2006 PROCEEDINGS

Colorado State University Cooperative Extension

Putting Knowledge to Work

24th Annual SOUTHERN ROCKY MOUNTAIN AGRICULTURAL CONFERENCE & TRADE FAIR

Conference Sponsored By:

San Luis Valley Area Extension

Trade Fair Sponsored By:

Monte Vista Chamber of Commerce

24th Annual

Southern Rocky Mountain Agricultural Conference And Trade Fair

January 31, February 1 - 3, 2006
Ski-Hi Park
Monte Vista, Colorado

CONFERENCE PROCEEDINGS

Conference Planning:
Merlin Dillon, Area Extension Agent, Agronomy
Rob Davidson, Extension Seed Potato Specialist
Marvin Reynolds, Area Extension Agent, Livestock

Conference Sponsored By:
Colorado State University Cooperative Extension
Proceedings Developed By:
Colorado State University Cooperative Extension
Trade Fair Sponsored By:
Monte Vista Chamber Ag Business Committee

POTATO DAY
Tuesday, January 31

7:00 BREAKFAST
Sponsored by: Monte Vista CO-OP

Potato Management Seminar

8:00 Chemical and Cultural Control of Nematode Associated Problems, ***Russ Ingham, Research Nematologist, Oregon State University, Corvallis, OR.***

8:50 Certification Snapshots, ***Kent Sather, Manager, Colorado Potato Certification Service, SLV Research Center, Center, CO.***

9:20 New Advanced Potato Selectionss, ***David Holm, Potato Breeder, SLVRC, Center, CO.***

9:30 Refreshment Break

10:00 "Hot Topics", ***Robert Davidson, Extension Seed Potato Specialist, SLVRC, Center, CO.***

10:30 Nitrogen Management in Potato Production ***Samuel Essah,. Potato Research Scientist, SLV Research Center, Center,*** **CO.**

11:20 Health Attributes of Potatoes, Potential Benefits? ***Cecil Stushnoff, Research Horticult-uralist, Colorado State University, Ft. Collins, CO.***

12:00 LUNCH And VISIT TRADE FAIR
Sponsored by: **Farm Credit of Southern CO**

1:30 Taking the Mystery Out of VFD's, ***Wayne Turnbow, Energy Management Co., Denver, CO.***

2:20 The SureHarvest Program, ***Jeff Dlott, President, SureHarvest, Soquel, CA***

3:10 Compost and Other Biologicals: A Viable Alternative? ***Rob Jones, SLV Potato Grower, Hooper, CO.***

4:00 SOCIAL HOUR (Growers & Speakers)
Sponsored by: **A & L Coors, Alamosa, CO.**

GRAIN DAY
Wednesday, February 1

7:00 **BREAKFAST**
Sponsored by: **SLV Rural Electric CO-OP**

Small Grain Management Seminar

8:00 Axial and Weed Control Strategies for Small Grains, ***Pete Forster and Kurt Jones, Syngenta Crop Protection, Ft. Collins, CO.***

8:50 Conservation Conundrums, ***Richard Sparks, NRCS Area Specialist, Center, CO, and Merlin Dillon, Area Extension Agronomist, Center, CO.***

9:40 Nitrogen Management for Hard Wheat Protein Enhancement, ***Brad Brown, Extension Crop Management Specialist, Parma, Idaho.***

10:30 Refreshment Break

10:45 Coors Barley Management, ***Jim Ehrlich, Coors Area Manager, Monte Vista, CO.***

11:30 Hard White Wheat; Past, Present, and Future, ***Speaker To Be Announced***

12:00 LUNCH And VISIT TRADE FAIR
Sponsored by: **First Southwest Bank**

1:30 KEYNOTE SPEAKER:
World's Worst Farmer
Lewis Baumgartner, Fulton, MO
Sponsored by:
Farm Credit of Southern Colorado

2:30 Refreshment Break

3:00 Potential On-Farm Biodiesel Production, ***Ravi Maholtra, ICAST, Boulder, CO.***

3:45 Economics and Water Use of Potato Rotation Crops, ***David Radke, Mountain Valley Crop Service, Ft. Garland, CO.***

4:30 SOCIAL HOUR (Growers & Speakers)
Sponsored by: **A & L Coors, Alamosa, CO.**

5:30 CPAC (Area II) Annual Meeting in Extension Meeting Room, Ski Hi Park.

FORAGE DAY
Thursday, February 2

8:00 BREAKFAST

Sponsored by: **Sunflower Bank**

Alfalfa Management Seminar

9:00 Weed Control Strategy in Alfalfa, ***Rick Arnold, Research Weed Scientist, NMSU, Farmington, NM.***

9:50 Refreshment Break

10:20 Measuring Alfalfa Quality, ***Bill Wailes, CSU Dept. Head/Extension Dairy Specialist, Ft. Collins, CO.***

11:10 Strategies for Roundup Ready Alfalfa, ***Peter Reisen, Forage Genetics, Nampa, Idaho.***

12:00 LUNCH and VISIT TRADE FAIR

Sponsored by: ***Community Banks of the Rockies***

1:30 Economics of Meadow Fertilization, ***Joe Brummer, CSU Research and Extension Forage Specialist, Gunnison, CO.***

2:20 Refreshment Break

2:40 Managing Alfalfa with Jr. Water Rights, ***Richard Sparks, USDA-NRCS, Area Conservationist, Center, CO.***

3:30 Managing Alfalfa Fertility, ***Bill Crowder, Agronomist, Agro Engineering, Alamosa, CO.***

4:15 SOCIAL HOUR (Growers & Speakers)

Sponsored by: **A & L Coors, Alamosa, CO.**

Continuing Education Credits are available for Certified Crop Advisors (CCA) and Commercial Applicators (CEC).
Evaluations are encouraged by random name drawings from filled or partially filled evaluation forms.

WATER / LIVESTOCK DAY
Thursday, February 3

8:00 BREAKFAST
Sponsored by: **San Luis Valley Federal Bank**

Water Management Seminar

9:00 Issues Affecting RGWCD, ***Steve Vandiver, Director, Rio Grand Water Conservation District, Alamosa, CO.***

9:50 Refreshment Break

10:20 Making the Most of the Water You Have, ***Jason Lorenz, Agro Engineering, Monte Vista, CO.***

11:10 Wells: Past, Present and Future, ***Mike Sullivan, Division Engineer, Division of Water Resources, Alamosa, CO.***

12:0O LUNCH and VISIT TRADE FAIR
Sponsored by: ***Mountain View Restaurant***

Livestock Production Seminar

1:30 Market Outlook for Beef Cattle, ***Jeff Tranel, CSU Extension Ag Business Mgmt Specialist, Pueblo, CO.***

2:05 "Scrapie" and the National Animal ID Program, ***Ed Kline, Colorado Scrapie Coordinator, Grand Junction, CO.***

2:40 Refreshment Break

3:00 Heat Synchronization: Natural Service & AI, ***Dr. Roger Ellis, CSU Extension Veterinarian, Colorado State University, Ft. Collins, CO.***

3:45 Herd Replacement: the True Cost, ***Jeff Tranel, CSU Extension Ag Business Mgmt Specialist, Pueblo, CO.***

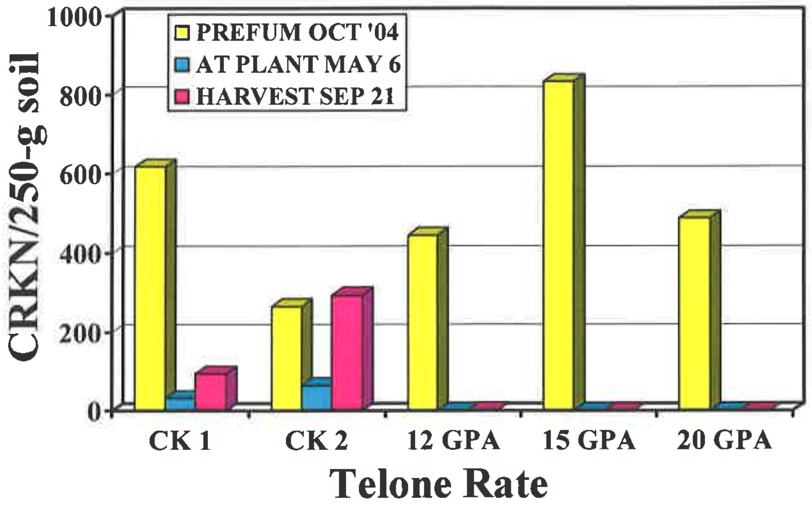
4:30 SOCIAL HOUR (Growers & Speakers)
Sponsored by: **A & L Coors, Alamosa, CO.**

POTATO DAY PROCEEDINGS
Tuesday, January 31

8:00 Chemical and Cultural Control of Nematode Associated Problems, ***Russ Ingham, Research Nematologist, Oregon State University, Corvallis, OR.***

(The following slides are the PowerPoint presentation by Dr. Russ Ingham as shown above).

Effects of Telone on Root-knot
San Luis Valley, CO - 2005 - Innovator



Effects of Telone on Root-knot
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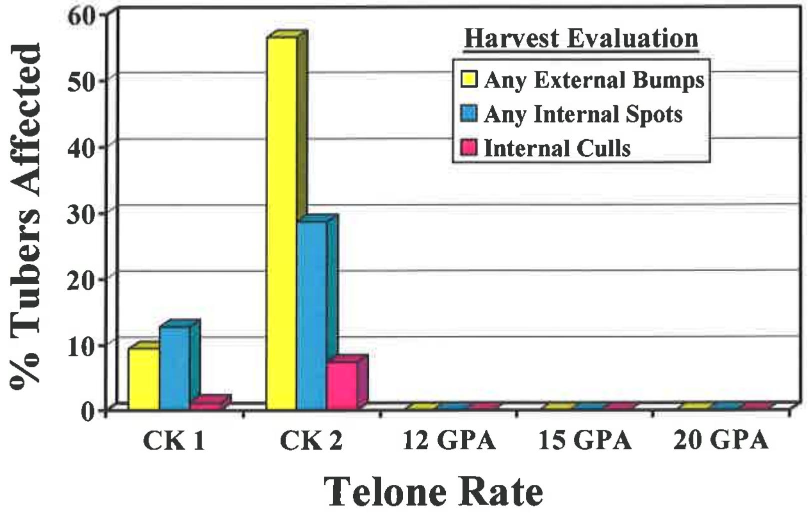
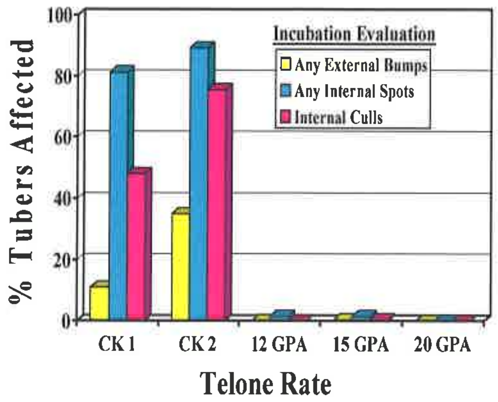


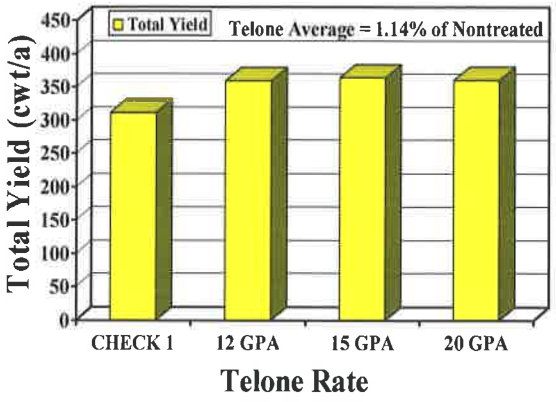
Effects of Telone on Root-knot

San Luis Valley, CO - 2005 - Innovator



Effects of Telone on Total Yield

San Luis Valley, CO - 2005 - Innovator

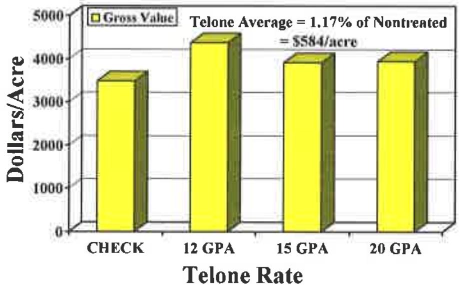


Potato Yield Calculation Parameters

Under 4 oz = $0.75/cwt
4-9 oz = $13.00/cwt
9-16 oz = $16.00/cwt
Over 16 oz = $14.00/cwt

Effects of Telone on Gross Value

San Luis Valley, CO - 2005 - Innovator



Nematode Damage Parameters

External Damage

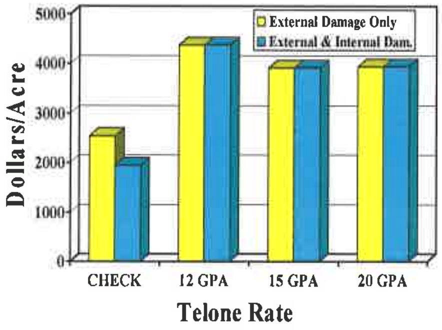
Remove tubers with 10% surface blemished
- At no cost up to 10% of tubers
- At cost of $0.68/cwt if 11-25% of tubers
- Discard crop at cost of $0.25/cwt if over 25%

Internal Damage

Culls = tubers with 6+ spots visible after peeling
- Discard crop at cost of $0.25/cwt if over 25%

Nematode Damage Adjusted Value

San Luis Valley, CO - 2005 - Innovator



Effect of Telone on Root-knot

San Luis Valley, Co - 2005 - Rio Grande

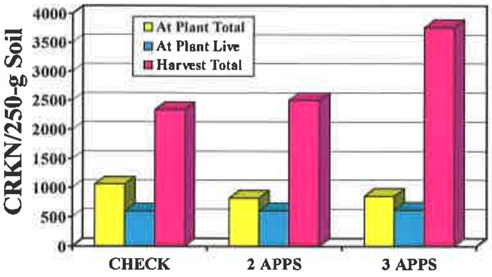
Root-knot/250-g soil

	Sep. 14, '04	May 5, '05 live
12 gpa	380-800 (x=560)	0-0 (x=0)
15 gpa	330-1,630 (x=900)	0-2 (x=<1)
20 gpa	360-2,090 (x=1,020)	0-7 (x=<1)

626 tubers peeled at harvest, no symptoms observed
620 tubers incubated, peeled, no symptoms observed

Effect of Vydate On Root-knot

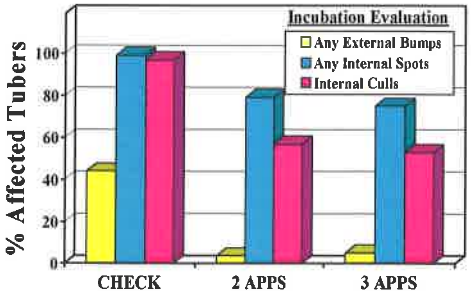
San Luis Valley, CO - 2005 - Rio Grande



Vydate (2.1 pt/a) on 6/8 and/or 7/6 &7/20

Effect of Vydate On Root-knot

San Luis Valley, CO - 2005 - Rio Grande



Vydate (2.1 pt/a) on 6/8 and/or 7/6 &7/20

Estimating Upper Limits of CRKN Suppressed by Vydate C-LV

San Luis Valley, CO - Russet Nugget
Planted May 1
Harvested September 20
Vydate Applied July 11 and July 20

