill Theme Paper on Conservation and the Environment (PDF, 0.7 MB)
http://www.usda.gov/documents/FarmBill07consenv.pdf)

and Executive Summary (PDF, 144 KB)
www.usda.gov/documents/FarmBill07consenvsum.pdf

Specifically according to info on its web site, the "Office of Environmental Markets (OEM) is a new office created within the U.S. Department of Agriculture to catalyze the development of markets for ecosystem services. OEM has a unique role in the federal government's efforts to develop uniform standards and market infrastructure that will facilitate market-based approaches to agriculture, forest, and rangeland conservation. OEM is bringing experts and stakeholders together with government agencies to build a robust, accessible, and scientifically credible market system that will protect and enhance America's natural capital into the future.
The office, formerly called Office of Ecosystem Services and Markets, was established in December 2008 to provide administrative and technical assistance to the Secretary in implementing Section 2709 of the Farm Bill. Sally Collins was named Director of the office, after serving as Associate Chief of the Forest Service for eight years." The following links provide more information:

USDA News Release (March 10, 2010): Secretary Vilsack announces details and objectives of USDA's Office of Environmental Markets
(http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2010/03/0115.xml)

USDA News Release (December 18, 2008): USDA announces new Office of Ecosystem Services and Markets
(http://www.usda.gov/wps/portal/usda/usdahome?contentidonly=true&contentid=2008/12/0307.xml)

USDA Secretary's Memorandum 1056-001: Establishment of the Office of Ecosystem Services and Markets (PDF, 20 KB)
(http://www.ocio.usda.gov/directives/doc/SM1056-001.pdf)

To get additional information you can email or phone via the contact information below.

Contact:

OEM@usda.gov
(202) 694-5345

Cooperative Extension—Mendocino County
890 N. Bush Street
Ukiah, CA 95482

University *of* California
Agriculture and Natural Resources
Making a Difference for California

NON-PROFIT
US Postage
Paid Permit
No. 15
UKIAH, CA

Facebook & Twitter Afficionados….

You can now follow John Harper's Livestock & Range Management updates on:

Facebook
Www.facebook.com\UCCE.Range.Livestock

Twitter
Www.twitter.com\MendoLakeRange

Also check out John's Blog on our office website: http://cemendocino.ucdavis.edu

Published by
**University of California
Cooperative Extension
Mendocino County**

890 N. Bush Street, Ukiah, CA 95482
Phone (707) 453-4495
FAX (707) 463-4477
http://cemendocino.ucdavis.edu

John M. Harper
County Director,
Livestock & Natural Resources Advisor
jmharper@ucdavis.edu

The University of California working in cooperation with Mendocino and Lake Counties and the USDA