Colorado State University

Western PhytoWorks

Western Colorado Research Center

Spring 2011

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Biomass to Biofuels

On March 24, 2011, a Biomass to Biofuels Symposium was held at the Colorado Mountain College, Rifle campus. More than 90 people filled Clough Auditorium to hear about efforts to produce biofuels in western Colorado using locally-grown biomass.

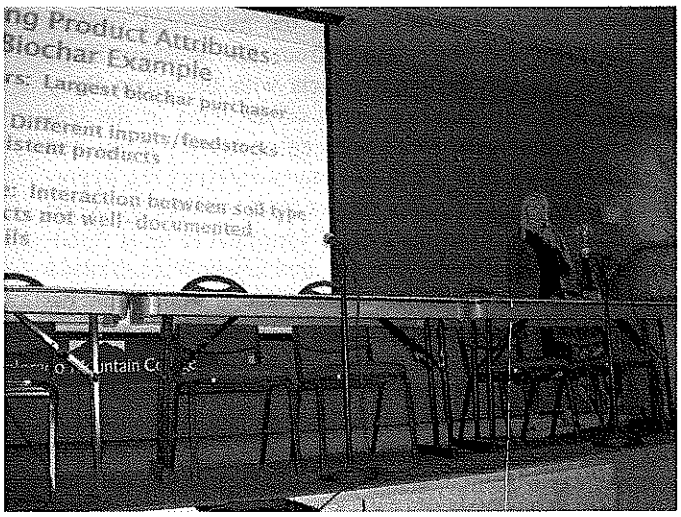
The need for sustainably produced, energy dense, liquid biofuels for transportation, construction, and heating is critical, and their development is mandated. In 2007, The U.S. Energy Independence and Security Act was signed into law requiring the production of 36 billion gallons per year of biofuels by 2022. To meet this mandate, current United States production of biofuels would need to more than triple from the 11.1 billion gallons produced in 2008.

The symposium program consisted of four speakers and a panel discussion. Morgan Williams, Executive Director of Flux Farm Foundation, was the first speaker and he spoke on "The Need for a New Type of Agriculture in the West." The topic of the second presentation was on "Developing Sustainable Biomass Resources in Western Colorado" and was made by Calvin Pearson, Agronomist and Professor at Colorado State University, Western Colorado Research Center at Fruita. Jon Prater, Coordinator of the Integrative Energy Technology Program at Colorado Mountain College, made the third presentation on "Community Scale Biobutanol Production at CMC." The fourth and final presentation was by Catherine Keske (see photo), Assistant Professor of Agricultural and Resource Economics at Colorado State University, on "Regional Economic Considerations for Biomass Energy Production."

Following the formal presentations, the four speakers along with Charlie Stevens, Utility Director, City of Rifle, formed a panel and symposium attendees were invited to ask questions to panel members. The panel discussion was invigorating and created an informative dialogue about producing biofuels in western Colorado using local biomass. Following a catered lunch, Jon Prater hosted a tour of the pilot-scale processing facility he is constructing on the CMC Rifle campus.

The symposium was hosted by The Western Colorado Carbon Neutral Bioenergy Consortium (WCCNBC), which was created in December 2009 as a partnership with CSU, Colorado Mountain College, The City of Rifle, and Flux Farm Foundation. The Consortium was formed to investigate the ability of western Colorado to sustainably produce and process biomass for biofuels and carbon sequestration through applied, interdisciplinary, scientific investigation.