Estimating Upper Limits of CRKN Suppressed by Vydate C-LV

Harvest Evaluation

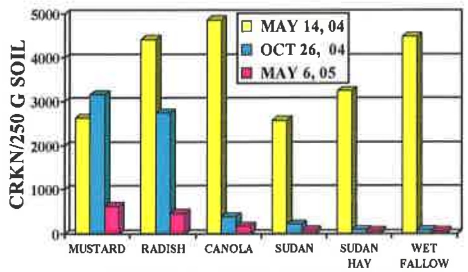
No./250-g Soil	% Any Ext.	% Int. Culls
< 100 (100)	0	4
100-200 (130)	0	0
200-400 (225)	0	0
400-600 (465)	0	0
600-800 (655)	0	0
800-1000 (830)	0	6
1000-1500 (1100)	0	0
1500+ (1590)	0	6

Estimating Upper Limits of CRKN Suppressed by Vydate C-LV

Incubation Evaluation

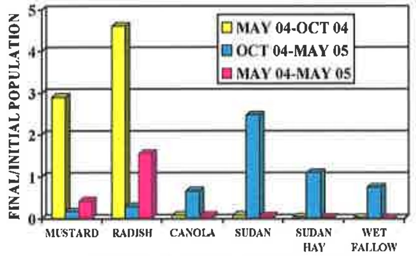
No./250-g Soil	% Any Ext.	% Int. Culls
< 100 (100)	0	20
100-200 (130)	0	16
200-400 (225)	0	0
400-600 (465)	0	2
600-800 (655)	0	0
800-1000 (830)	0	6
1000-1500 (1100)	0	22
1500+ (1590)	0	24

EFFECTS OF SPRING COVER CROPS ON COLUMBIA ROOT-KNOT NEMATODE
SAN LUIS VALLEY, CO - 2004-05



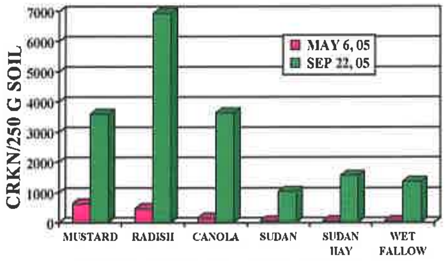
SPRING-PLANTED COVER CROPS
ONLY PLOTS WITH OVER 100 ON MAY 14, 2004

RELATIVE POPULATION CHANGE (R) OF COLUMBIA ROOT-KNOT NEMATODE
SAN LUIS VALLEY, CO - 2004-05



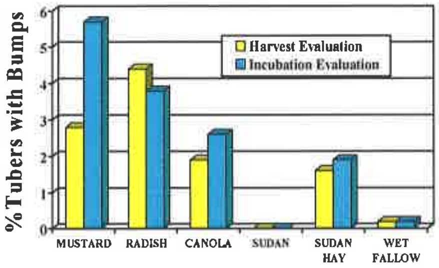
SPRING-PLANTED COVER CROPS
ONLY PLOTS WITH OVER 100 ON MAY 14, 2004

EFFECTS OF SPRING COVER CROPS ON COLUMBIA ROOT-KNOT NEMATODE POPULATIONS IN FOLLOWING POTATO CROP
SAN LUIS VALLEY, CO - 2004-05



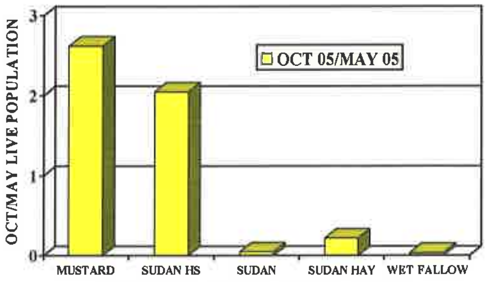
COVER CROPS PLANTED SPRING 2004
ONLY PLOTS WITH OVER 100 ON MAY 14, 2004

EFFECTS OF SPRING COVER CROPS ON COLUMBIA ROOT-KNOT NEMATODE EXTERNAL TUBER DAMAGE
SAN LUIS VALLEY, CO - 2004-05



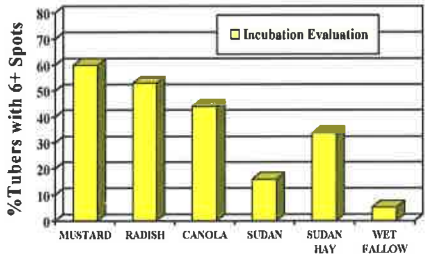
COVER CROPS PLANTED SPRING 2004

RELATIVE POPULATION CHANGE (R) OF COLUMBIA ROOT-KNOT NEMATODE
SAN LUIS VALLEY, CO - 2005-06



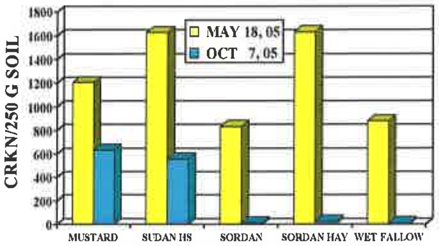
SPRING-PLANTED COVER CROPS
ONLY PLOTS WITH OVER 100 ON MAY 18, 2005

EFFECTS OF SPRING COVER CROPS ON COLUMBIA ROOT-KNOT NEMATODE INTERNAL TUBER DAMAGE
SAN LUIS VALLEY, CO - 2004-05



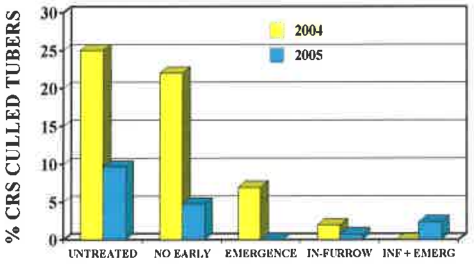
COVER CROPS PLANTED SPRING 2004

EFFECTS OF SPRING COVER CROPS ON COLUMBIA ROOT-KNOT NEMATODE
SAN LUIS VALLEY, CO - 2005-06



SPRING-PLANTED COVER CROPS
ONLY PLOTS WITH OVER 100 ON MAY 18, 2005

EFFECT OF EARLY SEASON VYDATE APPLICATIONS ON TUBERS WITH SYMPTOMS OF CORKY RINGSPOT YUKON GOLD – KLAMATH, OR



TREATMENTS RECEIVED 3 (2004) OR 4 (2005) CHEMIGATIONS AFTER EARLY SEASON APPLICATIONS

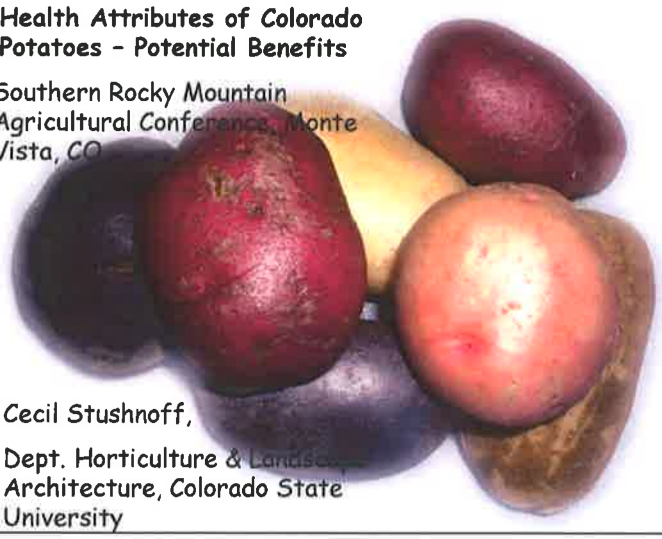
Ingham et al, 2005

NOTES

11:20 Health Attributes of Potatoes, Potential Benefits?
Cecil Stushnoff, Research Horticult-uralist, Colorado State University, Ft. Collins, CO.
(PowerPoint slides from this presentation are printed on the following pages)

Health Attributes of Colorado Potatoes - Potential Benefits

Southern Rocky Mountain Agricultural Conference, Monte Vista, CO



Cecil Stushnoff,

Dept. Horticulture & Landscape Architecture, Colorado State University

Nutritional Features

- Most widely consumed vegetable in America
- Avoid products that are deep-fried in saturated fats
- Medium size (6 ounce) baked potato with skin has only 163 calories
- Excellent source of potassium, vitamin C, and phenolic antioxidants
- Good source of fiber, niacin, vit. B6, and folate.
- Pigmented cultivars are a promising new source of antioxidants

(PowerPoint slides from this presentation on the following pages)

Topics

- Focus on a healthy image
- Cancer cell culture/inhibition studies
- Possible role of antioxidants and glycoalkaloids
- Antioxidant properties in CO cultivars

"Potato" Nutrients that are Deficient in American Diets

- Potassium -90 % men & 99% women deficient: blood pressure, reduces calcium excretion and promotes bone health
- Vitamin C -Surprisingly, 40% men & 38% women deficient: collagen, increases bone mineral content, immune function, muscle injury, wound healing
- Source: Dole Nutrition institute

Nutritious Food Features

- 30 calories per ounce
- Fat and cholesterol free
- Sodium free
- High in potassium
- High in vitamin C
- Good source of dietary fiber
- Good quality protein

Less Appreciated Antioxidant Health Properties

- Vitamin C
- Chlorogenic acid
- Anthocyanin pigments

Nutrition Facts

Serving Size 1 potato (148g/5.3oz)

Amount Per Serving	
Calories 100 Calories from Fat 0	
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Cholesterol 0mg	0%
Sodium 0mg	0%
Potassium 720mg	21%
Total Carbohydrate 26g	9%
Dietary Fiber 3g	12%
Sugars 3g	
Protein 4g	

Vitamin A 0%	• Vitamin C 45%
Calcium 2%	• Iron 6%
Thiamin 8%	• Riboflavin 2%
Niacin 8%	• Vitamin B_6 10%
Folate 6%	• Phosphorous 6%
Zinc 2%	• Magnesium 6%

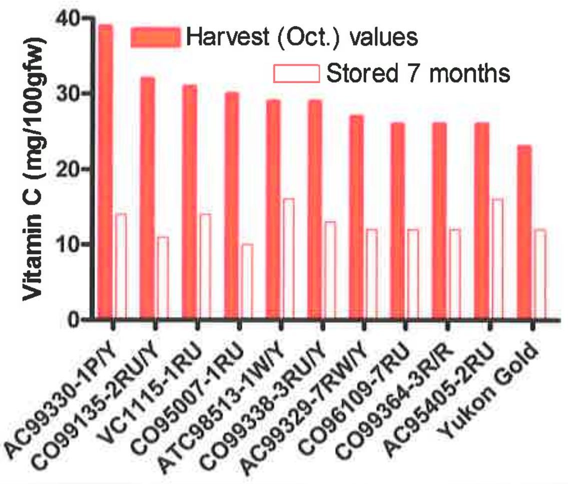
*Percent Daily Values are based on a 2,000 calorie diet.

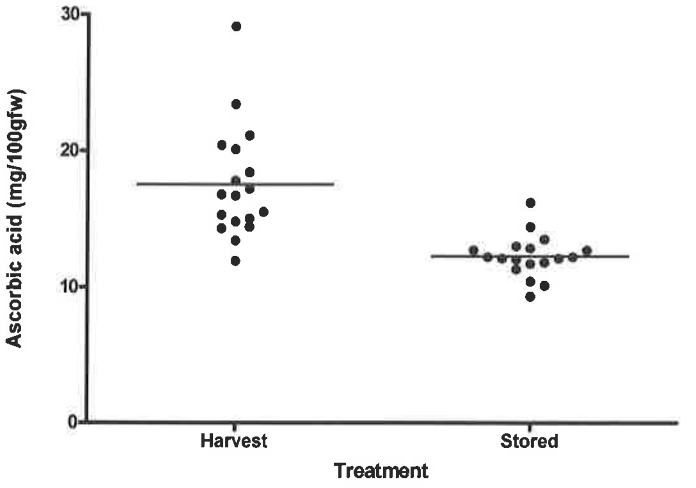
"Potato" Nutrients that are Deficient in American Diets

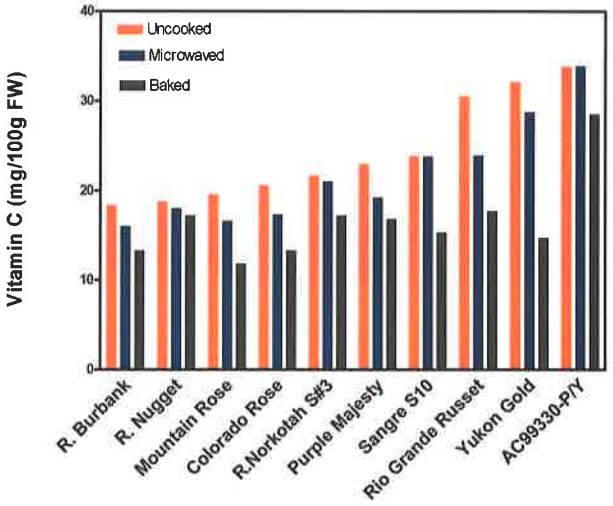
- Vitamin B6 - 33% women deficient: required for heart health and red blood cells, immune function, potatoes are a good source
- Potatoes also provide other nutrients that are deficient: magnesium (65% deficient), fiber (50%), zinc (33% over age 70),
- iron (15% women age 14-50), phosphorous women (40% age 9-18)
- Source: Dole nutrition Institute

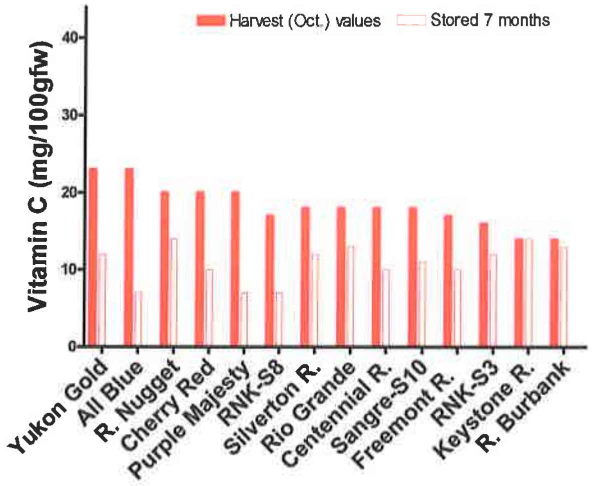
Vitamin C

- Antioxidant that protects against free radical stress
- Required for collagen/bones, cartilage, teeth, capillaries, muscle
- Healthy immune system, prevents scurvy
- Absorption of iron
- 200 gram (1/2lb) baked potato can provide 20-30% of daily requirement (90 mg/day)


Vitamin C (Top 10)


Vitamin C content after 6 months storage for 18 cultivars


Vitamin C After Cooking (2005 crop)


Cultivar Response to Storage

Cancer Studies

- Inhibition of breast cancer cell cultures
- Possible roles of chlorogenic acid, anthocyanin pigments, and glycolalkaloids

Analysis of Variance for inhibition of MCF7 breast cancer cell cultures.

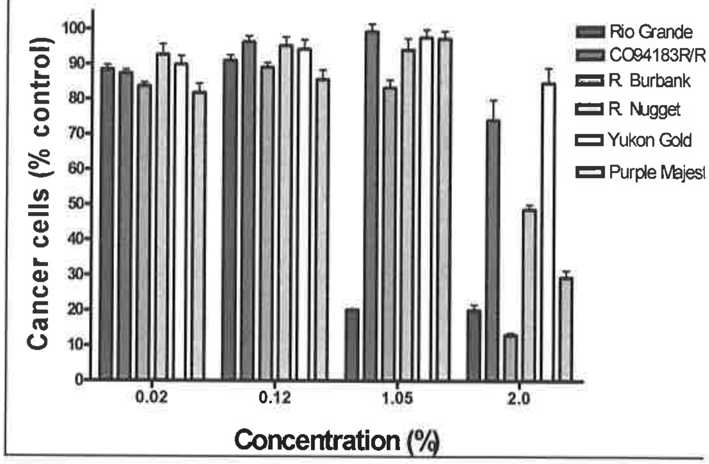
Source of Variation	Df	F Value	P	% total
Interaction	15	206.7	<0.0001	43.4
Concentration	3	791.4	<0.0001	33.2
Source (cultivars)	5	397.4	<0.0001	27.8

Analysis of Variance for inhibition of MDAMB46 breast cancer cell cultures.