For more information about this article contact Dr. Calvin Pearson at calvin.pearson@colostate.edu. If you would like more information about our biomass to biofuels project or to view the talks given at the symposium, visit the website at the Western Colorado Carbon Neutral Bioenergy Consortium www.wccnbc.org



Cold Hardy Grapes in the Colorado Wine Industry

On April 9, 2011, a Front Range Cold Climate Pruning Workshop was held at the vineyard of Rudy and Andrea Durán in Parker, CO. The Duráns and a number of other growers are planting cold hardy hybrids in areas outside of the traditional 'warmer' areas of the Grand Valley and the West Elks AVAs in western Colorado. Growers at the meeting were from various locations in Colorado, including northeastern and southeastern plains, southern and southwestern mesas, and even from the south central mountains. John Thull and Jenny Bradley, from the University of Minnesota Cold Hardy Grape Breeding Program, gave a talk on growing cold hardy grapes in the Midwest and how that might translate into the colder areas of Colorado. Dr. Horst Caspari, CSU Viticulture professor, spoke of the possibilities and limitations of growing both New York and Minnesota bred grape cultivars in Colorado's colder areas. Dr. Stephen Menke, CSU Enology associate professor, and Doug Caskey, Director of the Colorado Wine Industry Development Board, spoke of the kind of wines that are made from these higher yielding and more consistently yielding grapes, how these wines have created a whole new kind of wine industry in the mid-western and eastern US, and what are the possibilities of duplicating this phenomenon in Colorado. Attendees did hands-on pruning of the hybrid grapes in the Durán vineyard and posed many questions about growing various cultivars of hybrid grapes. Wines from some hybrid grape cultivars, made in both Colorado and Minnesota wineries, were tasted at the completion of the meeting, to inform everyone's palate on what is possible with these grapes.

Cold hardy grape cultivars are not entirely new to eastern Colorado, as Concord, Niagara, and Catawba cultivars were planted early in the 1900's, for table, juice, jelly, and wine use, and are still present in many home gardens. When the new generation of grape growers and winemakers re-started the Colorado wine industry in the 1970's, some of the hybrid grape cultivars were planted along the Front Range and some wines were made from them. But the traditional vinifera grape cultivars and their wines from the Western Slope quickly became the desired products with the urban Baby Boomers, who still purchase most of the wine in the US. However, the new grape and wine entrepreneurs in the rest of Colorado, such as those at this recent meeting, see opportunities in using both vinifera grapes from the Western Slope and hybrid grapes from the rest of Colorado to make food-friendly blends that excite younger and newer wine drinkers in urban Colorado. These wines will add a whole new dimension to the Colorado wine industry and help make it more diverse and profitable.

Dr. Horst Caspari, at the Western Colorado Research Center (WCRC) has grape variety trials that include many cold hardy hybrids. As well, Dr. Stephen Menke, also at WCRC, has made experimental wines from these hybrids and has conducted industry blending trials with both the hybrid and vinifera wines. They can be contacted, respectively, at horst.caspari@colostate.edu and stephen.menke@colostate.edu.

For more information on developing the Colorado wine industry contact Doug Caskey at dcaskey@coloradowine.com

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Evaluating Corn Breeding Material at WCRC - Fruita

Field testing of new breeding material for crops is essential to the success of public and private research and development programs. New corn grain hybrids and advanced breeding materials have been evaluated at the Colorado State University (CSU) Western Colorado Research Center (WCRC) at Fruita for several decades.

Corn hybrids perform differently in different locations creating what is termed a "genotype x environment interaction." Thus, it is important to test corn breeding material in a sufficient number of environments to determine in which locations corn hybrids are best adapted. This is of critical importance to allow companies and others to determine which hybrids to commercialize and how to market them.

Much of past corn grain breeding efforts and research and development of new corn grain hybrids have been on grain yield, grain quality, disease resistance, stalk strength, root strength, plant height, and others.

With the advent of biotechnological tools, new crop traits of commercial value include herbicide resistance, insect resistance, environmental stress such as tolerance to drought, with many others either in the development process or envisioned.

On September 10, 2010, Dow AgroSciences purchased Grand Valley Hybrids (GVH). Since 2007, we at WCRC-Fruita, have conducted advanced corn hybrid genetics testing for GVH. Given the sale of GVH to Dow Agrosciences, the testing we have been doing with GVH will come to an end and future corn hybrid genetic materials testing at WCRC-Fruita will be with Dow AgroSciences.

The Grand Valley of western Colorado historically experiences hot, dry weather which can limit the yield potential of grain corn; however, western Colorado has been

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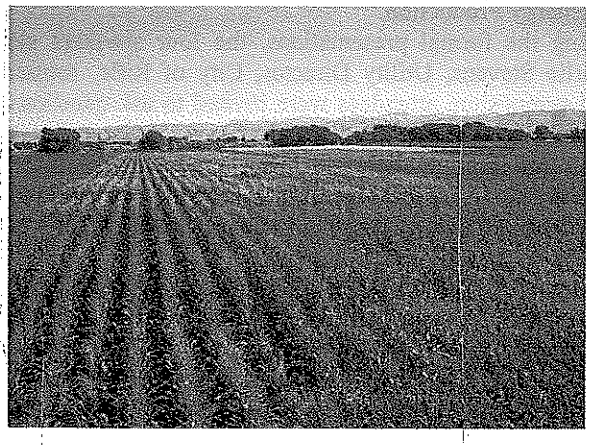

Field area showing the genetic variation of the corn entries planted for Grand Valley Hybrids at the CSU Western Colorado Research Center at Fruita during 2010. Photo by Calvin Pearson.

Vegetable production and marketing, an option for small landholders

In western Colorado cultivated land is often fragmented, characterized by small land holdings where big operations of traditional commercial crops are difficult and many times traditional crops in small acreages may not be profitable. However, crop diversification and production of specialty crops for niche markets may be more profitable to many small land holders. Thus, studies on production and market potential of diverse vegetables with health benefits have been ongoing at WCRC research center since 2007. Such niche crops, using fewer inputs such as fertilizers and pesticides, and with better market prices, may be the most suitable for small land holders and organic producers. Moreover, there will not be potential cold damage risks to these vegetables.

Vegetable cultivation at WCRC started with the objectives of the potential for crop diversification, income generation to small landholders, selecting crops for health benefits, and linking the production with market demand. Currently okra, bottle melon, bitter melon, luffas, eggplants, long green beans, and tomatoes are under study and results have shown that they can be produced with less input and might be options for organic producers. In addition, several berry crops are under investigation as an attempt to search for alternative and crop diversification effort for local environment.

While diversifying the vegetable cultivation, we are also linking to local marketing of such vegetables. Cultivation and consumption of such crops are often associated with the culture, geographic location, and sometimes the ethnicity of the people. However, diversity in food availability will increase the consumption and change the cuisine of people. At the same time, production of such vegetables is often dependent upon climatic adoptability, market, and profit to the producers. Moreover, the health benefit of vegetables is an increasingly major driving force in food selection. Small landholders can produce such vegetables to meet the needs of local markets for crops with health benefits.

Consuming foods high in fiber is essential for a person to be healthy, and fruits, vegetables, legumes and wholegrain products are the major source of fiber. Dietary fiber found in peas, beans, oats, apples and citrus fruits are soluble whereas fiber found in many vegetables, wheat bran, and nuts is insoluble. Foods rich in fiber have health benefits. Soluble fiber assists in the reduction of total cholesterol levels and the control of blood glucose levels, especially in diabetics. Insoluble fiber increases bowel movements and decreases constipation. Many credible studies to date have shown that high consumption of fiber-rich foods is associated with managing health problems such as lowering risk of cardiovascular disease and type 2 diabetes. The average American man or woman gets about 16 to 18 g and 12 to 14 g fiber per day, respectively against the need of such dietary fiber intake of 38g for men and 25g for women per day for adults under the age of 50.

Vegetables contain essential nutrients such as protein, fat, vitamins, and minerals required for body maintenance.

In addition, phytonutrients found in vegetables containing certain organic components (other than the essential nutrients), are thought to promote human health; currently many phytochemicals that possibly have medicinal properties are in clinical trials for a variety of diseases.