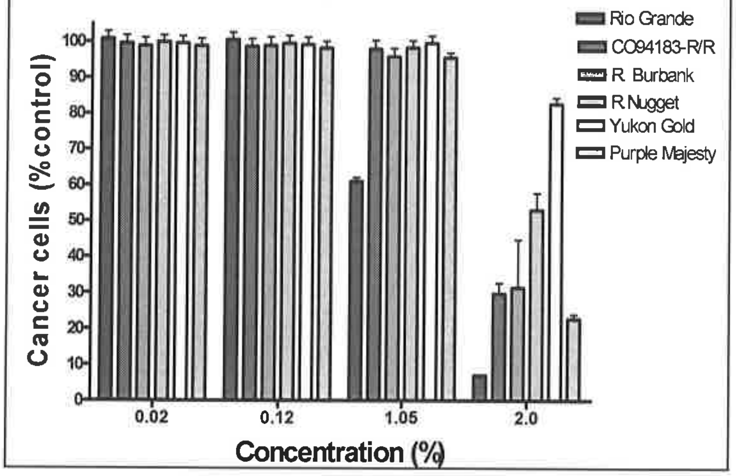
Source of Variation	Df	F Value	P	% total variation
Interaction	15	23.41	<0.0001	22.24
Concentration	3	320.7	<0.0001	60.96
Source (cultivars)	5	52.53	<0.0001	16.64

- Dose dependant response among cultivars
- Repeated three times

MCF7 Breast Cancer Cells (after 5 days in culture)



MDAMB46 Breast Cancer Cells (after 3 days in culture)

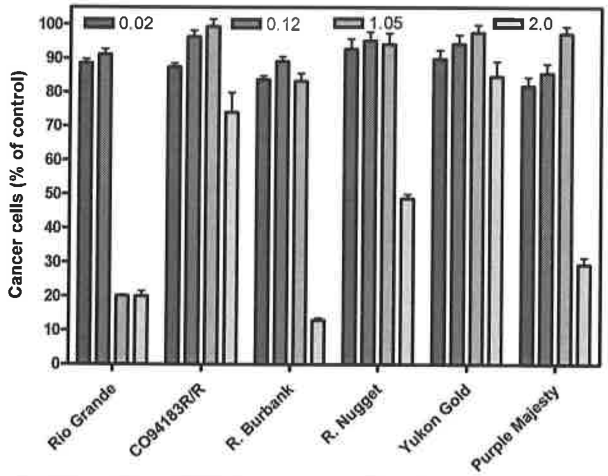


Potato Antioxidants

- Chlorogenic acid
- Caffeic acid
- Vitamin C

Anthocyanins (red, blue)
- Pelargonidin (Geranium)
- Peonidin (Peony)
- Petunidin (Petunia)
- Delphinidin (Delphinium)
- Malvidin (Pinot Noir wine)
- Carotenoids (yellow)

MDAMB46, 5DAYS



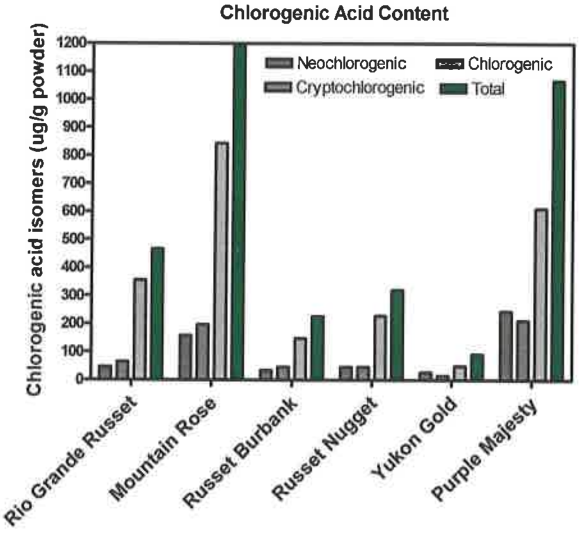
Anthocyanin concentrations in baked Purple Majesty (ug/g)			
Anthocyanin	Ug/g	Total	Activity
Petunidin-3-rutinoside-5-glucoside+coumaric	1579	1913	Apoptosis
Malvidin-3-rutinoside-5-glucoside+coumaric	119		Antiproliferation
Petunidin-3-rutinoside-5-glucoside	73		Apoptosis
Petunidin-3-rutinoside-5-glucoside+ferulic acid	61		Apoptosis
Delphinidin-3-rutinoside-5-glucoside+coumaric	43		Antiangiogenic
Peonidin-3-rutinoside-5-glucoside+coumaric	38		None found

Anthocyanin concentrations in baked Mountain Rose (No reported anticarcinogenic effects found)			
Cultivar	**Anthocyanin**	**Ug/g**	**Total**
Mountain Rose	**Pelargonidin-3-rutinoside+coumaric acid**	**1040**	**1638**
	Pelargonidin-3-rutinoside-5-glucoside	**315**	
	Pelargonidin-3-rutinoside	**159**	
	Pelargonidin-3-rutinoside-5-glucoside+ferulic acid	**124**	
	Peonidin-3-rutinoside-5-glucoside+coumaric acid	**trace**	

Chlorogenic Acid/Mechanisms

(Feng et al., 2005, JBC)

1. A549 human lung cancer cell cultures (80uM)
2. Pretreatment of JB6 mouse epidermal cells with 40 uM chlorogenic acid inhibits TPA (carcinogen) and UV-B induced cancer
3. Chlorogenic acid induced activity of two radical scavenging enzymes



Glycoalkaloid Effects

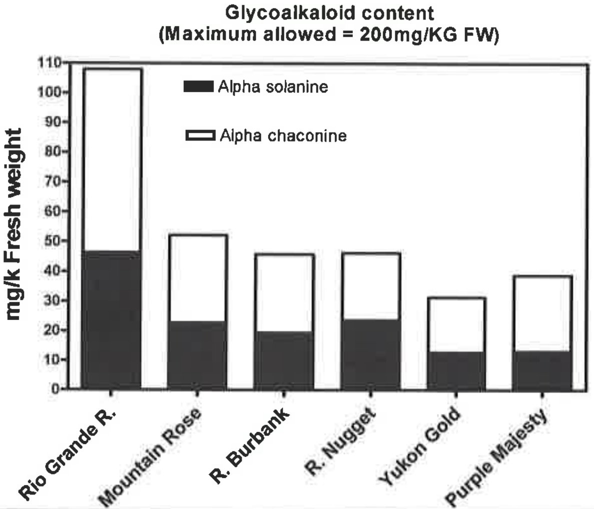
(Freidman et al., 2003, JAFC)

Beneficial
- Lower cholesterol
- Protect against *Salomonella*
- Inhibit cancer cell proliferation

Detrimental
- Cholinesterase inhibitors
- Cell membrane disruption
- 0.2 mg/gram FW new cultivar limit

Chlorogenic Acid

- Potato is an excellent source
- One of most abundant polyphenols in diets
- Found in fruits, vegetables, coffee
- Antioxidant
- Animal studies show it is an anticarcinogen

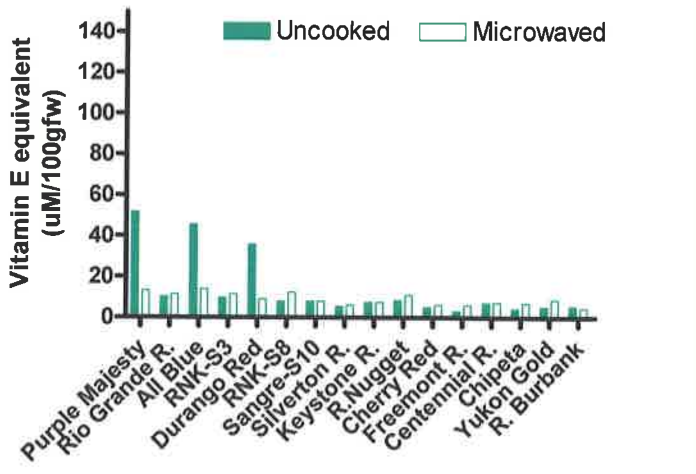


Total phenolics as gallic acid equivalents in mg/100g fresh wt.

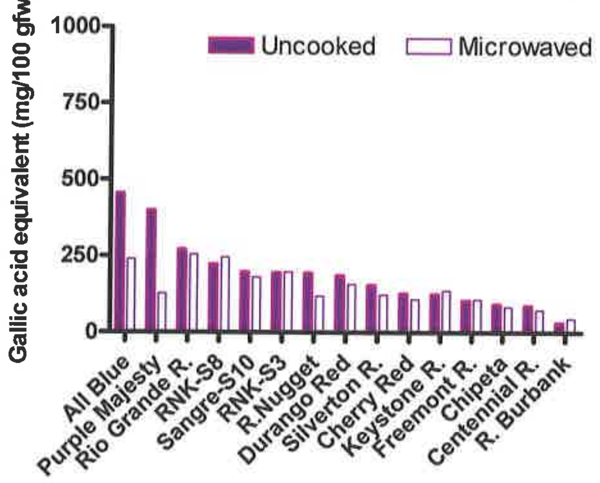
(Wu etal., 2004, JAFC; Our data)

Cooked white potato	136-179
Cooked Rio Grande Russet One medium sized spud	250 500
Carrot	125
Tomato	337
Blueberry	531-795
Granny Smith apple	341

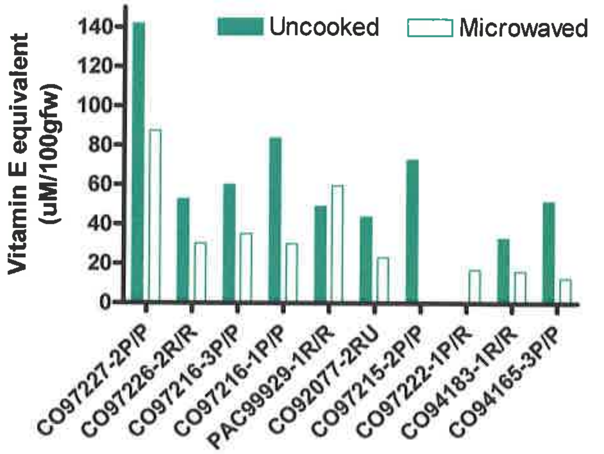
Radical Scavenging Capacity (cultivars)



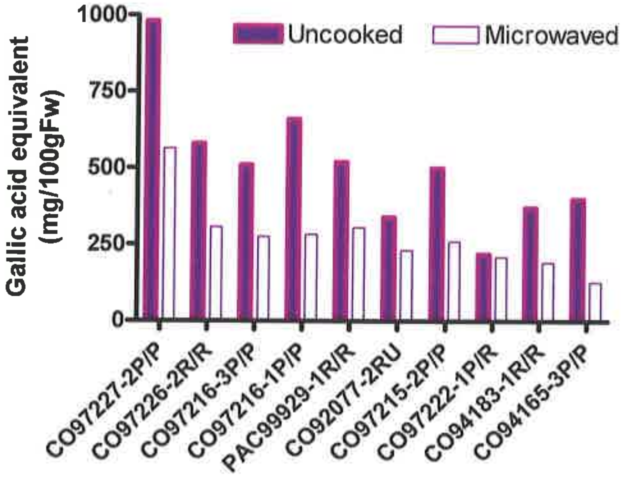
Cultivar Total Phenolic Content



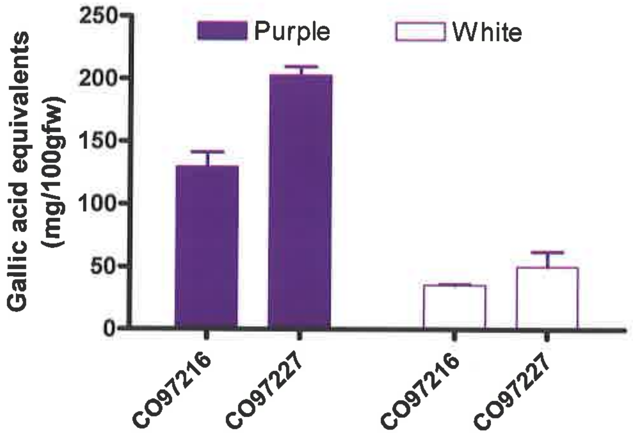
Radical Scavenging Capacity

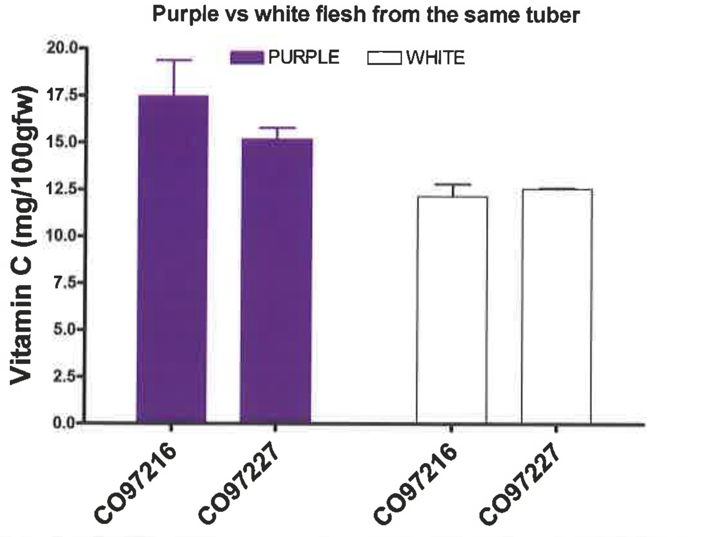


Total Phenolics (top 10 selections)



Total phenolics in purple and white tissue of the same tuber




Purple vs white flesh from the same tuber

Plans for 2006 and Beyond

- TP, ABTS, Vit. C, cooking, storage of 70 entries grown in 2005
- Screen 20 entries for colon cancer cell culture inhibition
- Assist marketing to promote health attributes of CO potatoes
- Mode of action for cell culture inhibition by potato extracts

Antioxidant Properties of Extracts Used in Breast Cancer Cell Culture Experiment (Baked samples)

Cultivar	Vitamin C mg/100gfw	Total Phenolics mg/100gfw	ABTS uM/100gfw
Rio Grande	8.0	393	196
Mountain Rose	3.6	350	392
R. Burbank	5.2	266	192
R. Nugget	11.1	210	268
Yukon Gold	9.1	191	177
Purple Majesty	11.1	311	272

Acknowledgements

- CPAC & CAES
- Chris Voigt
- David Holm, Rob Davidson, SLV
- Ann McSay (retired), Jeannette Stushnoff,
- Oktay Kulen, Amber Yohn,

3:10 Compost and Other Biologicals: A Viable Alternative? ***Rob Jones, SLV Potato Grower, Hooper, CO.***

Compost and Other Biologicals: A Viable Alternative?

Rob Jones, Potato Grower, Hooper, CO.

Summary

The primary objective of this project was to compare alternative sources of nutrient to conventional inputs and see if the more organic sources of nutrient would perform as well as inorganic products. Combinations of the two were also used together to see if the organic nutrients would enhance the inorganic products. The primarily organic strips did not perform nearly as well, however there were a couple strips where combinations of organic nutrients and conventional fertilizer did appear to perform better than just the conventional or organic. This information can be useful to the farmer who is looking to use less inorganic inputs in favor of more organic nutrients without having to go "cold turkey" totally organic all at once.

Materials/Methods

Compost and fish hydrolisate were the primary nutrient sources used in certain defined strips of the field. 12 specific test strips made up the entire circle (110 ac.)

They were as follows:

#1 3-4 tons/ac compost + 4gal. fish hydrolisate banded + 76# N & 44# S top-dress

#2 Same banded preplant as above + 54#N & 31#S + 10 gal. fish top-dress

#3 70-140-0-8-1.5 banded + 76#N & 44#S top-dress

#4 Same banded preplant a above+54#N & 31#S + 10 gal. fish top-dress

#5 70-140-0-8-1.5 with 2 tons compost banded +76#N & 44# S top-dress

#6 Same banded blend as above + 54#N & 31#S + 10 gal. fish top-dress

#7 3-4 tons/ac.compost + 4gal. fish hydrolisate banded + 76#N & 44# S top-dress

#8 Same banded preplant as above + 54#N & 31#S + 10 gal. fish top-dress

#9 105-180-100-44-2.5 preplant + 76#N & 44#S top-dress

#10 Same blend as above + 54#N & 31#S + 10 gal. fish top-dress

#11 70-140-0-8-1.5 with 2 tons compost banded + 76#N & 44#S top-dress

#12 Same blend as above banded + 54#N & 31#S + 10 gal. fish top-dress

All compost tea, fungicide, herbicide, and irrigations were done equally on the whole circle. Two gallons/acre of humic acid was banded with the banded compost. Soil biology samples were taken from each strip August 25, 2005 and analyzed by Soil Foodweb Inc. The yield was measured with a

HarvestMaster 500 yield monitor and potato samples were pulled randomly in each of the 12 test strips and each tuber was weighed and recorded..

Results

Petiole samples were taken and tested from each of the strips five times between mid-July and mid-August. N & P were tested in each sample. Micronutrients were tested in the first and last samplings. All petiole (N & P) and yield results are inserted on the first two aerial photo pages (pp.4-5). Only the two compost/fish-only strips had N levels below desired guidelines. However, test strips 1, 4, 7, and 12 probably started a little too low to begin with. Phosphate levels, with exception to 1, 2, 7, and 8 (compost/fish-only) held up fairly well. The straight fertilizer strips held up the best but the blended strips did hold up well too.

The Foodweb Inc. report (p.6) was rather interesting in comparing it to last year. All the bacteria and fungal numbers were good to excellent, but the protozoa numbers were almost all deficient. The good news is there were plenty of the basic food groups; bad news is there weren't enough critters to eat them and convert them into nutrients for the plants. The tea I produced this year was much better in the protozoa department so I don't know what was limiting them unless it might have been the new herbicide I applied this year. Whatever the cause, the nutrient cycling was definitely curbed because of this.

A revenue map is shown on page 7 where all spuds 4 oz. and over are multiplied by $7 and posted on the corresponding strips to illustrate the respective performances. The page 8 map shows those same values with the fertility costs deducted.

Yield results were quite varied. One reason is that the north half (strips 1-6) were planted as seven row beds and the south half (strips 7-12) were only four row beds, however each half can still be looked at separately and see the relative differences within each half.

Conclusions/Discussion

The one obvious observation has to be the stark difference in the east half (right side of map) and the west half (left side of map). The fish product just does not stimulate enough microorganism activity in this soil to produce enough N to keep the plant growing vigorously. I observed in both years of this project that the compost/fish preplant strips jumped out quicker than any of the fertilizer-only strips, had more root mass, and even set tubers up to a week sooner, but seemed to stop and fall behind after the plants got about 4"tall. This would seem to indicate that the compost/fish strips need N to be applied sooner and that some product other than the fish needs to be used for additional N at least in this soil.

The compost/fish strips performed similar to last year starting out fast and more vigorous but rapidly running out of gas. Both N & P petioles drop drastically before the end of July indicating a lack of bio-activity and less than adequate soil chemistry. On the other hand, the 2 tons of compost banded with a reduced fertilizer rate on the north half outperformed the straight reduced fertilizer rate by itself, showing that the compost is at least doing something which was very encouraging. Also, on the south half, the #10 strip was the only east-half strip that actually increased revenue significantly (p.8 $60/ac.net). It would seem that since there was adequate fertility in the band, the fish seem to enhance the effect of the fertilizer.

The most important conclusion I will make concerning this project has to be the results obtained off of the #5 and #6 strips where fertilizer was reduced and compost added. This section of the field outperformed the rest of the field hands down and does seem to validate at least in this particular crop year, the concept that enhancement of the soil biology will increase productivity. This was not the case on the south half of the field however, and so this concept did not hold consistent. Strips #11 and #12 have some severe erosion problems and I'm assuming this was the greatest limiting factor. Another limiting factor, which affected the whole field, was the fact that the field was planted fairly late (finished May 25).

The last point I would like to address refers the p.8 map listing the adjusted revenues with all fertility costs deducted. Most, if not all organic inputs, are more expensive than the conventional fertilizers and when all factors are considered, the bottom line is net profit. Strips #5 and #6, which were the most expensive plots, earned more than the straight reduced fertilizer strips (3 and 4) right next to them. But how would they have compared with a full rate of fertilizer? More stuff for next year.

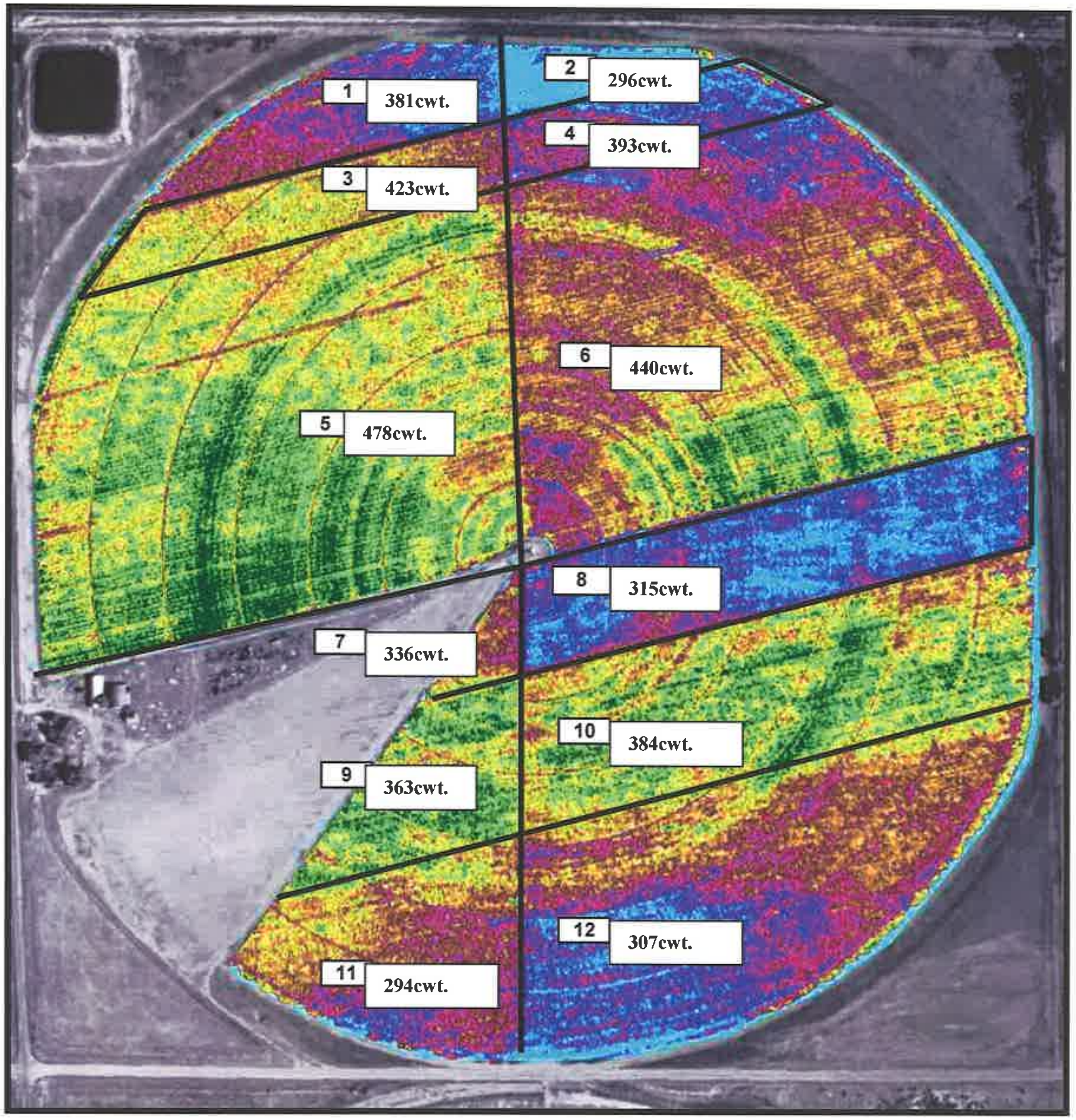
I would like to thank those of you who are responsible for the funding of this grant. I think it has been very worth while and I intend to continue doing these types of trials.

Budget

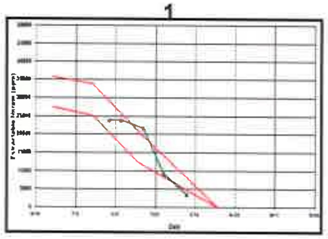
Budget Category	Description	Funds requested ($) (from SCP)	Matching Contributions ($) (my contributions)
Personnel	Petiole Tests	12-zones 2460.00	
	Blight monitoring		600.00
	Aerial photos		650.00
	Compost		5000.00
	Compost tea		5000.00
	Fish Hydrolase (N)	1900.00	
Materials and Supplies			
	Refractometer		
	Pivot tea brewer		
Equipment	Yield Monitor and GPS		10000.00
Equipment Purchases			
Outreach Expenses			
Postage Expenses	Soil samples to SFI lab	94.17	
Miscellaneous	lab testing (compost tea) 5x's	400.00	
	lab testing (soil) 14x's	3387.51	
Total		**$8241.68**	**$21300.99**

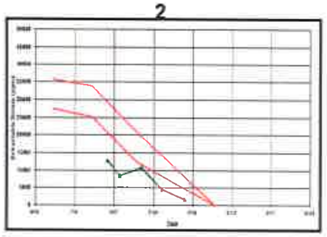
Total Grant Awarded for 2005 **$7500.00**

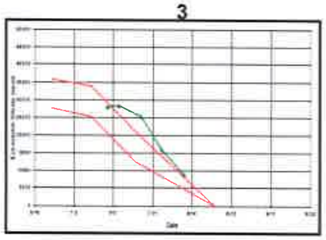
N Petiole: 8/11/2005

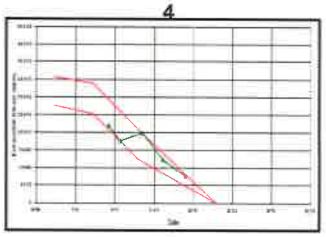


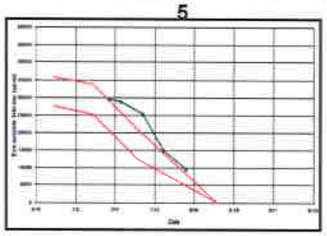
Min Guideline — Max Guideline — Actual

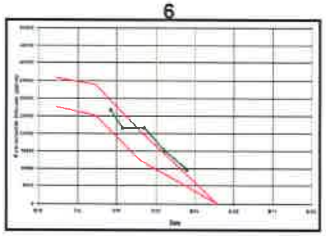


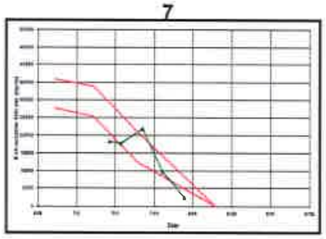


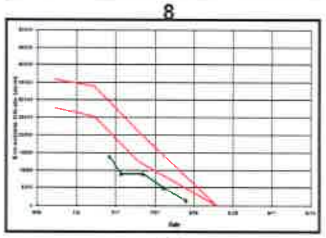


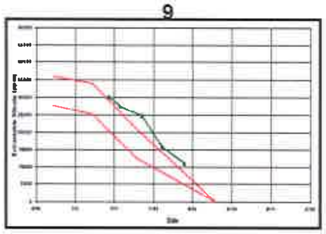


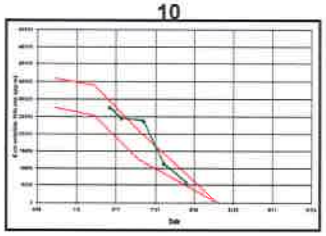


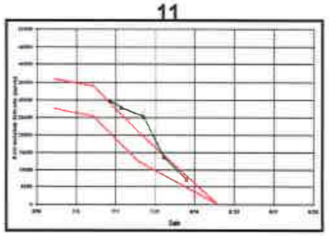


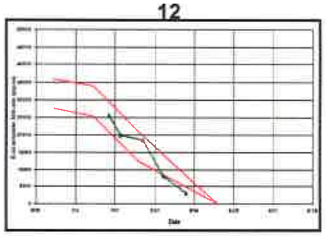




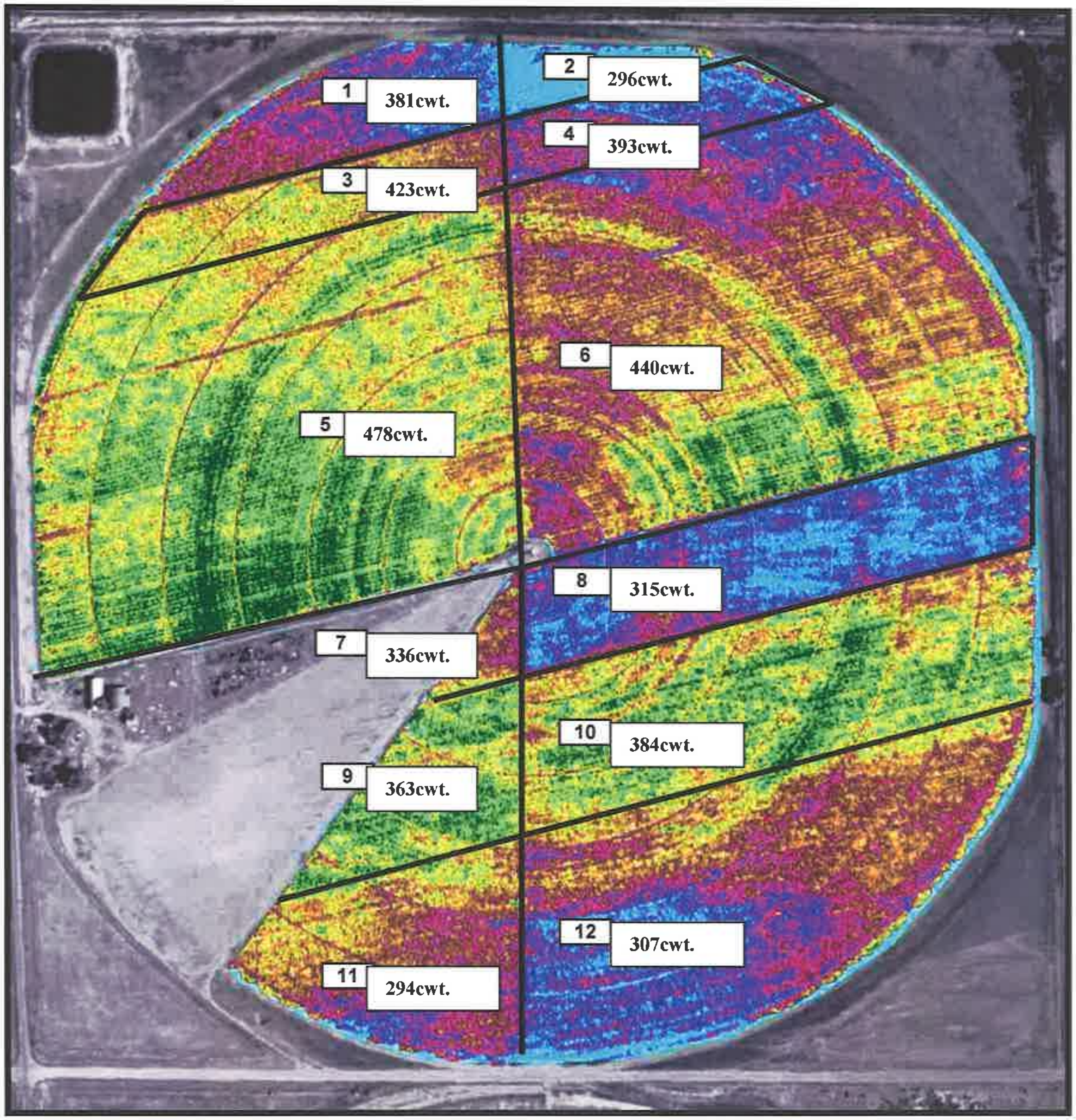








P Petiole: 8/11/2005



Actual

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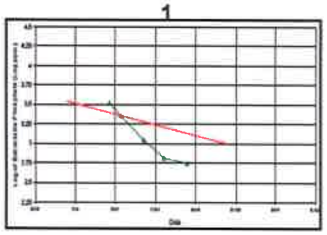