For example, lycopene from tomatoes has been tested in clinical trials for cardiovascular diseases and prostate cancer. An evaluation study on Zebra tomatoes (Fig. 1) which has 3 times higher lycopene content and double the sugar content as compared to other tomatoes is ongoing in a greenhouse condition at WCRC-Orchard Mesa site. The study indicated that growing Zebra, Round and Cherry tomatoes is possible throughout the year in a greenhouse environment in Western Colorado without any additional light facility or any major problems. At the same time, we are also looking for an option of a greenhouse facility that runs through solar energy. An evaluation study on the local adaptation of these tomatoes in field conditions will be conducted in coming season at WCRC-Orchard Mesa site.

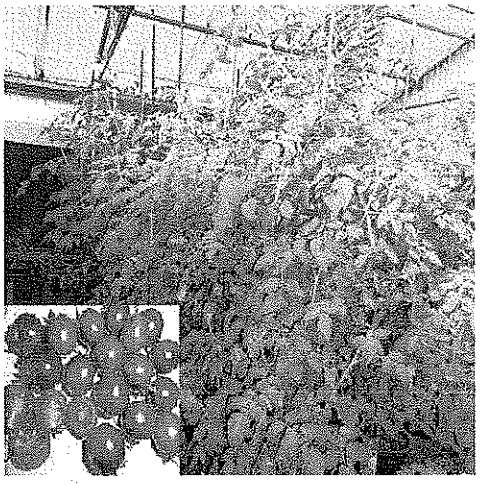

Fig. 1 Zebra tomoato plants in the WCRC Orchard Mesa greenhouse.

In addition, studies on okra are underway at WCRC. Okra production potential and assessment of local market need have been ongoing at WCRC since 2007. In addition, study of okra price in local farmers market revealed a trend toward increasing prices (Fig. 2).

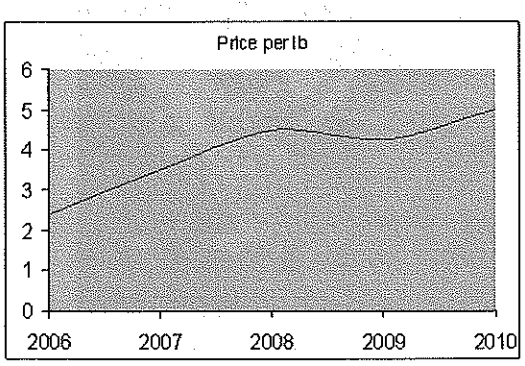

Fig. 2 Okra prices collected from local vendors at Grand Junction Farmer's Market 2006-

Okra (Fig. 3) is one of the vegetables with high dietary fibers along with vitamins A and C and is a good source of iron and calcium. It also contains starch, fat, ash, thiamine and riboflavin. The demand for this vegetable is increasing. Okra has been growing in our test plots without any problem. Okra grows with much less care and management and could be a good choice for an organic producer. The most laborious job is picking, demanding higher labor. Powdery mildew incidence later on the season was observed but did not affect production. Depending upon temperature, picking should be done on alternate days or 2 days after each picking. Okra can be preserved in a deep freeze for later use

Fig. 3 Okra grown at WCRC-Orchard Mesa.

Several other vegetables have been grown successfully in western Colorado conditions, including bitter melon (Fig. 4). Bitter melon contains 8 different vitamins, 6 different minerals and is rich in potassium, and phytonutrients such as carotene-ß, carotene-alpha, and lutein-zeaxanthin. It is also known to reduce blood sugar. It is bitter in taste, but many Asians like its taste, and with increased concern about the connection between health benefits and healthy food, consumption of such kinds of vegetables should be increased.

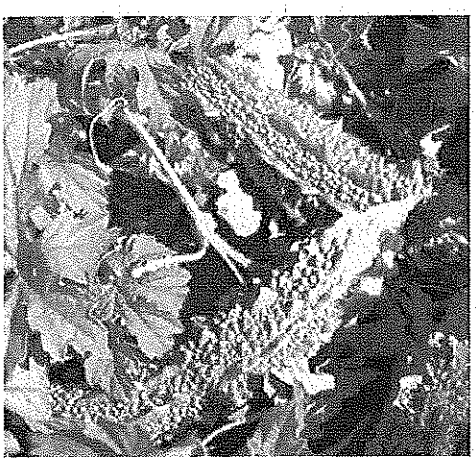

Fig. 4 Bitter melon grown at WCRC-Orchard Mesa.