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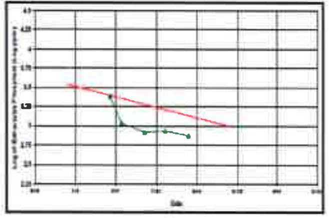

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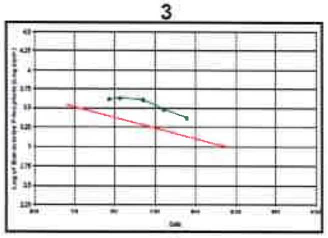

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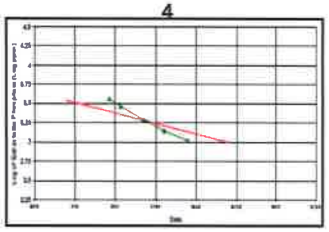

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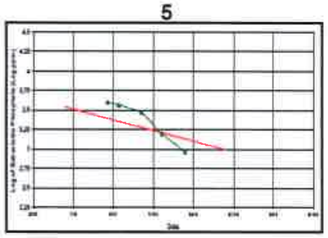

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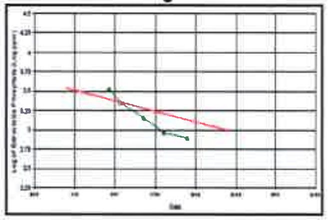

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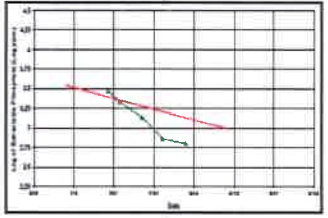

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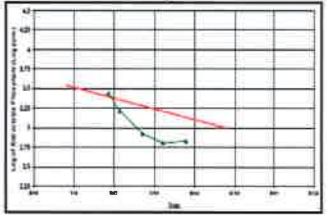

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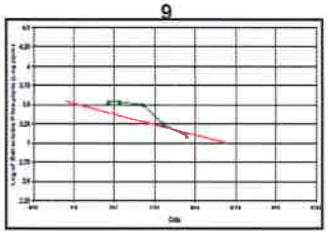

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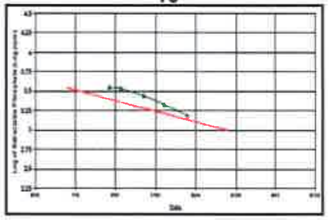

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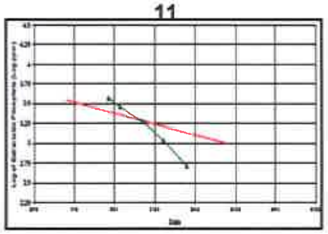

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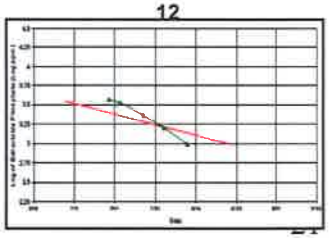
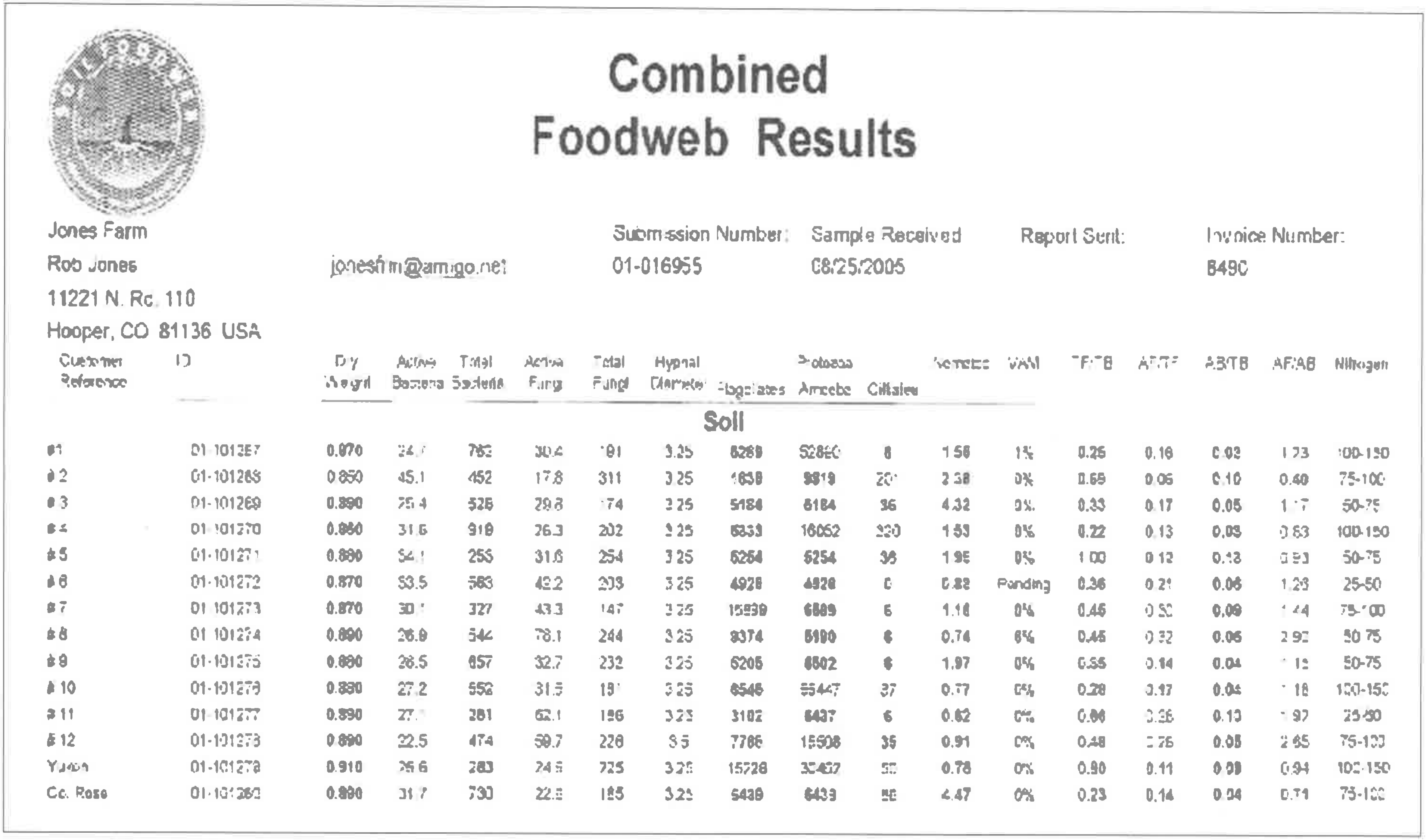




Combined
Foodweb Results

Jones Farm
Rob Jones
11221 N. Rd. 110
Hooper, CO 81136 USA

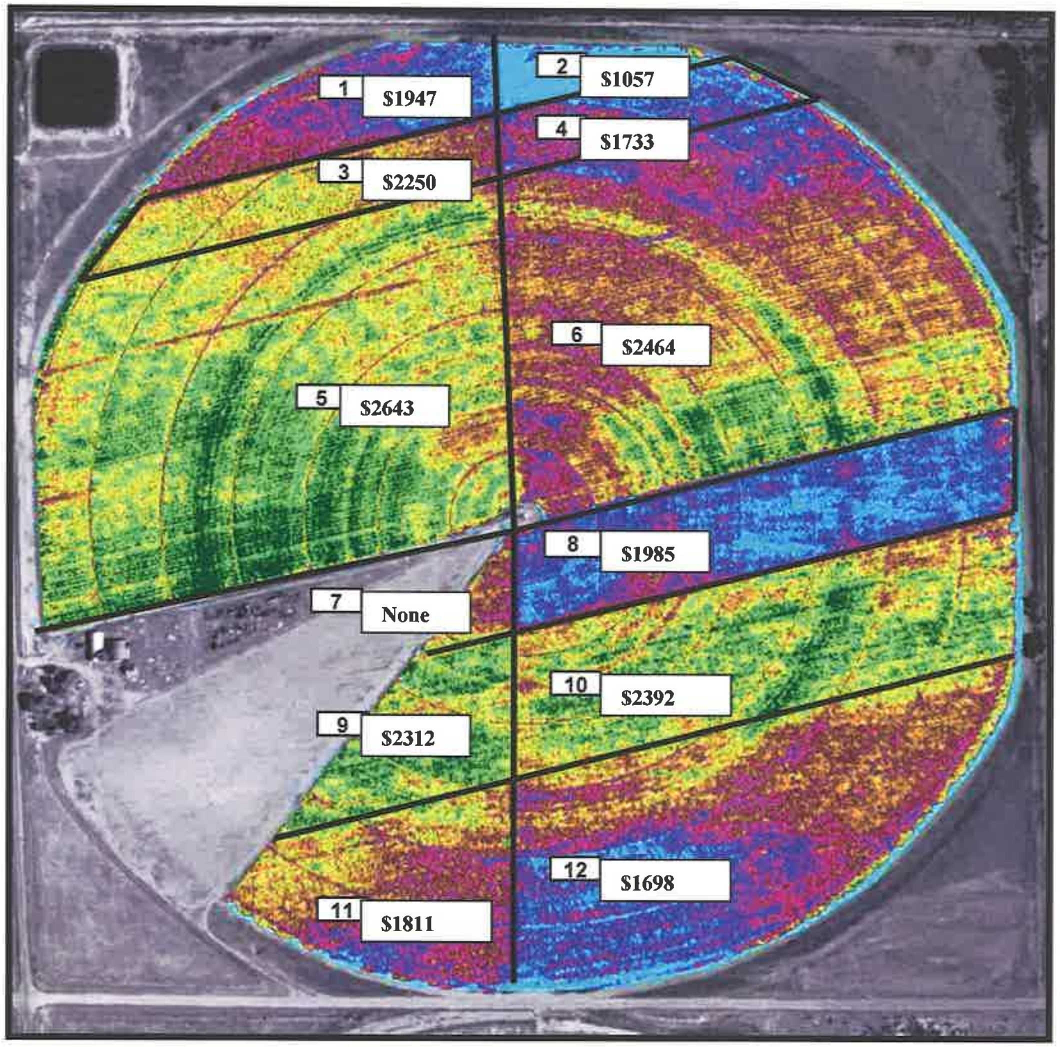
jonesfrm@amigo.net

Submission Number:	Sample Received	Report Sent:	Invoice Number:
01-016955	08/25/2005		8490

Soil

Customer Reference	ID	Dry Weight	Active Bacteria	Total Bacteria	Active Fungi	Total Fungi	Hyphal Diameter	Protozoa Flagellates	Protozoa Amoebae	Protozoa Ciliates	Nematodes	VAM	TF:TB	AF:TF	AB:TB	AF:AB	Nitrogen
#1	01-101267	0.870	24.7	763	30.4	191	3.25	6289	52860	8	1.56	1%	0.26	0.16	0.03	1.23	100-150
# 2	01-101268	0.850	45.1	452	17.8	311	3.25	1638	9819	201	2.38	0%	0.69	0.06	0.10	0.40	75-100
# 3	01-101269	0.890	25.4	526	29.8	174	3.25	5184	6184	36	4.32	0%	0.33	0.17	0.05	1.17	50-75
# 4	01-101270	0.860	31.6	918	26.3	202	3.25	6333	16052	320	1.53	0%	0.22	0.13	0.03	0.83	100-150
# 5	01-101271	0.890	34.1	255	31.6	254	3.25	6254	6254	36	1.95	0%	1.00	0.12	0.13	0.93	50-75
# 6	01-101272	0.870	33.5	583	42.2	203	3.25	4928	4928	0	0.82	Pending	0.36	0.21	0.06	1.26	25-50
# 7	01-101273	0.870	30.1	327	43.3	147	3.25	15939	6889	6	1.16	0%	0.45	0.30	0.09	1.44	75-100
# 8	01-101274	0.890	26.8	544	78.1	244	3.25	8374	6190	6	0.74	0%	0.45	0.32	0.05	2.92	50-75
# 9	01-101275	0.880	28.5	657	32.7	232	3.25	6205	6602	6	1.97	0%	0.35	0.14	0.04	1.15	50-75
# 10	01-101276	0.880	27.2	682	31.5	191	3.25	6546	55447	37	0.77	0%	0.28	0.17	0.04	1.16	100-150
# 11	01-101277	0.890	27.4	281	62.1	186	3.25	3102	6437	6	0.62	0%	0.66	0.33	0.10	2.27	25-50
# 12	01-101278	0.890	22.5	474	59.7	228	3.5	7786	15508	35	0.91	0%	0.48	0.26	0.05	2.65	75-100
Yukon	01-101279	0.910	25.6	283	24.5	225	3.25	15728	35437	55	0.78	0%	0.80	0.11	0.09	0.96	100-150
Co. Rose	01-101280	0.890	31.7	730	22.5	165	3.25	5438	6439	55	4.47	0%	0.23	0.14	0.04	0.71	75-100

Revenue Map


1 $1947
2 $1057
3 $2250
4 $1733
5 $2643
6 $2464
7 None
8 $1985
9 $2312
10 $2392
11 $1811
12 $1698

Revenue Map
(All tubers 4oz. and greater x $7)

Size Distribution

Adjusted Revenue Map when all fertilizer costs are deducted

1A	1B	2A	2B	3A	3B	4A	4B	5A	5B	6A	6B	7.00	8	9	10A	10B	11A	11B	12A	12B
4.4	4.4	3.2	3.5	4.3	5.1	4.2	3.7	5.0	4.8	4.7	5.3	none	7.1	6.2	5.5	7.1	5.5	7.2	5.0	5.2
10.8	12.3	8.5	8.5	15.0	13.5	10.3	8.8	9.8	11.5	17.5	11.0		23.5	16.0	16.0	20.5	17.3	18.0	19.0	13.0
1.0	0.5	1.0	0.8	0.5	1.5	1.3	0.8	1.5	1.3	0.8	1.5	taken	1.0	1.5	1.5	2.3	1.3	2.0	1.0	1.3
4.0	4.0	2.8	3.3	4.0	4.3	3.8	3.3	5.0	4.5	4.4	5.0		5.5	5.8	5.5	6.0	5.3	6.3	4.0	4.9
539.5	533.8	445.0	508.8	516.5	534.0	481.8	531.5	548.0	534.0	495.0	533.8		870.3	885.0	408.3	382.3	411.5	396.8	352.3	395.3
72%	74%	49%	54%	72%	79%	67%	59%	82%	75%	77%	83%		90%	91%	83%	95%	87%	88%	76%	82%

Pre-plant dress **Top-dress**

#1 $140 + $32

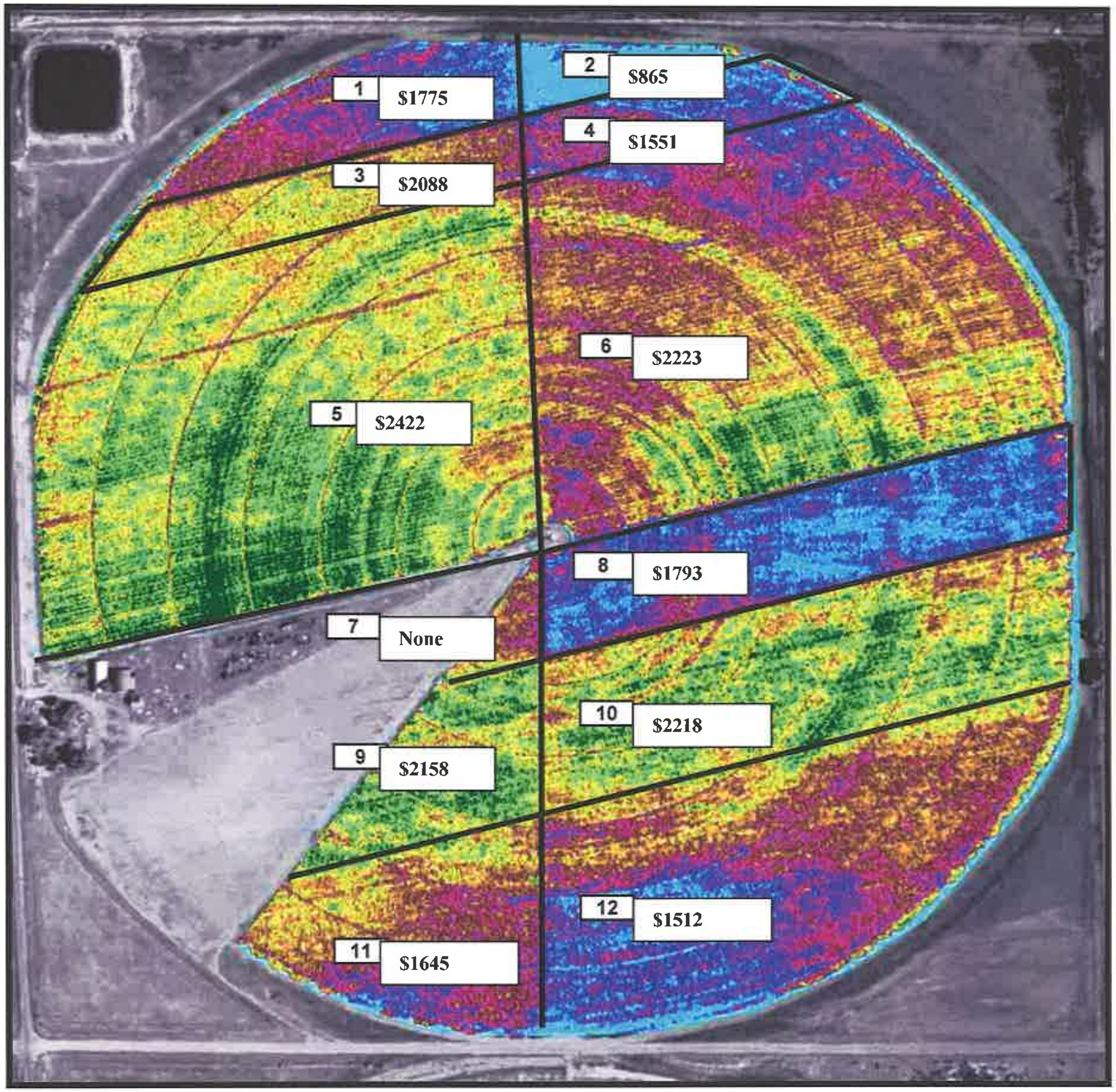
#3 $130 + $32

#5 $189 + $32

#7 $140 + $32

#9 $122 + $32

#11 $134 + $32



Pre-plant **Top-**

#2 $140 + $52

#4 $130 + $52

#6 $189 + $52

#8 $140 + $52

#10 $140 + $52

#12 $140 + $52

GRAIN DAY PROCEEDINGS

Wednesday, February 1

8:50 Conservation Conundrums, ***Richard Sparks, NRCS Area Specialist, Center, CO, and Merlin Dillon, Area Extension Agronomist, Center, CO.***

Conundrums in Conservation

By Merlin Dillon, Area Extension Agronomist, SLV Research Center
& Richard Sparks, USDA-NRCS Area Irrigation Specialist

Conundrums are contradictions in logic; the undesired conflicts in managing resources. Conundrums have always existed, and no matter how well intended they can result in benefiting one resource at the unacceptable cost of injuring another. Grower management practices are often at cross purposes with each other.

1) Irrigation Efficiency

Our SLV history reveals the conundrum of improving irrigation efficiency.

Improving efficiency has invariably facilitated an increase in acreage irrigated to its maximum potential. Was it not the improvement of irrigation efficiency that drove the conversion to border irrigation and *the increased acreage that came along with land leveling? (A conundrum!)* Was it not improvement of irrigation efficiency that drove the adoption of center pivot technology? *Look at the increased acreage it facilitated!* (A conundrum!)

It was a contradiction in logic to continually strive to be more efficient in our use of electrical power, labor, and irrigation water; yet, fail to recognize it made pumping groundwater so cost effective that we increased consumptime use (CU) beyond that which our groundwater could support.

Will our desire to now reduce consumptive use (CU) result in unintended damage to our soil resource through a decline in soil organic matter?

Practices whose purpose is to save water may in fact decrease soil organic matter (OM) and increase wind erosion. Reducing irrigation in our rotations results in less average crop biomass being produced. This can reduce soil OM and microbial biomass. It may also result in less crop residue on the surface to prevent soil blowing. We recognize that it may not be possible to meet desired water savings while maintaining desirable organic matter and microbial levels. No matter how well intended, these goals require management practices that interfere with each other.

2) Purpose of Barley in Rotation with Potatoes

A Conundrum: Potato growers rotate potatoes (low residue crop) with grain (high residue crop); then, bale off the grain straw.

- Baling the straw reduces the amount of crop residue returned to the soil.
- Returning less straw eventually reduces the soil organic matter level.
- Residue can be managed with modern conservation tillage equipment.
- Income gained by selling the straw may only pay for the nutrients removed that eventually must be replaced

Advantages of Soil Organic Matter

- Higher organic matter
- Improved soil health
- Reduced soil erosion
- Fuel savings
- Pesticide savings
- Fertilizer savings
- Reduced water quality impacts
- Improved potato quality and yield

This list includes most of the advantages for growers to increase or maintain high soil organic matter. Soils that have eroded have less clay and less organic matter and this tends to increase their tendency to suffer even more wind erosion. One goal of the potato/barley or potato/wheat rotation is to use the grain crop to help maintain the soil organic matter.

What can be done? Return all crop residues to the soil in potato grain rotations. Apply composts as much as practical.

Advantages of Green Manure Crops

- Reduce water use if grown judiciously.
- Can reduce potato pests. Local research has shown a definite reduction in Columbia Root Knot nematode after growing sorghum-sudan var. Sordan 79 for green manure. Verticillium is another pathogen that can be reduced too.
- Soil cover is provided during crop growth. And, crop residue could be left on the surface after the green manure crop. While moldboard incorporation leaves no surface crop residue, non inversion implements (chisel plows, discs, dynadrives, etc) could both incorporate the residue and leave some surface crop residue to protect the soil until the next crop.
- Green manure crops improve soil health by providing food sources for microorganisms in the soil.
- Rye or sorghum-sudan green manure crops can be grazed or harvested for hay. This does, however, reduce the amount of crop residue turned into the soil and will reduce OM.

What can be done? Lengthen the crop rotation by planting winter wheat after early potatoes and then green manure crop the following spring. Plant potatoes into the mulch tilled green manure crop. Or a grower might plant winter rye as a winter cover crop after the fragile residue green manure crop and go to potatoes the next spring.

3. Conundrum: Potato growers grow non-contract barley for negative net income.

- A green manure crop could be grown with less water and fewer crop inputs. The crop income is still negative but maybe not much less than the cash crop (barley).
- When the potato crop net income is calculated; it may be more profitable to grow a green manure crop than to grow a cash crop (see budget below).
- “Potato Production Systems” by University of Idaho Extension shows an increase in net income with the green manure included in rotation with potatoes. The example is a potential benefit of $260 per acre.
- A green manure crop can be grown with less water, estimated at 50% less than barley.

- Growers must plan for soil conservation before the green manure crop is planted and after the crop is incorporated.

4. Conundrum: Growers are asked to save water. Growers may unwittingly choose a practice that saves water (a renewable resource) but does not protect the soil (a nonrenewable resource).

- The choices are 1) Green manure crop, 2) Fallow irrigated land or 3) choose a crop that uses less water.
- Fallow costs very little and uses the least water. No crop is produced and the soil is not protected. Controlling weeds with cultivation further destroys organic matter.
- Green manure crops use few inputs, use less water than cash crops and could still provide cover to protect the soil.
- Growers may choose a crop that uses less water. Wheat is later maturing and requires a few more irrigations than barley. Even more savings can be made by replacing alfalfa acreage with another crop. Wheat and alfalfa, however, tend to improve soil organic matter more than barley.
- Growers may choose management practices that sacrifice soil to save water. **Water is eventually renewable; soil is not renewable.**

5. Conundrum: Growers are encouraged to keep the soil covered. This is the best overall soil conservation practice. How many months is the soil unprotected?

1. Potato/Grain Rotation (moldboard plow) 24 month rotation
   - Potato harvest to grain emergence --- 7 months
   - Grain harvest to potato cover --- 9.5 months

   TOTAL 16.5 MONTHS

2. Potato/Grain Rotation (barley & conservation tillage) 24 month rotation
   - Potato harvest to spring grain emergence --- 7 months
   - Barley harvest to potato ground cover --- 0 months
   - TOTAL 7 MONTHS

3. Potato/Grain Rotation (winter wheat & conservation tillage) 24 month rotation
   - Potato harvest to grain emergence (winter wheat) --- 1 month
   - Winter wheat after potatoes and disk / chisel plow wheat stubble --- 0 months
   - TOTAL 1 MONTHS

What can be done?

In order to keep the soil protected; consider these practices.........

1. **Plant winter wheat after potatoes (at least all early potatoes)**
2. **Plant winter rye after later harvested potatoes (and go to sorghum green manure next year?)**
3. **Grow these crops for hay, spring grazing, and green manure or for grain.**
4. **Soil cover needed prior to sorghum-sudan seeding in early June (High wind erosion period precedes sorghum planting).**
5. **Some kind of ground cover protection is needed prior to seeding canola in May.**
6. **Quit destroying protective residue by tilling under volunteer barley.**

Economics of Including Green Manure Crops in a Potato Rotation.

The following tables are from University of Idaho Extension "Potato Production Systems". Input costs for irrigation were increased from $1.30 to $14 per acre in both tables.

Table 6.1 is a summary of an enterprise budget that presents estimates of changes in production costs and income associated with including an oilseed radish green manure in a potato cropping system. This table is a compilation of the results of several trials and field demonstrations in Idaho that involved incorporating green manures into potato rotations. Table 6.2 summarizes the inputs and the annual costs of raising an oilseed radish green manure crop. Yellow mustard is usually seeded at 10 pounds per acre at a cost of $25 per acre, while barley seed costs are only about $10/acre.

For best results, growers need to treat green manures as a crop and not neglect them. Green manure crops need to produce enough biomass to produce optimum results.

Table 6.1 Costs and returns in a potato productions system with and without green manures. Adapted from University of Idaho enterprise budget EBB4-Pol-99. Southeast Idaho Russet Burbank No Storage.

	Conventional	Green Manure	
Gross Returns	$1485*	$1665*	
Irrigation	55.52	55.52	
Custom App.	57.05	57.05	
Fertilizer	**147.00**	**79.00**	
GM Costs	**0**	**90.07**	
Other Input Costs	69.00	69.00	
Potato Seed	151.00	151.00	
Pesticides	**292.00**	**162.00****	**No Fumigation**
Labor, fuel, etc	207.00	207.00	
Total Operating	**$979**	**$871**	

Now, what other options should you consider to reduce consumptive use?

- Plant a portion of your cropland acreage to drought tolerant introduced or native grasses that will go into dormancy and survive no irrigation during the summer months.
- After three to four years, rotate this acreage back into intensively managed crops and rotate other cropland acreage into native drought resistant grasses.

Concentrating consumptive use reduction on one field can allow more intensive rotations with high residue crops on more productive fields. For example, if you have one pivot that has severe nematode or pink rot problems, plant the entire field to a three or four year stand of drought tolerant grasses such as pubescent wheatgrass. Discontinue irrigation in dry years. In wetter years, irrigate enough for one cutting of grass hay in June, and discontinue irrigations until fall.

Benefits:

1. Set Aside fields will not lose as much organic matter since no tillage will be occurring.
2. Fields that have no pathogen problems can continue to be cropped intensively, and be managed to sequester carbon and build organic matter by including barley or winter wheat and returning all crop residues with mulch tillage practices.

3. Average soil losses will be less on your entire farm since set aside fields will have full cover.
4. Wells will still be used annually, not abandoned. Any discontinued pumping will be temporary.

Consider "Crane Grain"

- Leave stubble after grain harvest untilled and unchopped until March for sand hill cranes spring forage.
- After use by cranes, mulch till and plant to potatoes, canola, or alfalfa.
- Or plant spring barley, irrigate through May, and then discontinue all irrigation.

Keep in mind, biomass produced will be very low, compared with normal grain years.

What can be done on Alfalfa Acreage to Reduce Consumptive Use

- Plant your fall plowed out alfalfa acreage into winter triticale and bale in June.
- Do not irrigate or disc the stubble.
- Control volunteer weeds brought on by summer rains with herbicides.
- Drill new alfalfa in stubble the following May.

NOTES

9:40 Nitrogen Management for Hard Wheat Protein Enhancement, ***Brad Brown, Extension Crop Management Specialist, Parma, Idaho.***

NITROGEN MANAGEMENT FOR HARD WHEAT PROTEIN ENHANCEMENT

Brad Brown, University of Idaho

INTRODUCTION

High protein is desirable for hard wheat market classes as it is associated with greater kernel hardness, gluten strength and loaf volume. High protein hard wheat is frequently marketed at a premium to lower protein wheat. The premium (or avoided discount) may represent as much as 50% or more of the market price in low price years. Avoiding the discounts below 14% is more critical than gaining the premium above 14%. Discounts per bushel can be as much as three times the premium.

While some low rain-fed hard wheat production is typically high protein, highly productive wheat in high rainfall or irrigated systems is typically lower in protein, unless producers effectively manage N for enhancing protein. Even then, intensive N management can fail to produce the desired protein. Failure to produce high protein wheat despite greater expenditures of resources frustrates irrigated producers throughout the west, especially furrow irrigated producers. There would be greater irrigated acreage of HRS were it not for grower concerns about producing HRS with acceptable protein. Understanding the issues related to wheat protein is critical for growers to avoid or minimize low protein discounts and maximize their economic returns.