Some of these vegetables could be incorporated in between fruit tree rows, especially with trees up to three years of age to supplement the orchard income. A project to incorporate such vegetable production in between fruit tree rows is initiated at WCRC-Orchard Mesa site. Some of the fruit growers in the valley already have incorporated vegetable production along with fruits to supplement their farm income.

Multi- ethnic populations of Denver and surrounding areas are markets for diverse types of vegetables, such as bottle melon (Fig. 5) and luffa (Fig. 6), and Grand Valley might be a good potential source of supply. Concurrently we are working on: the production potentiality of such high value vegetables; assessing acreage needed to meet the market demand for such vegetables; and assessing local (including Denver) market demand for marketing such produce.

For further information regarding this article contact rameshp@colostate.edu

Fig. 5 Bottle Melon grown at WCRC-Orchard Mesa

Fig. 6 Luffa grown at WCRC-Orchard Mesa

Watch our Events page on the website (http://www/colostate.edu/programs/wcrc/comingevents) for Field Days, amateur wine competitions and other area events.

(continued from Page 3)
recognized as an environment in the U.S. for high corn yields.

Over the four years of testing GVH advanced corn genetic material we planted and harvested 4,889 plots at WCRC-Fruita and 264 plots at Olathe, CO. Over the testing period for GVH at WCRC-Fruita and at Olathe, approximately 10 new commercial corn hybrids were selected for commercial release by GVH. Typically, 2-3 new hybrids were identified each year. Estimates are that these new corn hybrids were used to plant 20,000 – 22,000 acres across the GVH sales area. These new corn hybrids were estimated to have a 10 bushel per acre yield increase over current GVH commercial hybrids. New GVH corn silage hybrids were estimated to have a 2.5 ton/acre yield increase over current GVH silage hybrids. Developing strong university/industry collaborative relationships are valuable in conducting research projects that result in benefits to the agricultural industry.

For more information about this article contact Dr. Calvin Pearson at calvin.pearson@colostate.edu.

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Profitable Irrigation Strategies in Western Slope Peach Orchards

Since 2009 CSU Extension and the Mesa Conservation District _ with support from Orchard Mesa Research Center, Palisade orchardists, and the Bureau of Reclamation – have been testing the benefits of Regulated Deficit Irrigation (RDI) strategies in western Colorado peach orchards. RDI was initially developed in Australia starting in the 1970s, with variations of the protocol now in use throughout the commercial peach growing world. RDI has proven especially effective where water is scarce and expensive. In Colorado, trials are exploring the savings in pruning labor and stewardship benefits.

After two encouraging seasons of testing RDI in the Palisade area, 2011 will see testing expanded to include experimental plots at the research center and in-orchard trials with four producers; three at East Orchard Mesa and one in the Hotchkiss area of Delta County. On-farm trials have fallen into two categories depending on soil type:

1. Cobbled soils with lower water holding capacity have demonstrated the need for as little as half the traditional set length (12 hours versus 24 hours) on the same interval i.e. half the seasonal water applied. Fruit yields and quality were comparable, though an extra picking was required.

2. Soils with less cobble and higher clay content are ideal for withholding irrigations during pit hardening on mid to late season varieties such as Cresthaven or O'Henrys. Up to 9 inches of applied water (two to four irrigations) has been successfully withheld during this phase.

How these savings translate to a producer's bottom line is as yet unclear. More efficient irrigation has been proven to reduce likelihood of chlorosis, a problem that continues to plague local orchards. Chlorosis is often unfairly blamed entirely on saline irrigation water but is probably as much a function of over-irrigated roots that are struggling to respire in tight soils. Less irrigation during pit hardening also limits foliage growth which is attractive on exceptionally vigorous trees, but impacts on yields are yet to been quantified. 2009 saw slightly higher yields with RDI; and 2010 saw lower.