Nitrogen (N) is critical for protein synthesis as N is part of the basic structure of amino acids. Providing adequate N is arguably the most important management factor for producing irrigated high protein hard wheat. Variety selection, water management, weed and insect control, and other crop management practices all impact protein in harvested wheat. But failure to understand the importance of N, its relation to both yield and protein, and its proper management for enhancing protein is typically the reason for low protein discounts and grower frustration. Effective N management throughout the season is critical for producing high protein high quality hard wheat.

WHEAT UTILIZATION OF NITROGEN

Wheat roots take up N in both the nitrate (NO_3-N) and ammonium (NH_4-N) forms. Under field conditions both forms are generally available, though NO_3-N generally predominates. Wheat uptake of N depends on the wheat's growth stage and the available N. The N accumulated in the wheat during vegetative growth follows a sigmoidal pattern (Fig. 1). It occurs slowly during early stages of plant establishment and tillering, proceeds most rapidly during stem extension and heading, and slows as the reproductive stage begins. The uptake and accumulation of N in the wheat plant precedes the production of biomass during vegetative growth. Maximum daily N uptake by wheat can approach 2.5-3.0 lb/day under favorable conditions. Whereas most N uptake occurs prior to flowering, some N can be taken up during the grain filling process.

The N accumulated by the plant through early and mid vegetative growth stages is used effectively for increasing yield potential. Yield potential is increased initially with available N by increasing tillers. The number of seed bearing tillers is typically the greatest single yield component affecting yield. Yield is also increased by increasing the number of seeds per head. The N uptake during and after late vegetative growth (heading) is used less effectively for increasing yield because by then yield potential has largely been determined. Late season available N influences protein more than yield.

After flowering, nutrients, including N, and energy compounds or carbohydrates are translocated from older plant tissues (stems, leaves, awns) to developing kernels where they are used to support cell division and expansion, and then the synthesis of storage proteins and starch. Plant N reserves at flowering may constitute all that is required for maximizing yield. In contrast, carbohydrates in the plant at flowering represent a smaller fraction of the total harvested with the grain. Nitrogen translocation to developing kernels and the synthesis of storage proteins occurs more rapidly than the accumulation of storage carbohydrates (starch) in kernels. Grain protein at harvest largely depends on the degree to which starch accumulates and dilutes the protein already present. Seasons with adequate moisture and cooler temperatures after flowering favor more extended grain filling, greater starch accumulation, greater dilution of the protein present and lower grain protein concentrations. Conversely, moisture stress and/or higher temperatures result in shorter grain filling periods, reduced photosynthesis, lower starch contents, and less diluted or higher grain protein concentrations. Late season stress reduces starch accumulation much more than protein accumulation in the developing kernel.

There is some indication that N can be lost from wheat leaves by volatilization. Research studies have reported instances of less N in the plant at maturity than at flowering. Volatile N losses are not well understood but generally occur when excess N is available to the plant. Volatile losses of N reduce plant N otherwise available for protein synthesis in the kernel.

YIELD, PROTEIN AND MOISTURE RELATIONSHIPS

The inverse relation of yield and grain protein is well known in rain-fed production systems, but also occurs in irrigated systems that are not limited in yield by either available N or moisture. Yield can fluctuate in these systems from crop management practices or environmental conditions other than available moisture or N. Higher yields due to more optimum planting dates, variety selection, alleviating other nutrient shortages, and cooler temperatures during grain fill can reduce grain protein. It occurs when either the number of kernels is increased (greater tillering) relative to the plant N reserves or individual kernel size is increased from better grain filling and greater starch content (protein dilution).

A common perception is that moisture stress during late grain filling is necessary to increase protein to acceptable levels. In southern Idaho studies, 14% protein was gained without inducing the stress (and sacrificing yield) if adequate late season N was effectively incorporated at heading. It should not be necessary to sacrifice yield for acceptable protein. In fact, maintaining soil moisture during grain fill, so wheat roots could continue to access soil N, increased protein in some years. Stressing wheat may not only reduce yield, it may also limit access to soil N otherwise available for protein enhancement.

Some have wondered if excessive late season overhead moisture can reduce protein at harvest. In southern Idaho late season sprinkler irrigation studies, protein was unaffected by watering later than necessary for maximizing yield.

SATISFYING THE N REQUIREMENTS FOR YIELD

Failure to reach acceptable protein (14% for HRSW) is commonly due to under estimating the N required for maximizing yield. The N required to maximize yield depends largely on the production system. Irrigated wheat may require as little as 1.6 to 1.8 lbs of total available N (residual soil N, mineralized N and applied fertilizer N) for each bushel. Typically, the more productive the system (the fewer the limitations to yield), the greater the N use efficiency, and the less N required per bushel to maximize yield. Still, to realize the high yield potential of modern varieties requires that sufficient N be available. Many producers may not provide enough N for irrigated wheat, especially if wheat is considered merely a rotation crop to be managed less intensively.

Without knowing the residual N available, it's difficult to know how much more N is needed to satisfy the N required for yield, much less the N required for raising protein to acceptable levels. Effective N management starts with a representative soil sample and the measurement of residual N available. Most all states have fertilizer guides for estimating wheat N requirements for yield. Fertilization practices that increase the effectiveness of applied N also serve to maximize protein.

NITROGEN AND WHEAT PROTEIN

Wheat protein at harvest can be both increased or reduced with increased available N during vegetative growth, depending on how N deficient the plant is (Fig. 2). When extremely N deficient, wheat responds to the first increments of added N by increasing seed number (mainly increasing seed bearing tillers) moreso than increasing the capacity of each seed to survive with higher protein. Although total grain protein N per acre at harvest increases, the grain protein concentration can decrease. When available N no longer limits the number of seeds or the biomass to support their development, an increasing proportion of the additional N is allocated to kernels, and grain protein concentration increases.

Lower than desirable protein at harvest occurs even when both yield and protein increase with N, because protein concentrations associated with the minimum N required to maximize yield are generally too low for avoiding low protein discounts. Producers increasing yield and simultaneously increasing protein from 11 to 13% are still woefully short of the 14% necessary for avoiding discounts. Maximum yield is associated with about 12.5% protein in HRS, about 11.5% in HRW and HWS wheat. Protein concentrations beyond these may improve hard wheat quality but generally are not required for maximizing yield. Protein concentrations well above the minimum required for yield may be associated with reduced yields.

A case study involving irrigated HRS production in central OR provides examples of protein both increasing and decreasing with higher yield (Fig. 3). Protein increased as yield increased for all sites where protein was less than 12.5%, suggesting that available N at these sites was not adequate for maximizing yield. In contrast, protein declined as yield increased at sites where protein exceeded 12.5%, suggesting N was adequate for maximizing yield but yield increased for other reasons.

Only when most of the N required for yield has been supplied will further N additions raise protein in the developing grain. At this point, the protein increase is often directly related to the amount of N available. This phase of linear protein increase with additional N continues well beyond the point where yield is maximized and generally to protein levels of 14% in HRS. Above 14%, the protein increase with increased N is reduced to the point where it may not be measurable, or economically significant.

Producers accustomed to fertilizing primarily for yield may not appreciate the extra N required for maximizing production of wheat with acceptable protein. Separate irrigated grower field surveys in central OR and western Idaho in 1999 found the average fertilizer N associated with 14% protein HRS to be 2.2-2.3 lbs per bushel. Research and case studies in irrigated HRS indicate the total available N (fertilizer, residual, and mineralized N) required to produce grain with acceptable protein (14%) may be upwards of 2.8 to 3.2 lb N per bushel, considerably higher than the 1.6 to 2.0 lb N/bu required for simply maximizing yield.

The additional fertilizer N required for acceptable protein can be considerable. If the additional N requirement is only 0.5 lb N/bu (2.3 -1.8 lb N/bu), it translates into 50 lb additional N/A for a 100 bu/A yield, and 75 lb N/A for 150 bu/A wheat. The additional N required is directly related to the production level. Few producers increase their late N fertilization rates by this amount for their HRS production.

Producers frequently ask whether sulfur (S) is needed to enhance grain protein. Sulfur apparently is more limiting for yield than it is protein. Providing adequate S earlier in the season for yield should not limit the protein increase to late season N. In some cases, pre-plant applied S can cause sufficient yield increase that grain protein without additional N is actually reduced.

LATE SEASON N FOR INCREASING PROTEIN

Many realize that more N is required for maximizing yield of wheat with acceptable protein. However, providing all the extra N during early vegetative growth can reduce yield from lodging, possibly other reasons. Applying N between the boot and flowering growth stages is a common practice for increasing HRS protein. If late season N is used by the plant to increase yield, the yield increase normally comes at the expense of the protein increase. Protein less than 14% following late season N suggests that more late N was required than was made available to the wheat for the conditions present.

A number of factors can influence the protein response to late season N. The most obvious factor governing the protein increase is the rate of late season N used. The protein increase from late season applied N is generally directly related to the rate applied, at least for protein raised to 14%. Increasing protein beyond 14% with applied N can be more difficult as protein may increase less with each unit of N applied. There may be an upper limit to how much N can be late season applied in one application for increasing protein. As much as 75 lb N/A were applied without adversely affecting yield in one three year study, but 80 lb N/A increased lodging and reduced yield in some years in a later study.

The amount of late season N required for increasing protein is in part a function of yield. For example, the total protein N difference for 40 bu/A wheat at 13 and 15% protein is only about 7.5 lb/A, but 22.5 lb protein N/A for 120 bushel wheat. The protein N in 40 bu wheat is about 50 lb/A, but is 150 lb/A for 120 bu wheat. The higher the yield, the more N required to change protein. Failure to reach 14% protein in HRS can result from too little N applied for the yield involved.

Late season N is most conveniently applied through sprinkler systems with injection units, or applied dry and then watered in with the sprinklers. Applying N through the lines reduces application costs, assures adequate N incorporation for root uptake, and allows higher N rates to be used than can be used with concentrated foliar sprays.

Providing late season N without sprinklers is more challenging. Concentrated foliar sprays at similar N rates are as effective as sprinkler applied N for increasing protein. But there is a limit on how much foliar N can be applied without burning leaves. Appreciable burning of the upper leaves of wheat can reduce yield, as these leaves are critical for providing photosynthates or starch for the developing seed. Yield can be reduced with as little as 30 lb N/A applied as a foliar treatment depending on the fertilizer used. Solution 32, or Uran, typically causes more leaf burn and reduced yield than comparable amounts of soluble urea N applied in the same manner. The two N sources did not differ in the protein that resulted from their application in three years of testing at Parma.

Under furrow irrigation, top-dressed dry N fertilizers can be less effective applications because they depend primarily on infrequent rainfall to move the N deep enough to be taken up by roots. Subsequent furrow irrigation not only fails to adequately incorporate topdressed N, it may exacerbate volatile losses of surface applied ammonium N fertilizers such as urea. Water running the N may be effective, but the uniformity of the application is limited by the uniformity of the water application.

Wheat protein can increase whenever additional N, regardless of source, is available to the plant during grain filling. Available N at deeper soil depths, or mineralized within the root zone will promote higher grain protein, provided there is root activity at those depths. Soils depleted of moisture have little root activity and N positioned in dry soils is largely unavailable to the plant. Confined animal feeding operations can provide manures for wheat production. Manuring can increase N mineralization, providing significant N during the last month of wheat growth for wheat protein enhancement.

Some have questioned whether the protein increase from late season N actually results in any improvement in bread baking quality. Bread baking results from several southern Idaho studies consistently indicate that protein increased to 14% or more from late season N results in larger loaf volumes. The only occasion when increasing protein with late N did not consistently increase bread making quality was when protein was already high (at or above 15% protein).

Planting dates and varieties have appreciable effects on grain yield and protein. At Parma, planting dates and varieties representing different market classes (HRS and HWS) affected protein in each of three years. But there was no effect of planting dates or varieties on the protein increase from late season N (Fig. 4). Protein increased about 0.3% for each 20 lb N/A applied at heading. Commonly grown varieties are frequently used primarily for their yield potential. Some varieties are higher in protein even at comparable yield levels. Higher protein varieties require less late season N to reach acceptable protein.

PREDICTING PROTEIN FROM PLANT ANALYSIS

Several wheat tissues at various growth stages have been evaluated for estimating grain protein at harvest. Flag leaf total N % (FLN) at heading or flowering is the most closely related to grain protein. Most of the N to be taken up by wheat is in the plant by this point. FLN is directly related to the N in the plant that can be translocated to the developing grain.

The flag leaf is the upper most leaf of the stem prior to heading. FLN concentrations of 4.2% were associated with 14% protein in HRS wheat in irrigated Idaho and Montana studies conducted for three years. The protein increase from late season N was greater the lower the FLN. If FLN was above 4.5% there was little protein increase from 20 or 40 lb/A of late season N. This research indicated that 40 lb/A of late season N was not adequate for increasing protein to 14% when FLN was only 3.0%.

It is critical to collect flag leaves as close to heading as possible, or to document the growth stage that samples are collected. FLN decreases as the plant develops, unless additional N is provided. It may be possible to collect flag leaves prior to heading and as late as flowering, but the critical FLN values necessary for acceptable protein are higher when sampled before heading and much lower when sampled after heading. Sampling earlier than heading provides additional time for the analysis and for N to be applied and incorporated. Unfortunately, FLN levels at full flag leaf emergence associated with 14% protein are less well documented than at heading. From our limited sampling, critical FLN will be 0.2 to 0.5% total N higher at full flag leaf emergence than at heading.

FLN is a reasonable approach for predicting late season N requirements. It is not fail proof. FLN is an index of plant N status at heading or flowering. Subsequent conditions during grain filling will ultimately dictate harvest wheat protein.

Non-destructive plant testing using Chlorophyll meters or Spectral reflectance have been evaluated for predicting grain protein. This technology has potential for providing immediate in-the-field estimates of N needs. They have proved more useful for predicting yield than they have for predicting protein above that associated with maximum yields (above 12.5% for HRS).

SUMMARY

Successful irrigated hard wheat production and marketing depends on avoiding low protein discounts. Effective N management throughout the season is essential for assuring both adequate production and high protein. Applying only enough N for maximizing yield will not be sufficient for producing wheat with acceptable protein. Incorporated late season N in particular may be essential for many producers to avoid low protein discounts. Flag leaf total N can be useful for predicting whether additional N is required for high protein, but subsequent conditions during grain fill also influence wheat protein.

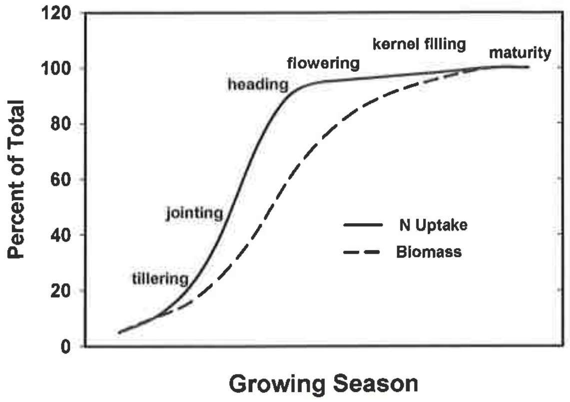


Figure 1. Wheat biomass and N accumulation during the growing season.

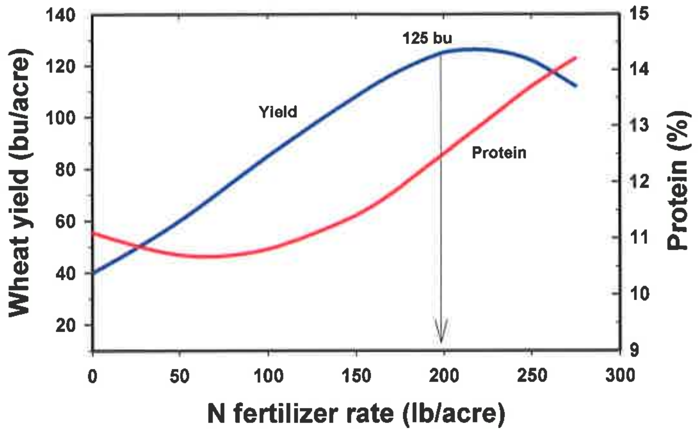


Figure 2. Yield and protein as affected by fertilizer N added to N deficient wheat.

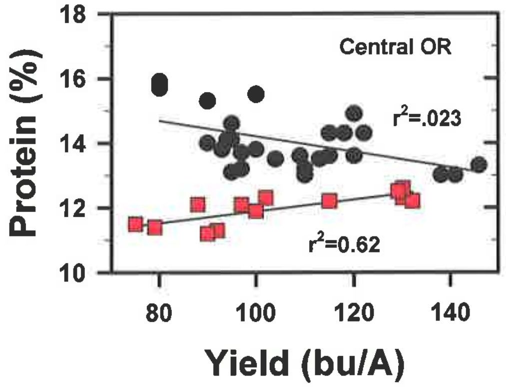


Figure 3. Yield and protein relations within specific protein ranges in Central OR.

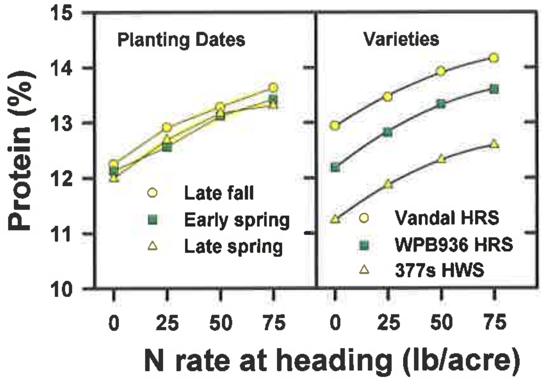


Figure 4. Protein as affected by planting date, variety and late season N.

3:00 Potential On-Farm Biodiesel Production,
Ravi Maholtra, ICAST, Boulder, CO.

BIODIESEL PRODUCTION FOR FARMERS IN COLORADO A FEASIBILITY STUDY

Rising energy costs threaten the survival of traditional farms and rural communities because energy is a primary component of all aspects of modern farming. Farmers cannot pass on these cost increases to consumers because external market drivers dictate agricultural commodity prices. Diesel is one of the primary energy sources on the modern farm, with some farmers consuming as much as 100,000 gallons/year.

ICAST evaluated the feasibility of biodiesel production from four different crops (sunflower, mustard, canola and soybeans) for three production capacities (10,000 gallons, 100,000 gallons, and 1,000,000 gallons per year). These scales correspond approximately to the fuel demand of an individual farmer, a small group of farmers, or a rural farming community.

While it is technically feasible for farmers to produce biodiesel at any scale, the economic viability varies with the scale of operation. We analyzed costs and revenues from growing and harvesting crops, cleaning and storing the seed, crushing and extracting the vegetable oil and meal cake, and finally, converting the vegetable oil into biodiesel and the meal cake into animal feed, bio-energy or pesticide. We concluded that the economic viability is highly sensitive to the price paid for seeds and petro-diesel. Also, having access to markets for the meal cake is crucial for profitability.

At the smaller scale, profitability is dependent on farmers having access to existing infrastructure and labor, i.e. seed storage capacity, space for seed-crushing and biodiesel production, and a willingness to operate their own facility. At the smaller scale, only low-tech equipment is affordable and the sole beneficiary is the farmer. Volume efficiencies allow larger scale operations to provide better product quality because it can afford trained operators and high-tech equipment to refine biodiesel. It also provides more options to extract value from waste streams. Acquiring government subsidies is more cost effective for a larger scale blending operation.

We recommend developing a community scale operation that can, under favorable market conditions, provide the community with new jobs, pay for new infrastructure and pump real dollars into the local economy. The production capacity is driven by local demand for biodiesel and access to meal cake markets. Smaller scale biodiesel operations tied to a larger facility can also be viable. Becoming a supplier of veg. oil and value-added meal products is another option.
Oil seed crops can provide a sustainable solution that improves soil conditions, reduces water needs and improves air quality. Community scale biodiesel operations can improve small farm profitability, strengthen rural communities and provide a renewable source of energy.

Steps to Biodiesel Production

Seed cultivation

Planting appropriate crops → Harvest seed

Seed processing

Seed Cleaning → Storage → Crushing → Meal & Oil

→ Meal → Processing → Markets

→ Veg. Oil → Refining → Markets or Biodiesel process

Biodiesel production

Transesterification → Cleaning → Blending → Markets

Crop Selection

- Crop Yield and Farming Costs
  - Primary drivers of biodiesel economics
    1. Opportunity to optimize crop yields and management practices
- Canola
  - Most promising crop for SLV
- Sunflower
  - Holds promise
  - Oil wholesale value is currently high (~ $4.00/gal)
- Mustard
  - Current yields are low
  - Needs a market for its meal
- Soybean
  - Appropriate seed variety needed

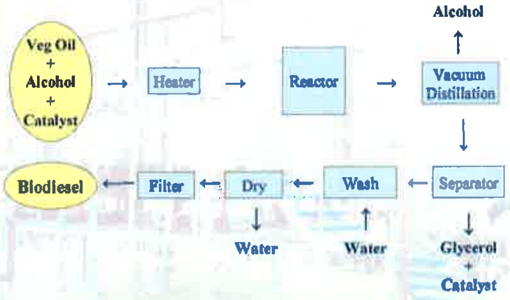
Seed Crushing

- **Chemical extraction**
  - Not economically viable at small scale
  - Hexane extraction: too hazardous and tech intensive
- **Mechanical extraction**
  - Less yields than chemical extraction
  - Simple, reliable, affordable and safe
  - Residual oil in meal provides higher value as feed
  - Equipment costs vary by capacity & manufacturer
    1. $2,000 for small-scale imported
    2. $200,000 for large-scale installed

Meal Products

- **Biodiesel economics depend on value of meal**
  - New meal markets need to be developed
- **Meal market opportunities**
  1. Animal feed (Soybean, sunflower & canola)
     - High protein + residual oil → higher value
     - Meal Cake or Pellets
  2. Soil conditioning (Mustard)
     - Organic fungicide, herbicide, insecticide
  3. Pellets for bio-energy
     - Low-value product

Biodiesel Production Process



Veg Oil + Alcohol + Catalyst → Heater → Reactor → Vacuum Distillation → Alcohol

Vacuum Distillation → Separator → Glycerol + Catalyst

Separator → Wash → Dry → Filter → Biodiesel

Water → Wash

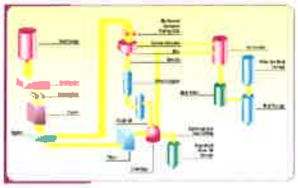
Dry → Water

Equipment List
1 million Gallons/Year

- Storage
  - Seed: **27,000 tons (900,000 bu)** Soybeans; **13,000 tons (900,000 bu)** Sunflower, **14,000 tons (55,000 bu)** Canola, Mustard (annual production)
  - Meal: **470 tons** Soybeans; **200 tons** Sunflower, Canola, Mustard (one week prod)
  - Oil: **25,000 gallons** (one week production)
  - Biodiesel: **25,000 gallons** (one week production)
- Crushing capacity
  - **100 tons/day** Soybeans; **50 tons/day** Sunflower. Canola, Mustard
- Biodiesel Production
  - Reactor capacity: **1500 gallons**
  - Batch size: **1100 gallons**
  - Batches per day: **3**

1 Million gallons of Biodiesel per year

Selling Glycerol+Cake+ Biodiesel + Incentives	Sunflower	Rapeseed / Canola	Soybeans	Brown Mustard
Total Revenues (Yr 1)	$3,915,833	$4,113,436	$6,104,789	$4,046,182
Total Costs (Yr 1)	$3,818,504	$3,836,554	$5,971,883	$4,029,957
Net	$97,329	$276,882	$132,906	$16,225



NPV - Canola at 1 Million gallons/yr

INPUT DATA	
Price of seed paid to farmer ($/lb)	$0.115
Price of seed to storage Co. ($/lb)	$0.138
Diesel price ($/gal)	$2
Interest rate	8%
Yrs. Loan Payment	10
Tax Rate	35%
Debt Ratio	0.8

NPV - Canola at 1 Million gallons/yr

OUTPUT SUMMARY	
Total acres planted	7,855
Capital Expenses	$1,600,000
Labor Expenses	$262,500
Price of seed for biodiesel ($/lb)	$0.142
Total Cost of seed for biodiesel	$2,781,804
NPV	$507,342
IRR	15%

Sensitivity to NPV
Canola at 1 Million gallons/yr

Assumptions	Contribution To Variance	Rank Correlation
Diesel price ($/gal)	73.70%	83.34%
Cost of Seed ($/lb.)	23.07%	-46.62%
Interest rate	1.90%	-13.39%
Equipment	0.89%	-9.18%
Labor	0.32%	-5.49%

Conclusions

- ☐ Technically feasible to make biodiesel at any scale
  - ➢ Requires similar equipment, operator and raw materials
- ☐ Economic viability varies with scale of operation
  - ➢ Highly sensitive to value of oilseeds & petro-diesel
  - ➢ Access to markets for the meal cake is crucial
- ☐ At the smaller scales profitability is:
  - ➢ Highly sensitive to cost of infrastructure and labor
    1. Access to existing seed storage and facility
    2. Ability & willingness to operate facility
    3. Low-tech equipment is affordable
    4. Diminished ability to extract value from waste streams
  - ➢ Acquiring government subsidies is costlier
  - ➢ Sole beneficiary is individual farmer

CAST

Recommendations

- ☐ Establish a seed storage and crushing facility
  - Wholesale veg. oil
  - Meal cake converted into feed pellets, pesticide, etc.
- ☐ Community scale biodiesel operation
  - Capacity driven by:
    1. Local demand for biodiesel
    2. Access to meal cake markets
  - Local Economic Development
    1. New Jobs
    2. New Infrastructure
  - Smaller scale biodiesel operations tied to the larger facility

CAST

Biodiesel Benefits

- ✓ Improve small farm profitability
  - Control rising fuel costs
  - Value-added market for oil seeds and animal fats
  - Can reduce water consumption
  - Can reduce need for chemicals and fertilizers
  - Can make producers diesel fuel independent
- ✓ Strengthen rural communities
  - Local Economic Development
    1. Direct and In-Direct Job Creation
    2. Money circulates locally
  - Minnesota has 2% mandated
- ✓ Provide a renewable and environmentally friendly source of energy
  - Excellent lubricating properties, even at B2 blends
- ✓ Decrease dependence on imported petroleum

CAST

Bio-Diesel: Statistics

- ☐ Total US farm usage = 3.1 billion gallons/yr
  - All the oil seeds currently produced in the U.S.
  - Approx. 10-15% of total productive land area
- ☐ US On-Road diesel fuel use
  - Entire world production of oil seeds
- ☐ **Bio-Diesel cannot be grown in surplus**
  - **The Market Exists – Issue is:**
    - **Access to markets**
    - **Economics**

CAST

NPV - Canola at 1 Million gallons/yr

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CAST

Sensitivity to NPV

Canola at 1 Million gallons/yr

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Diesel price ($/gal)	73.70%	83.34%
Cost of Seed ($/lb.)	23.07%	-46.62%
Interest rate	1.80%	-13.39%
Equipment	0.89%	-9.18%
Labor	0.32%	-5.49%

CAST

NPV - Canola at 1 Million gallons/yr

OUTPUT SUMMARY	
Total acres planted	7,552
Total Annual Revenues	$4,113,436
Total Annual Costs, Incl. seed	$3,510,023
Total Annual Profit	$326,997
Capital Expenses	$1,000,000
NPV	$550,165
IRR	18%

2:40 Managing Alfalfa with Jr. Water Rights,
Richard Sparks, USDA-NRCS, Area Conservationist,Center, CO.

Managing Alfalfa with Jr. Water Rights

Richard Sparks, Area Irrigation Specialist, NRCS

Growers with limited water are facing an increasingly difficult situation maintaining alfalfa stands. In previous decades, high sub characterized these areas and was critical in the establishment of new stands of alfalfa. In drought years, little or no water was received, but deeper rooted stands survived. With the recent decline in water tables, many stands have failed. Reestablishing these stands is proving to be very difficult.

Delivery of irrigation water to the fields has been greatly diminished by seepage losses in the main ditches. Fewer days of water can be delivered to the fields, and the rate of flow is diminished. Flow rates have diminished until established border widths are much too wide for flows to go through in a timely manner.

What Can Be Done to Help?

1. Decrease border widths!

If a grower has a field that still has a healthy alfalfa stand, border widths should be cut in half or less. Keep all the available water concentrated into one border, and change the water in four hours or less.

For example, a 48 ft border width on a land leveled loam soil ideally should have 2 cfs of water applied and go through in 4 hours. That would require 4 six inch siphon tubes. If the flow rate has fallen off, and only 1.5 cfs is typically available, the border widths would have to be reduced to approximately 24 feet wide so 2 six tubes will continue to go through in 4 hours.

*** One tube for every swather width on loamy soils.**
*** Two tubes per swather width for a gravelly soil or a sandier soil.**
*** On clay loam soils, one tube will take care of two swather widths.**

2. Increase Irrigation Frequency!

In high water table years, the deep percolation loss below the root zone in the field would build the sub even higher and alfalfa would do well even if it were three weeks to a month before the next irrigation could be applied. Today that same seepage loss cannot effectively raise the water table in most areas enough to benefit alfalfa so return irrigations must be in two to three weeks to keep alfalfa from wilting.

3. Establishing Alfalfa **(Always take care of what you've got before you decide to plow out and re-establish new stands of alfalfa)**

Take advantage of the new seedbed and correct the direction of irrigation and reduce border widths to as narrow as possible. For example, go to 12 or 16 foot borders to match your windrower on coarser textured (sandy loam) soils if your flow rates are less than 3 cfs or 1500 gallons per minute.

Also, in poor water years, delay alfalfa seeding, and plant oats for hay instead.

4. Establish Smaller Acreages!

Forget establishing the 40 and 80 acre fields. Cut the size down to 10 or 20 acres, and irrigate more frequently. In poor water years like this one, consider growing a year or two of oats for hay to clean up annual and perennial weeds, and to reduce the toxic effect of decomposing alfalfa. ***Again, you are better off to delay seeding new alfalfa until you have a better water year***.

5. Select Alfalfa Varieties Carefully.

Use deeper rooted alfalfas (***Ladak***) or low dormancy alfalfas (***Spreader or Maverick***). These may be lower producing, but will be longer lived. Establishing is not as simple as in the pivot fields that are seeded to three cutting, low dormancy alfalfas that may not live as long.

6. Mix Grass with the alfalfa.

Seed smooth brome and intermediate or pubescent wheatgrass with the lower dormancy alfalfas. Graze in early spring and take only one cutting later in the year. Fall graze the regrowth, but avoid winter damage that may result when grazed too hard.

7. Drill the new grass and alfalfa approximately 1/2 inch in depth.

Deeper seeding depth will be an advantage, so avoid broadcasting alfalfa seed. Also, pre-irrigate the field in May before drilling the new stand. Irrigate after drilling, and come back with the next irrigation a week later. This is critically important for successful alfalfa germination and emergence.

Growers with limited water are facing an increasingly difficult situation maintaining alfalfa stands. In previous decades, high sub characterized these areas and was critical in the establishment of new stands of alfalfa. In drought years, little or no water was received, but deeper rooted stands survived. With the recent decline in water tables, many stands have failed. Reestablishing these stands is proving to be very difficult.

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