Seasonal consumptive use savings could be as much as ten inches depending on fruit variety and soil. Groundwater return flow reductions could see a decrease of up to 1,500 pounds of salt per acre per year based on USDA-NRCS loading rates. These fringe benefits could become more of a factor as the shadows of drought, endangered species, and compact obligations continue to hang over western Colorado.

The Bureau of Reclamation is generously helping fund two years of expanded testing through the 2011 Water Conservation Field Services Program. The project's key objective is to identify irrigation strategies that provide the most profitable yields by accounting for shifts in labor cost in addition to nutrient and salt concentration changes around the root zone. The project will include field days in orchards and at the Experiment Station. For more information contact Denis Reich: 970-201-8467 Denis.Reich@Colostate.edu

Thanks to Wayne Guccini (Mesa Conservation District); Ron Godin (CSU Extension); Horst Caspari and Ramesh Pokharel (Orchard Mesa Research Center); Talbott Orchards; and Dan Crabtree (Reclamation) for their continued support of this project.

Data logger installed at WCRC-Orchard Mesa.

Tree on left shows the effects of the Regulated Deficit Irrigation in it's size.

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Lavender Research in Western Colorado

Research plots have been initiated at the Western Colorado Research Center-Orchard Mesa, to determine the growth, water needs, and yield of five cultivars of lavender when either grown between rows of grapes or without the influence of grape vines. In addition to determining the viability of lavender as an economic crop when grown in vineyards, the statistical analysis of the data will provide information on the yield and quality difference of the five cultivars included in this trial. Data will be collected for a minimum of three years and the results used to grow this industry.

Demonstration plots, at the CSU Extension office at the Mesa County Fairgrounds, have shown *Lavandula angustifolia* (English Lavender) and *Lavandula* x *intermedia* (a hybrid of *L. angustifolia* and *L. latifolia*) are relatively hardy, having survived the extreme winter of 2009-2010. Lavender is a relatively new crop for western Colorado with approximately eight-thousand plants in the ground at the end of 2010. Thousands more are being planted in the area in 2011. This shrub has a producing life expectancy in this area of ten to fifteen years with each plant producing a profit of $106 per plant over a 15 year period. With two-thousand and fifty plants per acre that equates to $265,500 per acre over 15 years. This data is based on an analysis of the wholesale profit of the flower shoots conducted by Rod Sharp, Colorado State University Regional Extension Specialist, Agriculture and Business Management. The sale of buds, oils, and value-added products will likely result in higher profits for growers and retailers alike. This industry has already had a positive impact on businesses distilling essential oils, selling irrigation supplies, amendments, transplants, and other required production, harvest and processing equipment. Those involved in installing irrigation systems and formulating lotions and other value-added products are also benefiting from this new industry.

Lavender is sold as bundles of flowering shoots (spikes), as buds, and as oil. The oil is used in aromatherapy and used to produce value-added products such as lotions, bath oils, shampoos, and similar products. Culinary grade oil is used in cakes, cookies, teas, ice creams, gelato, to flavor white wines, and in various other edible products. Buds are added to pastries, and used to flavor meats, as well as in pillows, neck bands and similar products.

The WCRC research plots will be irrigated using drip tubing. Specifics on the design and cost of the system will be provided through the Lavender Project web pages (http://WesternSlopeGardening.org) and the CSU Extension listserv for lavender growers. To be added to the listserv and be kept up-to-date on lavender activities in western Colorado, send Swift an email at Curtis.Swift@colostate.edu.

Researchers involved with this project are Curtis Swift, CSU Area Horticulturist, Horst Caspari, CSU Viticulturist, Ramesh Pokharel, CSU Nematologist & Fruit Pathologist, and Denis Reich, CSU Water Resource Specialist. Funding for this research is being provided by CSU Extension and the CSU Agricultural Experiment Station. Questions on this research should be addressed to Curtis Swift, Ph.D., Colorado State University Extension